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Adoption Pattern and Marketing Channels of Rose Cut Flower Growers

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ABSTRACT

The present study was carried in Anekal taluk of Bangalore Urban district of Karnataka state during 2020-21 to know the extent of adoption of recommended cultivation practices by flower growers and to identify the marketing channels of flower growers. Sixty flower growers were interviewed using a pre-tested interview schedule. Ex-post facto research design was employed for the present study. The results revealed that a majority of flower growers (51.67%) were having high overall adoption of recommended cultivation practices, while one-fourth (25.0%) and 23.33 per cent of the flower growers were having medium and low overall adoption of recommended rose cultivation practices, respectively. Further it was found out that Channel I (Producers → Commission Agents→Retailers →Consumers) (Rank I) was most preferred marketing channel for marketing of rose cut flowers by the respondents followed by Channel II (Producers→Local Traders→Retailers →Consumers) (Rank II), Channel III (Producers→ IFAB → Retailers → Consumers) (Rank III) and Channel IV (Producers → Exporters→Retailers →Consumers) (Rank IV) in the order of importance.

Key Words: Adoption, Consumers, Extension activities, Flower growers, Marketing channels.

INTRODUCTION

Growing of cut-flowers is one of the significant industry catering the needs of the demand of corporate houses, hotels and restaurants *etc.,* in the world. Due to the entry of corporate, there is a significant development in the floriculture sector and the corporate are producing cut flowers in adequate quantity to fulfill the ever rising demand of floricultural products to various countries across the globe. The rose is one of the leading cut flowers in the global floriculture trade and used at almost every event in both local and international markets. Rose cut flowers in the country are mostly grown under cover in Nasik, Pune, Hosur, Kodaikanal, Kalimpong, Ooty, Darjeeling, Bangalore, Solan, Palampur, Shimla, Srinagar, Delhi, Ludhiana and Kolkatta. A good number of recommended cultivation practices are advocated by the farm scientists and horticulture extension functionaries to the rose cut flower growers for getting increased and sustained yield. However, it is found that there is slow adoption of the cultivation practices by the rose growers resulting in low yield (Sunilkumar, 2019). Hence, the present study is conducted to know the extent of adoption of recommended cultivation practices by rose cut flower growers and to identify the marketing channels.

MATERIALS AND METHODS

The study was carried out during 2020-2021 in Bangalore urban district purposively selected being the largest producer of roses in the Southern districts of Karnataka. Rose was cultivated in an area of 1082 ha in the district during the year. Out of the five taluks in the district, Anekal taluk was purposively selected since rose was cultivated in

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656 ha as compared to Bangalore East (257 ha), Yelahanka (132 ha), Bangalore South (26 ha) and Bangalore North (11 ha) taluks. Twelve villages were randomly selected in Anekal taluk for the study. Five rose growers were randomly selected in each of the 12 sampled villages. Thus, the total sample constituted 60 rose growers. Ex-post-facto technique was adopted for the study.

A set of 24 recommended cultivation practices were identified and score of three, two and one was given to the rose growers who had completely adopted, partially adopted and not adopted respectively for each of the cultivation practices. The minimum and maximum score one could get was 24 and 72, respectively. Further, the respondents were grouped into low, medium and high adoption based on mean (56.02) and half standard deviation (6.50).

Category	Criteria	Score
Low	< (Mean – ½ SD)	<52.77
Medium	(Mean ± ½ SD)	52.77-59.27
High	>(Mean + ½ SD)	>59.27

The respondents were asked to mention the marketing channels they preferred for selling the rose cut flowers and it is expressed in terms of frequency and percentage and ranks. Local traders, retailers, commission agents, exporters and International Flower Auction Board were the prevailing marketing channels for rose cut flowers in the study area.

RESULTS AND DISCUSSION

Adoption of specific recommended cultivation practices by rose cut flower growers

A perusal of data in Table 1 revealed that all the flower growers (100.0%) had grown rose in red soil as recommended, while 70.0 per cent had grown the recommended varieties (Tajmaha l (Red)/ Gold Strike Yellow)/ Nobles (Light Pink)/ Rock Star Orange) /Peach (Avalaunch). Eighty five per cent of the respondents had followed the recommended row spacing (35-40 cm), while three-fourth had followed the recommended plant spacing (16-17 cm) (75.0%). All the flower growers had used grafted plants (100%) for growing rose and a majority of flower growers (58.33%) had followed the recommended time of planting grafts (September to October months).

The research results pertaining to manures and fertilizers reveals that two-third of the flower growers had completely adopted the recommended quantity of farm yard manure/compost (62.5t) (63.33%) and top dressing of NPK (47.5:47.5:47.5) (66.66%). The basal dose of fertilizer (15:30:30) was not adopted by 26.66 per cent of the flower growers, while 25.0 per cent and less than half (48.33%) of the flower growers had partially and completely adopted the basal dose of fertilizer, respectively. One-tenth of the respondents (10.00%) had non adopted the micronutrients as recommended (50g $MnSO_4$+37.5g $MgSO_4$+25g $FeSO_4$+12g B), whereas 50.0 and 40.0 per cent of the flower growers had partially and completely adopted the recommended quantity of micronutrients to the rose crop. As high as 45.0 per cent of the respondents had not applied the recommended quantity of growth regulators (Giberlic acid (1.5-2ml/l) to the rose crop, while 36.64 and 18.33 per cent of the flower growers had partially and completely adopted the recommended quantity of growth regulators, respectively. All the rose cut flower growers (100.0%) had adopted drip method of irrigation to the rose crop.

In the case of intercultural operations, a majority of the flower growers had followed the recommended practices such as: bending technique (88.33%), wild shoot removal (91.66%). deshooting and disbudding (86.66%), and using yellow trap for attracting pests (53.33%). With respect to the plant protection measures for control of insect pests, it was found that 65.0 per cent of the flower growers had not adopted any control measure for controlling the white grub, while 21.66 and 13.33 per cent of the

Table 1. Adoption of recommended cultivation practices by rose cut flower grower. (n=60)

Sr. No.	Rose production technologies	Rose cut flower growers					
		Complete adoption		Partial adoption		Non adoption	
		No.	%	No.	%	No.	%
1.	Soil type (Red soil)	60	100.00	00	0.00	00	0.00
2.	Recommended rose varieties Tajmahal (Red)/ Gold Strike(Yellow) Nobles (Light Pink)/ Rock Star(Orange)/Peach (Avalaunch)	42	70.00	00	0.00	18	30.00
3.	Spacing						
a.	Row to Row (35-40 cm)	51	85.00	00	0.00	9	15.00
b.	Plant to Plant (16-17cm)	45	75.00	00	0.00	15	25.00
4.	Propagation						
a.	Grafted plants	60	100.00	00	0.00	00	0.00
b.	Time of planting grafts (September- October)	35	58.33	00	0.00	25	41.67
5.	Manures and fertilizers (ha)						
a.	Quantity of FYM/compost (62.5t)	38	63.33	22	36.67	00	0.00
b.	Basal dose of NPK (15:30:30)	29	48.33	15	25.00	16	26.66
c	Top dressing of NPK (47.5:47.5:47.5)	40	66.66	14	23.34	06	10.00
d	Quantity of micronutrients (50 g $MnSO_4$+ 37.5 g $MgSO_4$+ 25g $FeSO_4$+12.5g B)	24	40.00	30	50.00	6	10.00
e.	Quantity of bio –fertilizers (5 kg Azospirillum and Phospho-bacteria mixed with 250 g FYM in pit weekly)	15	25.00	23	38.00	22	36.00
f	Quantity of growth regulators - Giberlic acid (1.5-2ml/l)	11	18.33	22	36.64	27	45.00
6.	Irrigation method (Drip irrigation)	60	100.00	00	0.00	00	0.00
7.	Inter cultural operations						
a.	Bending technique	53	88.33	00	0.00	07	11.67
b.	Wild shoot removal	55	91.66	00	0.00	05	8.34
c.	Deshooting and disbudding	52	86.66	00	0.00	08	13.34
d.	Yellow trap (used to attract pest)	32	53.33	10	16.67	18	30.00
8.	Plant protection measures						
a	Insect pests control						
i.	White grub (Phosalone 35EC@ 2ml/l)	8	13.33	13	21.66	39	65.00
ii.	Red spider mite (Abamectin 1.9 EC @ 0.5 ml/l)	45	75.00	12	20.00	03	5.00
iii	Thrips ,aphids , leaf eating caterpillars: (Acetamiprid @ 0.3 g/l)	48	80.00	9	15.00	03	5.00

iv	Leaf miner (Imidacloprid @ 0.5 ml/l)	36	60.00	15	25.00	09	15.00
b	Disease control						
i	Black spot disease (Carvebdazim 1g/l)	33	55.00	19	31.66	08	13.34
ii	Powdery mildew (Wettable sulphur 2g/l)	38	63.33	15	25.00	07	11.67
9.	Time of harvest (Morning)	52	86.66	08	13.34	00	0.00

respondents had partially and completely adopted the recommended plant protect measure to control the white grub (Phosalone 35EC@ 2ml/l (90%), respectively. On the other hand, a majority of flower growers had completely adopted the recommended plant protection measures for controlling the pests such as thrips, aphids, leaf eating caterpillars (Acetamiprid @ 0.3 g/l) (80.0%), red spider mite by using Abamectin 1.9 EC @ 0.5 ml/l (75.0%) and leaf miner (Imidacloprid @ 0.5 ml/l (60.0%).

It was found that a majority of the flower growers had completely adopted the recommended control measures for black spot disease (Carbendazim 1g/l) (55.0%) and powdery mildew (Wettable sulphur 2g/l). It was also noticed that a overwhelming number of flower growers (86.66%) had harvested the rose flowers during morning hours for getting optimum yield. Similar findings were reported by Neha and Jahagiridar (2018).

The major reason for majority of the flower growers for having completely adopting almost all the recommended cultivation practices in rose cultivation was due to the good knowledge possessed by the respondents on recommended rose cultivation practices. Possessing good knowledge is a prerequisite for the adoption of recommended cultivation practices. It was also observed from the study that the production technologies which are simple to practice, non- cash and low cost was completely adopted by the flower growers.

However, it was found that the a sizable number of respondents had not completely adopting the recommended rose cultivation practices such as, application of right quantity of manures and fertilizers, and controlling of insect pests and diseases. Lack of knowledge of the rose cut flower growers on the above cultivation practices and due to high cost of manures, fertilizers and plant protection chemicals, the respondents have not completely adopted the recommended quantity of manures and fertilizers. More or less similar findings were reported by Uddin *et al* (2018).

Overall adoption of recommended cultivation practices by rose cut flower growers

The results also revealed that a majority of the flower growers (51.67%) were having high overall adoption of recommended cultivation practices, while one-fourth (25.0%) and 23.33 per cent of the flower growers were having medium and low overall adoption of recommended rose cultivation practices, respectively. It is evident that more than three-fourth of the flower growers (76.67%) were having medium to high overall adoption of recommended cultivation practices. Frequent contact with farm scientists and horticultural extension personnel and regular participation in horticulture extension activities were the reasons for more than three-fourth of the flower growers (76.67%) for having medium to high overall adoption of recommended rose cultivation practices.

Marketing channels preferred by rose cut flower growers

A bird eye view of Table 2 reveals that Channel I (Producers → Commission Agents→Retailers →Consumers) (Rank I) was most preferred marketing channel for marketing of rose cut flowers by the respondents followed by Channel II (Producers→Local Traders→Retailers →Consumers) (Rank II), Channel III (Producers→ IFAB → Retailers → Consumers) (Rank III) and Channel IV (Producers → Exporters→Retailers →Consumers) (Rank IV) in the order of importance. The respondents have used more than

Table 2. Marketing channels of rose cut flower growers (n=60)

Sr. No.	Particular	Channels *	Rose cut flower growers		
			No.	%	Rank
1	Channel-I	Producers → Commission Agents→Retailers →Consumers	55	91.66	I
2	Channel-II	Producers → Local Traders→Retailers àConsumers	46	76.66	II
3	Channel-III	Producers→ IFAB+ → Retailers → Consumers	20	33.33	III
4	Channel-IV	Producers → Exporters→Retailers →Consumers	08	13.33	IV

*Multiple response; *IFAB =International Flower Auction Board

one marketing channel for marketing of rose cut flowers. Commission agents and local traders are providing credit for purchasing agricultural inputs to the rose cut flowers growers and also they are paying more price for the rose cut flowers compared to International Flower Auction Bangalore Limited (IFAB) and exporters, hence the respondents are selling the produce to commission agents and local traders. Similar finding was reported by Sumana *et al* (2018).

CONCLUSION

It can be concluded that more than three-fourth of the rose cut flower growers (76.67%) were having medium to high overall adoption of recommended rose cultivation practices. The respondents have used more than one marketing channel for marketing rose cut flowers and the most preferred marketing channel by 91.66 per cent of the rose cut flower growers was Producers → Commission Agents→Retailers →Consumers.

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Aluminium Unipole Ladder Can Replace Bamboo Pole Used in Harvesting of Black Pepper at Kollihills of Tamilnadu

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ABSTRACT

Tribal Sub Plan Scheme is being implemented by ICAR-KVK, Namakkal at Elangiyampatti, Kollihills since 2020. Here pepper is cultivated in an area of 80 ha. by 242 farmers. As pepper vines grow up to 4 -5 m height, manual harvesting which is only available method in Kollihills that requires a ladder and a skilled labour. Normally, single bamboo pole is used as a support to climb the shade trees of black pepper for harvesting. It is a very time-consuming activity with lot of difficulties and it is harmful to the vine. In order to avoid such situation in black pepper harvesting, KVK, Namakkal has introduced and supplied Aluminium ladder to the tribal farmers on cost sharing basis under TSP. Comparing the field efficacy of both the ladders, totally 4 pepper vines of 15 yr old or 6 vines of less than 10 yr old were harvested in a day by using bamboo pole when compared to aluminium ladder (6 - 8 vines respectively). In aluminium pole method, farmer could harvest 500 kg of green berries/ day and spend only Rs.22500/0.4 ha alone for harvesting, besides saved up to Rs.13500/ 0.4 ha as against Rs.36000/0.4 ha in bamboo pole method.

Key Words: Black pepper, Harvesting , ladders – Kollihills.

INTRODUCTION

Black pepper (*Piper nigrum*) is one of the important spice crops grown in Kollihills of Namakkal district in an area of 2340 ha with a productivity of 0.2 t / ha (Source: Department of Horticulture, Namakkal, 2020). It is an introduced crop to Kollihills during 1970's as an alternative to the traditional cereals and millets. It provides many useful products such as black pepper, white pepper, oil, and oleoresin. Now it is cultivated as a pure crop or intercropped with coffee or other crops including cardamom. Ninety-eight per cent of the pepper area is under the variety Panniyur-1, Panniyur 2 and the rest are with Kottanadan, Karimunda and Kurumilagu local. Most of pepper vines are 10 -15 yr old. In Elangiyampatti village, Gundurnadu Panchayat of Kollihills, Black pepper is cultivated in an area of 40 ha by 242 farmers. In this village the crop is harvested during the month of April - May. It is important to harvest pepper at the proper stage of maturity to achieve a dried product of good colour and appearance. Harvest starts when one or two berries turn yellow. The spikes are nipped of by hand and collected in bags in the young plantations. Since pepper vines grow on some host trees, it is necessary that for plucking one must climb on the trees. As, pepper vines grow up to 4 -5 m height, manual harvesting which is only available method in Kollihills that requires ladder and skilled labour (Singh and Devi, 2020). Normally, single pole bamboo ladder is used as a support to climb the shade trees (Silver oak – *Grevillea robusta*) of black pepper for harvesting. It is a very time-consuming activity with lot of difficulties and dangerous to the labourer and also harmful to the vine. The required skills include climbing up the ladder, avoiding ant bites, and conquering the fear of heights. Therefore, this operation of pepper harvesting is limited only for skilled labours. This process of plucking pepper involves high risk that there are chances of

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Table 1. Comparison of Bamboo Pole Vs Aluminium Unipole Ladder.

Sr. No	Description	Bamboo pole	Aluminium unipole ladder
1	Target user	Skilled labour	Farmer and farm women
2	Target farmer	Pepper growers	
3	Material	Bamboo	Aluminium
4	Commercial value / pole	Rs.700 / pole	Rs.11500 / ladder
5	Durability	2 -3 yr	14 -15 yr
6	Safety	Unsafe	User friendly & highly safe
7	Weight	30 - 35 kg	20 kg
8	Operating mechanism	Used as a support to climb the trees	
9	Portability	Heavy weight	Very easy – light weight
10	Industry standard	Single use	Multipurpose
11	Technology	Indigenous	Modified based on the indigenous method. 30 ft length unipole ladder (20 ft + 10 ft) with connector and bottom shoe

falling from the bamboo ladder. Likewise, it causes severe physical and health problems. Therefore, the objective of this study was to introduce affordable, efficient harvesting equipment that can be operated by any person, to increase the effectiveness of harvesting process.

MATERIAL AND METHODS

In order to avoid such situation in black pepper harvesting, KVK, Namakkal has introduced and supplied 30 feet Aluminium unipole ladder to tribal farmers on cost sharing basis (50% TSP + 50% farmers share) at Elangiyampatti village, Gundurnadu Panchayat of Kollihills under TSP 2020 -21. Before that KVK conducted off campus and skill trainings to farmers on that basis during August and October 2020. Farmer's doubts also cleared in the group meeting conducted during August - November 2020 and frequent crop advisories also provided. The aluminium unipole ladder was used by the farmers during the harvesting season of pepper and its effectiveness was observed in the 15 yr old pepper plantations of Kollihills and feedback of the farmers also collected.

RESULTS AND DISCUSSION

In indigenous method of pepper harvesting, farmers purchased 30 - 40 feet well matured 5-7 yr old bamboo pole @ Rs.700/ pole from nearby villages. Then they removed the unwanted thorns in the bamboo and kept the bamboo pole in the plain ground and placed the 5-10 kg stones above that in 2 feet distance for 30 - 40 d to straighten the pole. After that they used the pole for harvesting purpose. Farmers / skilled labours climb the tree by using branch as a step arose from nodes of bamboo pole. By using bamboo pole the labours or farmers faced problems such as foot and leg pain. Continuous harvesting is not possible in this method because of pain in leg, mostly harvesting is proceeded with alternate days. This leads to fallen of matured berries and caused wastage and yield loss. With respect to durability, bamboo poles having minimum durability only 2-3 yr when compared to aluminium pole (14-15 yr) (Table.1) due to rain caused fungal infection and termite incidence that leads to breakage of pole. So it is unsafe to the climber.

By using Aluminium unipole ladder the farmers first got confidence to reached the vine height

Table 2. Field Efficiency of Bamboo Pole Vs Aluminium Unipole Ladder for Pepper Harvesting.

Sr. No	Particular	Bamboo pole	Aluminium unipole ladder
1	No. of vines harvested / day 15 yr old vine Less than 10 yr old vine	 4 vines 6 vines	 6 vines 8 vines
2	No. of labours required /day	4	4
	No. of labours utilized for harvesting of 360 vines (average) or 0.4 ha	72	45
3	Time taken to harvest / vine	1.30 – 2 hrs	1 hr
4	Quantity of pepper spikes with berries harvested / day	300 kg green berries	500 kg green berries
5	Cost involved / harvesting / day	Rs.500 /person & Rs.2000/ day	
6	Total cost involved for harvesting / 0.4 ha	Rs.36000/-	Rs.22500/-

without fear. Safely reached the height up to 30 feet by using step like attachment in the unipole, it provided good grip to the foot of the climber. The farmers could harvest and carried the weight up to 100 kg of green berries. The farmers also realized about that which gives good hold with ground soil or base of the tree by bottom shoe, it tightly fixes the ladder. This was in conformity with the findings of Rahul *et al (* 2012).

With respect to field efficacy of both the ladders, highest number of pepper vines that is 6 pepper vines of 15 yr old or 8 vines of less than 10 yr old were harvested in a day from morning 7 am to afternoon 1 pm by using aluminium unipole ladder when compared to bamboo pole (4 & 6 vines). This was in accordance with the findings of Kahandage *et al* (2017). In a single vine two skilled labours harvest the matured pepper spikes around the vine by using two bamboo poles. On 0.4 ha area of land totally 330 -360 pepper vines were planted at a spacing of 10 x 10 feet or 12 x 12 feet by the farmer. By comparing the time taken for harvesting, one hour is required for harvesting single vine and an average of 500 kg pepper spikes were harvested / day by using Aluminium unipole ladder as against 1.30 hr – 2 hr/ vine and harvested 300 kg/d by bamboo pole method. Totally 72 skilled labours were involved in harvesting of 0.4 ha pepper plantations having 360 vines by using bamboo pole as against 45 labours by using aluminium ladder. So, the farmer could spend Rs.2000/- day as a labour charge for harvesting of pepper spikes for 6 hr (7 am -1 pm). In bamboo pole method, farmer could spend Rs.36000/- for labour charges of harvesting alone. But in aluminium pole method, farmer could spend only Rs.22500/- alone for harvesting, besides they save up to Rs.13500/- 0.4 ha.

The economic analysis (Table 3) revealed that the highest expenditure (Rs.87000/-) was incurred in bamboo pole method as compared to aluminium ladder (Rs.30000/-) and the maximum net return (Rs.2,06,500/-) was obtained by using aluminium unipole method. The highest cost of cultivation was due to high labour involvement in bamboo pole method of harvesting. Therefore, farmers could save an amount of Rs.13500/- besides getting additional profit of Rs.206500/- while using aluminium unipole ladder for harvesting. The cost: benefit ratio also highest (1:3.80) in this method. This was in conformity with the findings of Hameed Hussain and Nakkeeran (2017).

CONCLUSION

Considering the utility and profitability, the farmers expressed satisfaction with the performance of Aluminium unipole ladder because it got better

Table 3. Cost involved in pepper cultivation.

Sr. No	Particular	Detail	Total cost / 0.4 ha (Rs.)	
			Bamboo pole	Aluminium pole
1	Weeding & earthing up	2 times/year @ Rs.200 / 6 hr (7 am -1 pm) 20 female labour / time Total 40 labour @ Rs.200/-	8000	
2	Pruning of standard tree	One time/ year 40 men labour @ Rs.500/-	20000	
3	Cost of Farmyard Manure (including transport)	1 lorry load/ 0.4 ha or 15 t	13000	
4	Farmyard Manure application	20 m @ Rs.500/- men labour	10000	
5	Harvesting	Bamboo pole - 72 men labour/ 0.4 ha Aluminium unipole ladder – 45 men labour / 0.4 ha @ Rs.500/ men labour	36000	22500
Total expenditure			87000	73500
6	Yield	Green berries: 2100 - 2800 kg / 0.4 ha Dry recovery – 3:1 Dry pepper: 700 - 935 kg / 0.4 ha @ Rs.400/kg		
7.	Economics	Gross income / 0.4 ha	2,80,000	
		Net income / 0.4 ha	1,93,000	2,06,500
		B:C	3.22	3.80

preference due to its safety, affordability which can be operated by any person for harvesting pepper irrespective of gender and skill, easy handling, fearless harvesting, cost saving and increased effectiveness of harvesting process. In addition to weight bearing bottom stand consist of a shoe

Preparatory work in bamboo pole for harvesting of pepper

Training on Pepper harvesting by using Aluminium unipole ladder

Harvesting of pepper by using bamboo pole

Harvesting of pepper by using aluminium unipole ladder

like structure to support to the ladder to operate in vast range of area without moving the ladder. The locknut was made at a 20 feet height with a tightening mechanism to hold the ladder at desired height. Since this equipment is a simple one and chances of frequent maintenance will be less.

The plucking of pepper spikes with this equipment has been tried by the laborers including ladies. The total achievable height of the equipment was 30 feet. The farmers of adjoining areas were also convinced and interested to adopt this tool for pepper harvesting. It can be concluded that, this aluminium unipole ladder can effectively replace the bamboo pole harvesting of pepper.

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Carp Seabass Polyculture Concept is an Eco-Friendly Farming Technology in Freshwater Aquaculture

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ABSTRACT

In this study, the carps were cultured with Asian seabass (*Lates calcarifer*) to access the feasibility, growth, survival and production of fishes in freshwater condition for two consequent years. Carps (*Catla catla, Labeo rohita, Cirrhinus mrigala* and *Ctenopharyngodon idella*) were cultured along with seabass in experiment pond whereas only carps were reared in control pond. The result showed that the water and sediment quality were optimum in both the ponds as per fish growth and survival. The work revealed that average growth of carps in terms of length, weight, biomass and production was significantly high ($P<0.01$) in experiment pond during the subsequent years of the study. Satisfactory results and the positive impact of introducing seabass in carp polyculture may be attributed to seabass stocking after the carps have attained appropriate size. The stocking of seabass seeds was done after getting the proper size of carps that help protect these carps from predation and chasing, availability of primary food components for consumption than the supplementary feed and consumption of weed fish by seabass minimized competition for food, oxygen and space for carps. Based on these findings, it was concluded that such practices would be a milestone for fish farming in freshwater.

Key Words*:* Carps, seabass, survival rate, growth, polyculture.

INTRODUCTION

Aquaculture is discrete from capture fisheries because of production, employment and economic values (Belton and Thilsted, 2014). Therefore, stagnation in capture fisheries and the rise in fish culture practice is shifted as the primary source of fish (Beveridge *et al,* 2013) which fullfil the demand for the growing population, urbanization and economy (Merino *et al,* 2012; Beveridge *et al,* 2013; Tacon and Metian, 2013; Waite *et al,* 2014). The culture of carp is an ancient activity, using different feeding habits of fishes in freshwater (Salehi, 2004) while sea bass (*Lates calcarifer*) can be cultured in specified culture systems using either marine water, brackish water or freshwater (Harpaza *et al,* 2005). The polyculture system of sea bass has been reported with shrimp, mullet and milkfish (Rauangpanit *et al,* 1984) and tilapia (Singh and Shirgur, 1994; Monwar *et al,* 2013). Seabass is a predatory fish and cannibalistic in case of variations in size or lack of feed sufficiency during the culture (Singh, 2000; Mathew, 2009). The study on polyculture of carps and seabass is minimal (Singh *et al,* 2001). Therefore, the present study was conducted to evaluate seabass's effect on carps' growth and survival in a polyculture system.

MATERIALS AND METHODS

The present study was conducted attwo different locations namely Danti pond (experiment pond) and SWMRU pond (control pond) situated at the research station of Navsari Agricultural University, Navsari (Gujarat) during the year 2008-09 and 2009-10. For fishes culture, dried ponds of 0.3 ha size were separately prepared (water filling, liming @ 100 kg/ha, manuring with raw cattle dung @ 1 toN/ha, *etc*.) to follow the prescribed method (Coche *et al,* 1996). The carps' seeds were procured

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Table 1. Important water and soil quality parameter of the ponds during polyculture of carps and seabass

Parameters	Control pond		Experiment pond	
	2008-09	2009-10	2008-09	2009-10
Water quality parameters				
pH	8.13±0.07	8.36±0.03	8.05±0.09	8.16±0.05
Total Alkalinity (ppm)	179.73±10.46	177.58±9.732	215.66±19.01	213.57±17.90
Total Ammonical N (ppm)	0.12±0.04	0.07±0.01	0.22±0.05	0.15±0.05
NO_2-N (ppm)	0.02±0.01	0.07±0.01	0.12±0.03	0.13±0.03
NO_3-N (ppm)	0.190.06	0.07±0.01	0.14±0.04	0.10±0.01
Soil quality parameters				
pH	8.48	8.12	8.12	8.48
Electrical Conduction (dSm^{-1})	0.49	1.06	1.06	1.26
Organic C (%)	0.11	0.15	0.15	0.28
Available P($kgha^{-1}$)	37	155.31	155.31	203.57
Avail K ($kgha^{-1}$)	250.5	675.48	675.48	789.31
Available N($kgha^{-1}$)	77.52	612.5	612.5	798.69

from a local vendor while seeds of seabass were procured from Fish Seed Production Unit, CIBA (Chennai). The control pond was stocked with 2000 carp yearlings (*Catla catla, Labeo rohita, Cirrhinus mrigala and Ctenopharyngodon idella*; 3:3:2:2 ratio). In experiment pond, bottom feeder and slow-growing carp (mrigal) were partially replaced by seabass (*Lates calcarifer*) and stocked with 2000 carp yearlings and sea bass in the ratio of 3:3:1.5:2:0.5. The stocking of carps was done in one month advance, and later on, sea bass was stocked assuming that in this duration carps will grow up to sufficient size to escape from predation and sea bass will feed upon the available weed fishes in the pond. Supplementary feed (Crude protein 18.16 ± 0.21%; crude lipid 2.29 ± 0.289%; crude fiber 9.96 ± 0.763% and Ash 19.19 ± 0.777%) were also provided in both the ponds with perforated hanging bags @ 3% fish bodyweight. The fishes' culture duration was eight months, and at the end of the crop, the achieved biomass,growth (total length in cm and weight in g) of the individual specimen of cultured fishes was measured randomly.

Water quality parameters, including pH, total alkalinity, total ammonical nitrogen (TAN), nitrite-nitrogen (NO_2) and nitrate-nitrogen (NO_3), were analyzed to follow the standard method (APHA, 2005). Pond soil samples were analyzed for pH, electrical conductivity (EC), organic carbon (OC), available nitrogen, phosphorus and potassium (Jackson, 1973).

The statistical tool *t*-test validated the variation in the variables, *e.g*. total length, weight, biomass and total production of ponds by SPSS 16.0.

RESULTS AND DISCUSSION

Asian seabass is euryhaline commercially important fish, and in the current study, it was cultured with carps in fresh water. Quality of pond water and sediments were analyzed during the culture period and it was observed that these were optimum and suitable for fish culture in both the ponds (Table 1). These findings were supported by Singh *et al* (2001) and Monwar *et al* (2013) in polyculture system of Asian sea bass with other fishes.

Table 2. Culture and production of carps and seabass during 2008-09

Components	**Control pond***				**Experiment pond***				
Area (ha)	0.3				0.3				
Culture duration (days)	245				245				
Fish species	**C. catla**	**L. rohita**	**C. mrigala**	**C. idella**	**C. catla**	**L. rohita**	**C. mrigala**	**C. idella**	**L. calcarifer**
Fish seed stocked (No.)	600.00	600.00	400.00	400.00	600.00	600.00	300.00	400.00	100.00
Fish seed survived (No.)	492.00	534.00	296.00	100.00	462.00	528.00	144.00	76.00	95.00
Fish seed survived* (%)	82.00	89.00	74.00	25.00	77.00	88.00	48.00	19.00	95.00
Mean length* (mm) ± SE	390.55 ± 3.97	421.17 ± 8.42	330.78 ± 2.60	397.11 ± 7.32	486.00 ± 12.65	420.50 ± 7.83	446.89 ± 17.31	485.11 ± 17.45	400.18 ± 3.57
Mean weight* (g) ± SE	950.09 ± 34.59	968.42 ± 51.24	704.33 ± 13.24	870.33 ± 63.98	1813.00 ± 121.25	969.67 ± 54.71	1259.00 ± 98.62	1836.22 ± 188.99	836.91 ± 21.89
Biomass (kg)*	467.44	517.13	208.48	87.03	837.61	511.98	181.30	139.55	79.51
Total biomass (kg)	1280.10				1749.95				
Increment in biomass (%)	36.70								
Yield ($Kgha^{-1}$)	4266.57				5832.58				

*The variations in the variables at 1% level of significance

In the present study, the survival rate for catla (82-84%), rohu (83-89%), mrigal (67-74%) and grass carp (18-25%) was noted in control pond whereas it was for catla (77-86%), for rohu (79-88%), mrigal (48-51%), grass carp (19-20%) and for sea bass (95-89%) in experiment pond during the year 2008-09 and 2009-10 respectively (Table 2 & 3). These results showed that the survival rate of carps was comparatively high in the control pond.

Growth of catla, rohu, mrigal and grass carp in terms of length 390.55± 3.97, 421.17 ± 8.42, 330.78 ± 2.60 and 397.11 ± 7.32 cm and weight was 950.09 ± 34.59, 968.42 ± 51.24, 704.33± 13.24 and 870.33 ± 63.98g for the respective fish in control pond during 2008-09 (Table 2). Whereas, length 388.91 ± 4.88, 426.58 ± 9.79, 351.56 ± 10.14 and 425.11 ± 9.05 cm and weight of 952.73 ± 46.70, 994.75 ± 55.66, 797.56 ± 47.64 and 1116.33 ± 81.74 g were noted in respective fish in control pond during 2009-10 (Table 3). In experiment pond,the length and weight of catla (486.00 ± 12.65 cm and 1813.00 ± 121.25 g), rohu (420.50 ± 7.83 cm and 969.67 ± 54.71), mrigal (446.89 ± 17.31 cm and 1259.00 ± 98.62 g), grass carp (485.11 ± 17.45 cm and 1836.22 ± 188.99 g) and sea bass (400.18 ± 3.57 cm and 836.91 ± 21.89 g) were recorded during the year 2008-09 (Table 2) while during 2009-10, these were observed for catla 487.73 ± 14.03 cm and 1803.00 ± 143.77 g, rohu 431.42 ± 9.40 cm and 996.63 ± 55.94 g, mrigal 435.11 ± 16.46 cm and 1225.89 ± 84.26 g, grass carp 496.89 ± 9.41 cm and 1933.22 ± 99.43 g and seabass 388.91 ± 4.31 cm and 865.00 ± 25.47 g (Table 3).

At the end of crop harvested biomass of individual species was comparatively high in experiment pond. In control pondbiomass was

Table 3. Culture and production of carps and seabass during 2009-10

Components	Control pond						Experiment pond		
Area (ha)	0.3						0.3		
Culture duration (days)	245						245		
Fish species	C.catla	L.rohita	C.mrigala	C.idella	C.catla	L.rohita	C.mrigala	C.idella	L.calcarifer
Fish seed stocked (No.)	600.00	600.00	400.00	400.00	600.00	600.00	300.00	400.00	100.00
Fish seed survived (No.)	504.00	498.00	268.00	72.00	516.00	474.00	153.00	80.00	89.00
Fish seed survived* (%)	84.00	83.00	67.00	18.00	86.00	79.00	51.00	20.00	89.00
Mean length (mm)* ± SE	388.91± 4.88	426.58 ± 9.79	351.56± 10.14	425.11 ± 9.05	487.73± 14.03	431.42± 9.40	435.11 ± 16.46	496.89 ± 9.41	388.91 ± 4.31
Mean weight (g)* ± SE	952.73± 46.70	994.75 ± 55.66	797.56± 47.64	1116.33 ± 81.74	1803.00 ± 143.77	996.63± 55.94	1225.89± 84.26	1933.22 ± 99.43	865.00 ± 25.47
Biomass (kg)*	480.17	495.39	213.74	80.38	930.35	472.40	187.56	154.66	76.99
Total biomass (kg)	1269.68				1821.95				
Increment in biomass (%)	43.50								
Yield (Kgha^{-1})	4231.84				6072.56				

*The variations in the variables at 1% level of significance

noted 467.44, 517.13, 208.48 and 87.03 kg during 2008-09 and 480.17, 495.39, 213.74 and 80.38 kg during 2009-10 for catla, rohu, mrigal and grass carp,respectively whereas, in experiment pond it was 837.61, 511.98, 181.30, 139.55 and 79.51 kg during 2008-09 and 930.35, 472.40, 187.56, 154.66 and 76.99 kg during 2009-10for catla, rohu, mrigal, grass carp and sea bass respectively (Table 2 & 3).In the experiment pond, total fish production was 1749.95 kg, which was 36.70% more than total fish production of 1280.10 kg in the control pond during 2008-09. In comparison, 43.50% increment in total fish production (1821.95 kg) was noted in experiment pond compared to 1269.68 kg total fish production of control pond during 2009-10 (Table 2 , 3).

The statistical tool t-test verified the variations in the variables including fish survival, length, weight, biomass and total fish production. The result depicts that variations in these variables are significantly varied at a 1% level of significance, indicating that significant increment in growth (length and weight), survival and total fish production were observed in simultaneous study years. These results spectacles the positive impact of seabass in carp polyculture system that may be attributed to the consumption of weed fishes (*Oreochromis, Puntius, Ambasis etc.*) by sea bass and ultimately minimized the competition of feed, space and dissolved oxygen for carps in experiment pond.

Singh *et al* (2001) conducted a similar study, and their findings were sounded uneconomical. However, the pond conditions were almost the same, the production1.5-1.8 t/ha and survival of catla (28.8-87%), rohu (7.5-50.7%) and mrigal (70%) was meagre compared to the present study. The stocking of high sea bass and tilapia numbers seems unscientific as the high sea bass numbers might have preyed upon the carp seeds. The high tilapia numbers might have affected the average size of catla 1.2 kg, rohu 1.1 kg and mrigal 0.82 kg at harvest, significantly less compared to the present study. The average weight of harvested sea bass was reported 670g in their research study, which was also low than the present study (837-865 g). ICAR (2010) reported that sea bass attained 450 to 950 g after 270 DOC in tilapia poly farming with sea bass at Kakdwip, India and similar findings were also reported in poly farming of seabass and tilapia by Hossain *et al* (1997) and Monwar *et al* (2013). The higher growth and survival (89-95%) obtained in the present study reveals that the stocking density of seabass (5%) for such polyculture systems are ideal compared to the research conducted by Singh *et al* (2001). Kasim and James (1986), Hossain *et al* (1997) and Monwar *et al* (2013) also suggested undertaking such kinds of research on prospects of seabass culture.

CONCLUSION

Carp seabass polyculture concept is an eco-friendly farming technology in freshwater aquaculture. The novel technology of introducing predatory fish would be a milestone in fish farming. The implications of such research are to bring the vast underutilized aquatic freshwater resources under fish culture. Thus, harnessing a profitable and generating employment opportunities to the small and marginal farmers. It is concluded that the seabass introduction has a positive impact in carp polyculture systems. The stocking of seabass after appropriate size of carps has attained, prevents the predation and chasing, availability of primary food components for the carp fishes, supplementary feeding and consumption of weed fish by seabass minimizing the competition for food, oxygen and space for the growing carp fishes.

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Character Association Studies in Sweet Potato [*Ipomea batatas* (L.)]

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ABSTRACT

An experiment was conducted at SG college of agriculture and research station, IGKV, Jagdalpur to estimate correlation and path analysis among different characters of twenty eight sweet potato genotypes in randomized block design in 3 replication during *Kharif* 2020-21. Observed thirteen quantitative characters *viz.,* vine internode length, length of tubers per plant, diameter of tubers, starch, dry matter of tubers, no. of tubers per plant, tubers weight per plant, harvest index and tubers yield (t/ha). Analysis of variance revealed that mean sum of squares due to genotypes was highly significant for all the characters. Correlation revealed that tubers yield (t/ha) showed high significant positive correlation with tubers weight per plant at both phenotypic and genotypic level (0.807 and 0.963) followed by number of tubers per plant, starch (%), diameter of tubers (cm), length of tubers (cm), harvest index (%), dry matter of tubers (%). Path co-efficient analysis revealed maximum direct contribution towards tubers weight per plant showed maximum positive direct effect on tubers yield (1.125t/ha) followed by diameter of tubers, vine length, number of tubers per plant, TSS of tubers percent and length of tubers per plant.

Key Words: Correlation, Path co-efficient, Character association, Tuber weight, Tuber yield.

INTRODUCTION

Sweet potato (*Ipomea batatas* (L.) is one of the most popular and extensively consumed tubers vegetable crops grown worldwide due to its acclimatization to a wide variety of environments, as well as its high nutritive value. In Chhattisgarh it is locally known as "Kalmal Kanda", 'Maati Kanda' and 'Kevat Kanda' is one of the most popular and important tubers crops in India and abroad because of its yield potential and high calorific value. Sweet potato ranks fifth after rice, wheat, maize and cassava, sweet potato (CIP, 2018). In India sweet potato occupied 1.16 lakh thousand ha area with 12.07 lakh thousand Mt production and having productivity of 10.2 thousand Mt/ha whereas in Chhattisgarh it covers 4.47 thousand ha area with 48.15 thousand Mt production and having productivity of 10.75 thousand Mt/ha (Anonymous, 2020). In breeding programme information about extends of genetic variability, correlation is basic requirement. Genotypes exhibiting high variability for desirable characters that contribute to the yield are to be selected in such a programme of evaluation in the breeding programme, selection of parents for hybridization is largely based on high yield potentials, wide adoption and genetic diversity.

The efficiency of selection can be improved by using correlation between different characters. The phenotypic correlation indicates the extent of observed relationship between two characters and this includes both hereditary and environmental influences, while genotypic correlation coefficient provides a real association between two characters and is most useful in selection (Johnson *et al,* 1955). Genetic correlation can result either from pleiotropy or from linkages. While phenotypic value is a non-additive combination of both genetic and environmental correlation. This study merely

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Table 1. Analysis of variance for fruit yield and its component characters in sweet potato.

Sr. No.	Character (df)	Mean sums of square		
		Replication	Treatment	Error
		(2)	(27)	(54)
01	Vine length (cm)	186.46	8591.04**	157.61
02	Vine internode length (cm)	1.04	6.94**	0.19
03	Vine weight per plant (fw) g	9920.39	18282.32**	1143.10
04	Length of tubers (cm)	13.96	46.88**	3.23
05	Diameter of tubers (cm)	0.17	3.01**	0.20
06	TSS of tubers (%)	0.29	5.67**	0.25
07	Starch (%)	0.04	61.55**	2.33
08	Dry matter of tubers (%)	0.42	133.89**	1.16
09	Dry matter of foliage (%)	760.96	542.73**	37.04
10	No. of tubers per plant	0.37	3.48**	0.19
11	Tubers weight per plant (g)	1189.97	15366.18**	768.04
12	Marketable tubers yield per plant (g)	1211.63	12769.83**	774.42
13	Marketable tubers yield (t/ha)	5.43	56.01**	3.49
14	Weevil infested tubers yield per plant (g)	0.23	732.62**	1.12
15	Weevil infested tubers yield (t/ha)	0.00	3.25**	0.00
16	Biological yield (g/plant)	17540.10	40323.76**	1454.59
17	Harvest Index (%)	25.42	257.67**	19.28
18	Tubers yield (t/ha)	67.36	67.58**	8.29

*: Significant at 5%, **: significant at 1%

indicates the nature of association and this alone does not provide the exact insight of the relative effect of each component character. A component character may have no direct effect on considerable economic trait but it may influence it via related characters. Hence, knowledge of direct and indirect effects of different characters on desired traits is essential for selection to improve the population. The path coefficient divides the correlation into direct and indirect effects and thus determines the nature of association (Falconer, 1960).

MATERIALS AND METHODS

The experiment was carried out during the year 2020-2021 at Instructional cum Research Farm of S.G. Collage of Agriculture and Research Station, Jagdalpur, Bastar. The experimental material comprised of twenty-eight genotypes along with two checks Indira Nandini as local check and Sree Bhadhara as national check. The experiment was laid out in a randomized block design with three replications at the spacing of 60 cm between rows and 20 cm between plants to plant. A net plot size of 2 x 1.8 m was kept for each genotype. All the recommended cultural practices were taken to grow a healthy crop. Data were recorded on five randomly selected plants for thirteen characters *viz.,* vine length (cm), vine internode length (cm), vine weight per plant (fw) g., length of tubers (cm), diameter of tubers (cm), TSS of tubers (%), starch (%), dry matter of tubers (%), dry matter of foliage (%), no. of tubers per plant, tubers weight per

Table 2. Genotypic and phenotypic correlation coefficient between tubers yield and its component characters in sweet potato

Characters		1. Vine internode length (cm)	2. Vine weight per plant (fw) g	3. Length of tubers per plant (cm)	4. Diameter of tubers (cm)	5. TSS of tubers (%)	6. Starch (%)	7. Dry matter of tubers (%)	8. Dry matter of foliage (%)	9. No. of tubers per plant	10. Tubers weight per plant (g)	11. Harvest Index (%)	12. Tubers yield (t/ha)
Vine length (cm)	P	0.395*	0.214	-0.043	0.016	-0.120	0.302	-0.050	0.029	0.233	0.195	-0.066	0.172
	G	0.415 *	0.255	-0.043	0.188	-0.131	0.325	-0.055	0.333	0.258	0.230	-0.077	0.243
Vine internode length (cm)	P	1.000	-0.092	-0.039	0.044	0.010	0.038	-0.354	-0.031	-0.170	-0.059	0.003	-0.059
	G	1.000	-0.103	-0.034	0.076	0.014	0.041	-0.377 *	0.045	-0.207	-0.047	0.015	-0.052
Vine weight per plant (fw) g	P		1.000	0.307	0.371	-0.202	0.059	0.046	0.068	0.188	0.155	-0.713	0.165
	G		1.000	0.335	0.430 *	-0.267	0.060	0.065	0.754**	0.208	0.225	-0.701	0.225
Length of tubers per plant (cm)	P			1.000	0.483**	-0.154	0.487 **	0.350	0.208	0.408*	0.540**	0.118	0.509**
	G			1.000	0.585 **	-0.198	0.549 **	0.410 *	0.287	0.508 **	0.647**	0.171	0.676**
Diameter of tubers (cm)	P				1.000	-0.397*	0.472 *	0.160	0.452*	0.543 **	0.664 **	0.141	0.622**
	G				1.000	-0.431*	0.628 **	0.181	0.518**	0.679 **	0.786**	0.149	0.850**
TSS of tubers (%)	P					1.000	-0.322	-0.074	-0.348	-0.378*	-0.380 *	-0.038	0.354
	G					1.000	-0.377*	-0.066	-0.405*	-0.422 *	-0.417 *	0.171	-0.446*
Starch (%)	P						1.000	0.477*	0.205	0.683 **	0.707 **	0.428*	0.664**
	G						1.000	0.524**	0.207	0.764 **	0.825 **	-0.007	0.856**
Dry matter of tubers (%)	P							1.000	0.051	0.569 **	0.418*	0.252	0.394*
	G							1.000	0.072	0.624 **	0.460 *	0.277	0.469*
Dry matter of foliage (%)	P								1.000	0.312	0.257	-0.391*	0.244
	G								1.000	0.344	0.333	-0.498 **	0.364
No. of tubers per plant	P									1.000	0.723**	0.329	0.655**
	G									1.000	0.842**	0.407 *	0.895**
Tubers weight per plant (g)	P										1.000	0.564 **	0.807**
	G										1.000	0.522**	0.963**
Harvest index (%)	P											1.000	0.493*
	G											1.000	0.563**

*: At 5% level of significance, **: At 1% level of significance

Table 3. Direct and indirect effect of component character on tubers yield and its components in sweet potato

Characters	1. Vine length (cm)	2. Vine inter-node length (cm)	3. Vine weight per plant (fw) g	4. Length of tubers per plant (cm)	5. Diameter of tubers (cm)	6. TSS of tubers (%)	7. Starch (%)	8. Dry matter of tubers (%)	9. Dry matter of foliage (%)	10. No. of tubers per plant	11. Tubers weight per plant (g)	12. Harvest Index (%)	13. Tubers yield (t/ha)
Vine length (cm)	0.028	-0.011	-0.048	0.000	0.007	0.000	-0.027	0.001	-0.001	0.002	0.280	0.013	0.244
Vine internode length (cm)	0.012	-0.026	0.019	0.000	0.003	0.000	-0.003	0.005	0.000	-0.001	-0.057	-0.003	-0.052
Vine weight per plant (fw) g	0.007	0.003	-0.188	0.001	0.016	-0.001	-0.005	-0.001	-0.001	0.001	0.275	0.118	0.226
Length of tubers per plant (cm)	-0.001	0.001	-0.063	0.003	0.022	-0.001	-0.045	-0.005	-0.001	0.003	0.791	-0.029	0.676**
Diameter of tubers (cm)	0.005	-0.002	-0.081	0.002	0.038	-0.002	-0.050	-0.002	-0.001	0.004	0.942	-0.025	0.828**
TSS of tubers (%)	-0.004	0.000	0.050	-0.001	-0.016	0.004	0.031	0.001	0.001	-0.003	-0.510	0.001	-0.446
Starch (%)	0.009	-0.001	-0.011	0.001	0.023	-0.001	-0.082	-0.006	0.000	0.005	1.008	-0.088	0.856**
Dry matter of tubers (%)	-0.002	0.010	-0.012	0.001	0.007	0.000	-0.043	-0.012	0.000	0.004	0.563	-0.046	0.469*
Dry matter of foliage (%)	0.009	0.001	-0.142	0.001	0.020	-0.001	-0.017	-0.001	-0.002	0.002	0.392	0.080	0.342
No. of tubers per plant	0.007	0.005	-0.039	0.001	0.025	-0.002	-0.063	-0.008	-0.001	0.006	1.029	-0.068	0.895**
Tubers weight per plant (g)	0.006	0.001	-0.042	0.002	0.029	-0.001	-0.067	-0.006	-0.001	0.005	1.125	-0.088	0.963**
Harvest index (%)	-0.002	0.000	0.132	0.000	0.006	0.000	-0.043	-0.003	0.001	0.003	0.638	-0.168	0.563**

Residual value: 0.128

Diagonal and bold underlined figures show direct effect on tubers yield plant (g), harvest index (%), were recorded on five competitive random plants from each replication. Three important characters *viz*., tubers yield (t/ha), marketable tubers yield (t/ha) and weevil infested tubers yield (t/ha) were calculated on the basis of observed data.

RESULT AND DISCUSSION

The analysis of variance for tubers yield and its component characters indicated that mean sum of squares due to genotypes were highly significant for all the characters under study. Significant mean sum of squares due to tubers yield and attributing characters revealed existence of considerable variability in material studied for improvement of various traits. These findings were closely associated with the reports of Anshebo *et al* (2004), Teshome *et al* (2004), Chaurasiya (2012), Mohanty (2013), Dash *et al* (2014), Bhadauriya *et al* (2018). In general, the genotypic correlations were observed to be higher than the corresponding phenotypic correlations for all the character combinations in present investigation, thus indicating the suppression of phenotypic expression under the influence of environmental factors (Table 2). Nedunzhiyan and Reddy (2000), Choudhary *et al* (2000) also found similar results in their studies on sweet potato.

Tuber yield

Tuber yield (t/ha) showed high significant positive correlation with tubers weight per plant at both phenotypic and genotypic level (0.807 and 0.963) followed by number of tubers per plant (0.655 and 0.895), starch (%) (0.664 and 856), diameter of tubers (cm) (0.622 and 0.850), length of tubers (cm) (0.509 and 0.676), harvest index (%) (0.493 and 0.563), dry matter of tubers (%) (0.394 and 0.469) and significant negative correlation observed with TSS of tubers (-0.446) at genotypic level only. Similar result had been also reported by Choudhary (2000) for tubers yield, Hussain (2000) for tubers weight, number of tubers per plant, Nedunzhiyan and Reddy (2000) for growth parameters, Sahu (2005) for Diameter of tubers, harvest index and length of tubers, Engida *et al* (2006) for storage root weight and harvest index, Jha (2012) for harvest index, Mohanty (2013) for number of root per plant and root girth, Dash *et al* (2015) for diameter of tubers and harvest index. Correlation coefficient analysis revealed that tubers yield (t/ha) showed high significant positive correlation with tubers weight per plant at both phenotypic and genotypic level followed by number of tubers per plant, starch, diameter of tubers, length of tubers, harvest index, dry matter of tubers and significant negative correlation observed with TSS of tubers at genotypic level only.

Path coefficient analysis

The path coefficient analysis which splits total correlation coefficient of different characters into direct and indirect effect of yield attributing characters on tubers yield (t/ha) was presented (Table 3). The data revealed that genotypic path, tubers weight per plant showed maximum positive direct effect on tubers yield tone per hectare (1.125) followed by diameter of tubers (0.038), vine length (0.028), number of tubers per plant (0.006), TSS of tubers percent (0.004) and length of tubers per plant (0.003) which indicated that these were the main contributors to the tubers yield which was in consonance with the findings of Hossain *et al* (2000), Shasikant *et al* (2008), Tirkey *et al* (2011), Bhadauriya *et al* (2018). Whereas, vine weight per plant showed maximum negative direct effect (-0.188) followed by harvest index (-0.168), starch percent (-0.082), vine internode length (-0.026), dry matter of tubers percent (-0.012) and dry matter of foliage percent (-0.002).

The effect of residual factor (0.128) on tuber yield was low, thereby, suggested that no other major yield component is left over. Overall, the path analysis confined that direct effect of tubers yield, diameter of tubers, length of tubers, starch, dry matter of tubers, no. of tubers, tubers weight per plant should be considered simultaneously for amenability in tubers yield of sweet potato.

CONCLUSION

In this present study the correlation between tuber yield and a character is due to direct effect of tubers weight per plant, vine length, diameter of tubers, number of tubers per plant, length of tubers revealed true relationship between them and direct selection for this trait would be rewarding for yield improvement. Overall, in this study selection of genotypes having higher tubers weight or selection of tubers weight characters for further breeding programme will improve the tubers yield per hectare. In genotypic path, tubers weight per plant showed maximum positive direct effect on tubers yield tone per hectare followed by diameter of tubers, vine length, number of tubers per plant, TSS of tubers percent and length of tubers per plant which indicated that these are the main contributor to the tuber yield.

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Comparative Performance of Chaff Cutter with Local *Machete Dao*

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ABSTRACT

Pig rearing is an important enterprise for the Tribal people of Kohima district. It is reared for its meat and is closely associated with their culture and tradition. The practice is to keep one or two pigs as backyard farming in-order to convert kitchen waste, industrial waste and green fodder into protein for human consumption. Freshly harvested green leaves from garden, forest and fields are chopped using *dao* which result in postural discomfort over time. The present study introduces manually operated chaff cutter with 2 blades and 3 blades in the district to overcome such constraints. The findings show that chaff cutter with 3 blades had the superiority over the other in various parameters. It had the capacity to cut 27.38 kg/hr over the local dao (19.35 kg/hr) showing an increase in output by 41.49 percent, operating cost for producing one quintal reduced from 280.77 to 196.30 and time spend to produce the same quantity was reduced by 43.75%. It eliminated complete pain from upper back, legs, neck and fingers, while reduced the severity of pain from the lower back, lower arms, shoulders, and hands.

Key Words: Chaff cutter, Dao, Tribal, Green fodder, Drudgery, backyard.

INTRODUCTION

Livestock plays an important role in Indian economy. About 20.5 million people in India depends upon livestock for their livelihood. It provides employment to about 8.8 percent of India's population, contributes 4.11 percent towards GDP growth and 25.6 percent towards total Agriculture GDP (Anonymous, 2019). As per 20th Livestock census the total pig population has decreased by 12 percent over previous 19th livestock census. However, piggery sector contributes 1.7 percent towards livestock population. In Nagaland, pig rearing is the most important enterprise as each household rear in small units interwoven with tribal culture and economic condition. The capability of pig to convert kitchen waste, industrial waste, green fodder and feeds into protein for human consumption has increase the demand for pork meat and the per capita consumption of meat to be the highest in the country. Small and Marginal tribal farmers of Kohima district usually feed the pigs with rice bran and freshly harvested green leaves which are cooked along with vegetables waste and other leafy materials before being fed (Talukdar *et al,* 2019). Green leaves such as Boehmeria platyphyllla, Collocasia *spp*, Elatosema disssectum *etc*. (Padmakumar *et al,* 2015) are collected from garden, fields and forest and cut into pieces to increase the consumption and palatability of feeds and reduce wastage. Chopping of leaves is time consuming and manually done using local machete called *'dao'*. It is used in sitting and squatting position which is physically demanding and increases the postural discomfort leading to back, shoulder, arms and wrist pain. This *dao* is also used for all agricultural operation (Singh and Devi, 2020). Keeping the above constraints faced by the tribal farmers on daily basis, it was necessary to introduce manually operated chaff cutter with two blades and three blades which can be conveniently handled by a person. Chaff cutter is a mechanical device for cutting young plants, into pieces before

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Table 1. Performance parameters of the cutting tools.

Year	Quantity of cuts (kg/hr)		Percentage Change of improved over local (%)	Quantity of cuts (kg/hr)		Percentage Change of improved over local (%)
	Local	2 blades		Local	3 blades	
2019	17.35	14.80	-17.22	17.35	26.85	+54.75
2020	21.35	14.56	-46.63	21.35	27.91	+30.72
Mean	19.35	14.68	-31.81	19.35	27.38	+41.49

- Indicates % Decrease over local, + Indicates % Increase over local.

Table 2. Operating cost for cutting.

Year	Cutting cost (` Rs./q)		Percentage cost difference of improved over local (%)	Cutting cost (`Rs./q)		Percentage cost difference of improved over local (%)
	Local	2 blades		Local	3 blades	
2019	309.79	363.17	+17.23	309.79	200.18	-54.75
2020	251.75	369.16	+46.63	251.75	192.58	-30.72
Mean	280.77	366.16	+30.41	280.77	196.38	-42.97

*Wage calculated @430/day. - Indicates % Decrease, + Indicates % Increase

Table 3. Time consumed for cutting.

Year	Time consumed (hr/q)		Percentage Time consume of improved over local (%)	Time consumed (hr/q)		Percentage Time consume of improved over local (%)
	Local	2 blades		Local	3 blades	
2019	7.6	9.0	+18.42	7.6	4.9	-55.10
2020	6.2	9.1	+46.77	6.2	4.7	-31.91
Mean	**6.9**	9.05	**+31.15**	**6.9**	4.8	**-43.75**

- Indicates % Decrease over local, + Indicates % Increase over local.

Table 4. Overall Discomfort rating during chopping.

Treatments	ODR*	MSP*	RPE*
Local *dao*	7.75	Severe pain in upper and lower back, lower arms, legs, necks, shoulders, hands and fingers.	Heavy
2 blade chaff cutter	4.5	Moderate to mild pain in shoulders, lower back, hands and arms	Moderately Light
3 blade chaff cutter	4.8	Moderate to mild pain in shoulders, hand, arms and lower back	Moderately Light

ODR*= mean value of Overall Discomfort Rating, MSP*=Musculo Skeletal Problem, RPE*=Rating of Perceived Exertion mixing together with other forage and fed to pigs (Pongen *et al,* 2019).

.MATERIALS AND METHODS

The demonstration was conducted in Phesama and New Tesophenyu village during 2019 and 2020 under Kohima district of Nagaland. Twenty subjects were involved in the operation, having good experience in using conventional Local *dao* for preparing green fodder. Chaff cutter developed by Central Institute of Agricultural Engineering (CIAE) Bhopal was procured and distributed to the subjects. Green fodder leaves of tapioca, collocasia and sweet potato were collected in equal proportion from nearby fields and garden before the operation. The tools were assessed on allotted time period of 60 minutes, and the quantity of leaves cut were collected and weight after every 10 minutes interval. The following terms were used for performance assessment of the tools.

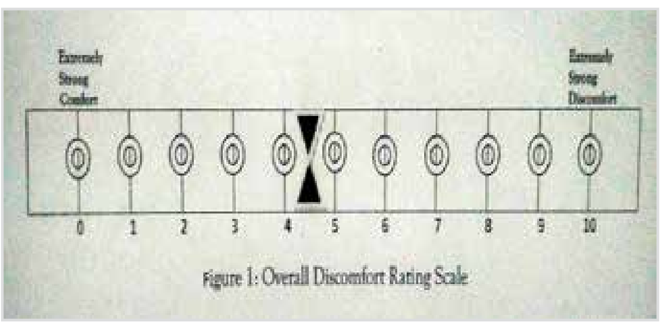

Figure 1: Overall Discomfort Rating Scale

Overall Discomfort Rating (ODR) scale technique developed by Corlett and Bishop (1976) was used for the assessment. The scale consisted of a 70 cm long graduated scale with its left marked as '0' and its extreme right as '10' that represented "Extremely strong Comfort" and "Extremely strong Discomfort" respectively. A sliding pointer was provided on the scale to indicate the discomfort level. After every performance the subjects were asked to give their overall discomfort rating on the scale by sliding the pointer (Fig 1). The overall discomfort ratings were averaged to get the mean rating. Musculo Skeletal Problems (MSP) experience by the subject during handling the tools was identified by indicating the pain in the body

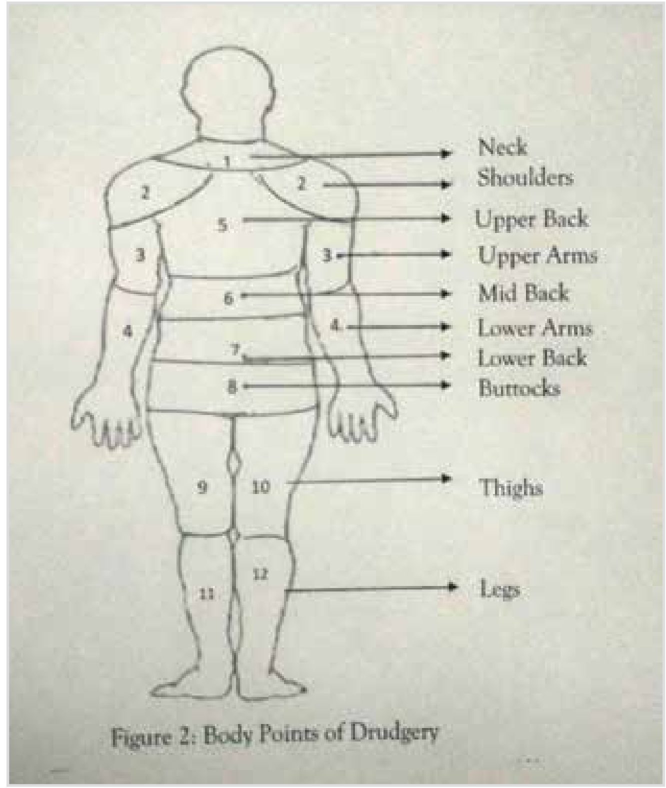

Figure 2: Body Points of Drudgery

map (Fig 2) after completion of every operation. Five point rating scale was used for recording the intensity of pain in various body parts *viz.,* 5, 4, 3, 2 and 1 for the intensity of pain as very severe, severe, moderate, mild and very mild, respectively. Rating of Perceived Exertion (RPE) was recorded in terms of pain and discomfort felt in body parts while performing the activity. Scale on perceived exertion developed by Varghese *et al* (1994) was used to assess the exertion. Attitude of the farmers towards the introduced tool were obtained through a questionnaire prepared for the purpose. They were asked to mark in favour of the best tool of their choice with respect to every satisfactory statement.

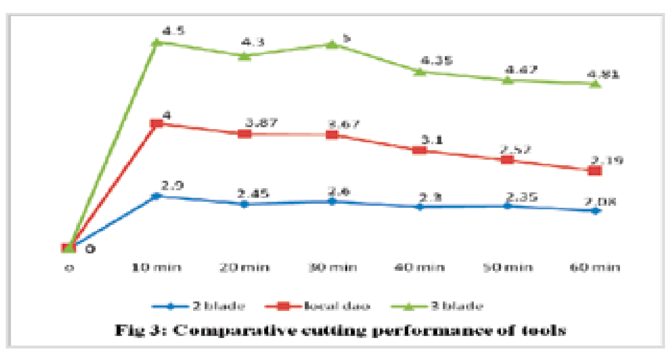

Fig 3: Comparative cutting performance of tools

Table 5. Attitude of farmers towards the tools. **(N=20)**

Sr. No	Statement	No of positive Responses		
		Local	2 blade	3 Blade
1.	Satisfaction with the tool for cutting purpose.	6(30.0)	5(25.0)	9(45.0)
2.	Satisfactory with the uniformity of size cut.	5(25.0)	5(25.0)	10(50.0)
3.	Satisfactory with the quality of material.	6(30.0)	5(25.0)	9(45.0)
4.	Satisfactory with ease of handling and operation.	8(40.0)	6(30.0)	6(30.0)
5.	Satisfactory with long hours of use.	4(20.0)	7(35.0)	9(45.0)
6.	Satisfactory with time saved.	13(65.0)	3(15.0)	4(20.0)
7.	Satisfactory with maintenance.	10(50.0)	5(25.0)	5(25.0)
8.	Satisfactory with drudgery reduction.	-	10(50.0)	10(50.0)
Mean score		5.2	4.6	6.2
Rank		II	III	I

(Figures in parenthesis denotes percentage)

RESULTS AND DISCUSSION

Freshly harvested green leaves were staged together at an ideal place for chopping. Three tools were used for its performance and compared for days. The tools were assessed for its capability to cut per hour and found that 3 blades chaff cutter on average had the capacity to cut 27.38 kg/hr over the local *dao* (19.35 kg/hr) showing an increase in cut by 41.49 per cent, while the capacity to cut the green plants in case of 2 blades (14.68kg/hr) was found to be less efficient as compared to the local *dao* (19.35kg/hr) on average with the same allotted time period (Table 1). A comparison of cutting between the three tools (Fig. 3) showed that 2 blades and 3 blades chaff cutter produce near consistent quantity of cuts throughout the assessment period, while the quantity produced by using local *dao* decreased gradually by 82.65% at end of assessment. It can be interpreted that local *dao* is handy for use only for a short time period and on continued use its efficiency decreases.

The operating cost (Table 2) for producing one quintal of green fodder was also tabulated for two different years. It found that the average cutting cost incurred by using 3 blades chaff cutter amounted to Rs.196/- which was the minimum expenditure among the three tools. The operating cost for the same tool during different years of 2019 and 2020 amounted to Rs 200/- and Rs 192/-, respectively. The average operating cost of local *dao* was estimated to be Rs 280.77 whereas it was Rs 366/- in case of chaff cutter with 2 blades.

The Time consumed to cut one quintal (Table 3) of green fodder was also recorded and found that maximum average time of 9.05 hr was taken by 2 blades chaff cutter followed by local *dao* (6.9 hr) and 3 blades chaff cutter (4.8 hr). Therefore, it can be assumed that 43.75% of precious time can be saved by using 3 blades chaff cutter to produce one quintal of green fodder.

Musculo Skeletal Problems

Musculo skeletal problems and posture exertion were obtained by asking the subject to express the pain felt in the body after chopping for hours with traditional *dao* and chaff cutter. It is shown (Table 4) that working in a particular posture for long hours cause fatigue and with the same working posture beyond certain time limit for years causes Musculo skeletal disorders in the body, thereby reducing the working efficiency of the subject. Working in squatting posture for long period might be the reason that almost all the subject reported severe and moderate pain in upper and lower back, lower arms, legs, necks, shoulders, hand and fingers, so the subject perceived the task as a heavy one(Joshi *et al,* 2018). On the other hand, by using 2 blades chaff cutter pain in upper back, legs, neck and fingers disappeared, while moderate to mild pain was felt in the shoulders, lower back, hand and arms. Likewise using the chaff cutter with 3 blades moderate to light pain was felt in shoulders, hand, arms and lower back. Chaff cutter was made to operate in a raised plate-form either on a stool or table that eliminated the sitting posture and reduce some body movement and exertion. The rating of perceived exertion was also reported to be moderately light with the improved tools.

Farmers' attitude towards the tool were obtained at the end of the performance. It was observed (Table 5) that the subjects were satisfied with their own local *dao* in respect to maintenance of the tool (50%) and time saved for cutting (65%). On uniformity of fodder size cut it found that half of the respondent (50 %) was satisfied with the introduced 3 blades chaff cutter. However, with respect to drudgery reduction with the tool, the respondent favoured equally (50:50) to both the introduced chaff cutter while it was nil response in case of local *dao*. The positive responses obtained in favour of each tool can be summarized and concluded that the chaff cutter with 3 blades obtained more favours followed by local *dao* and chaff cutter with 2 blades and ranked in the order of 3blades >local dao>2 blades, respectively.

CONCLUSION

The study found that the introduced 3 blades chaff cutter proved to be superior in many parameters as compared to the smaller 2 blades chaff cutter and the local *dao*. Local *dao* proved to be efficient initially during the early part of the experiment however, by evening its efficiency to cut reduced, this shows drudgery and Musculo skeletal increases with constant use over time. However, cutting consistency was observed in 2 blades and 3 blades chaff cutter, though the cutting efficiency of 2 blades was not comparable to the local *dao*, it can still be promoted for use as it reduced the musculo skeletal pain in body parts. Therefore, the two introduced chaff cutters may be popularized for backyard farming purpose. However, for large scale production of green fodder machine operated chaff cutter may be promoted.

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Composting *Limnocharis flava* Buchenau : A Comparative Analysis

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ABSTRACT

Limnocharis flava (L.) Buchenau is fast achieving the status of an invasive weed in the sandy loam soils of Onattukara, Kerala, India. There is high prospect for composting *Limnocharis* due to its nutrient recycling compared to the normal weed management through herbicides. The present study was undertaken with a view of recycling *Limnocharis flava* using various composting methods during November 2020 to January 2021 at Onattukara Regional Agricultural Research Station, Kayamkulam, Kerala. The treatments were T_1- normal composting, T_2 - vermi-composting, T_3 - composting using KAU inoculum and T_4 - composting using enriched *Pleurotus florida*. The design used was CRD and was replicated five times. The results revealed that all the composting methods tried had converted *Limnocharis flava* to quality compost. The highest recovery percentage was registered for vermi composting. The highest N, Ca and Fe contents were found to be in composts from *Pleurotus florida* (T_4) but the highest BC ratio was recorded for vermi composting (T_2). Hence, for commercial use, *Limnocharis flava* can be profitably converted to vermi-compost.

Key Words: Compost, Economics, *Limnocharis*, Nutrient uptake, Vermicompost.

INTRODUCTION

Water cabbage or Yellow bur-head, *Limnocharis flava* (L.) Buchenau is a weed which is fast achieving the status of an invasive weed in the sandy loam soils of Onattukara, Kerala, India. *Limnocharis flava* belongs to the family of Alismataceae. It is a native of tropical and sub-tropical America (Chandran and Ramasamy, 2015) and found to be invading swamps, shallow ditches and rice wetlands in Kerala. *Limnocharis flava* clogs irrigation channels, water drainages and wet lands making the area unsuited for cultivation. The weed is mainly propagated by seeds and a single plant is capable of producing 10,00,000 seeds every year. The weed can also propagate vegetatively. Since it flowers throughout the year, the seeds are easily dispersed through birds, animals and even by farm machineries. Hence eradicating the weeds prior to flowering is much necessary. The weed can be easily uprooted by hand and is the most effective method of weed eradication. But this is a very labour intensive and cost incurring process.

Onattukara sandy tract covers an area of over 71,000 ha extending from the sandy tracts of Alappuzha to Kollam and Pathanamthitta districts in Kerala. The main cropping system followed here is rice-rice-sesame. *Limnocharis flava* is now taking hold of the wetlands in this region (plate 1). The weed can effectively be managed by application of herbicides like 2,4-D (Nishan, 2012) or Glyphosate depending on the crop stand, but as the weed contains a large amount of nutrients, using herbicides will only result in the loss of these nutrients. The nutrients present in this weed can be recycled by composting. Water cabbage is ideal for composting (Anushma, 2014). Hence the present study was undertaken with a view of recycling *Limnocharis flava* using various composting methods.

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MATERIALS AND METHODS

A trial was carried out during November 2020 to January 2021 at Onattukara Regional Agricultural Research Station, Kayamkulam, Kerala with a view of utilizing the weed *Limnocharis flava* by composting. *Limnocharis flava* was collected and composted using different composting techniques. The treatments were T_1- normal composting, T_2 - vermi-composting, T_3 - composting using KAU inoculum, T_4 - composting using enriched *Pleurotus florida*. The design used was completely randomised design (CRD) and replicated five times. In normal composting, the weed biomass and cow dung were placed in layers. For vermi-composting, the weed biomass was mixed with cow dung in 8:1 ratio (on weight basis). Earth worms (*Eudrillus euginiae*) were introduced after 10d, after the completion of the thermophilic stage. In T_3 (composting using KAU inoculum), composting inoculum developed from the Department of Microbiology, College of Agriculture, Vellayani, Kerala was used. For every kilogram of the weed biomass, 10g inoculum on weight basis was used for composting and was filled in layers. In T_4, *Pleurotus florida* was used for composting the weed biomass and was enriched with urea (10 g). A layer of the weed was followed by a layer of *Pleurotus* and again by a layer of the weed followed by a layer of urea. This was repeated till the pots were filled up. Chopped pieces of coconut husks were placed before subjecting the pots to treatments to ensure proper drainage of excess moisture. Adequate moisture was given by watering at regular intervals. Turning was given at regular intervals to provide aeration. Days for compost maturity was recorded from the physical appearance of the compost. The recovery percentage was worked out to find the quantity of compost produced from biomass used and was measured by the formula,

$$\text{Recovery (\%)} = \frac{\text{Weight of compost}}{\text{Initial weight of biomass}} \text{ x } 100$$

Standard procedures were done for laboratory analysis. Nitrogen content was found out using the modified microkjeldahl method. Phosphorus, sulphur and boron was recorded using spectrophotometer. Potassium content in the compost was recorded using flame photometer. Atomic absorption spectrophotometer was used to record calcium, magnesium, iron, manganese, zinc and copper.

Plate 1. *Limnocharis flava* dominance at ORARS, Kayamkulam, Kerala

RESULTS AND DISCUSSION

The results revealed that all the composting methods converted *Limnocharis flava* to compost. The compost recovery was found to be the highest for vermi composting (T_2) with 12.47% followed by KAU inoculum composting (T_3) with 8.93% (Table 1). The population of earthworms after the trial in the treatment T_2 was found to be low. This was in accordance with the findings of Nishan and George (2014) who has also reported low earthworm population after the experiment. The lowest recovery (7.07%) was obtained for T_4 (composting using enriched *Pleurotus florida*) even though the time taken for compost was the lowest (60d) among all the treatments. The longest time taken for composting was recorded for the treatment T_1 (normal composting) with 70 d. Vermi composting (T_2) had taken 67 d for formation of compost. This is in confirmation with the studies of Bhat *et al* (2017) who had reported that vermicomposting accelerates the bioconversion process as compared to traditional composting. The colour of the composts produced were promising and of different colours (plate 2). Composts produced from normal composting and vermi-composting were black in colour whereas compost produced by using enriched *Pleurotus florida* had a brownish black colour. The compost produced using KAU inoculum was greyish black. This colour difference might be due to talc which is used for producing KAU inoculum.

Table 1. Effect of types of composting on recovery and days for composting.

Treatment	Recovery (%)	Days for composting
T_1- Normal composting	7.93	70
T_2- Vermi-composting	12.47	67
T_3 - Composting using KAU inoculum	8.93	64
T_4 - Composting using enriched *Pleurotus florida*	7.07	60

Plate 2. Composts prepared from different composting methods

Table 2 depict the effects of types of composting on the content of primary and secondary nutrients in compost from *Limnocharis flava*. Composting methods produced significant results for nitrogen. The highest nitrogen content (1.63%) was registered for T_4 (composting using *Pleurotus florida* which was followed by T_2 (vermi-composting) with 1.15 per cent. This increase in nitrogen may be due to the application of urea in T_4. Even though, the results were non-significant, the highest phosphorus was recorded for T_4 (0.19) followed by t_3 with 0.14 per cent. Highest potassium content was registered for the treatment T_1 (1.75%). But the treatments were not found to be significant. Among the secondary nutrients, highest calcium content was registered for T_1 with 0.55 per cent, but was found to be on a par with T_4 (0.54%). The highest magnesium content was registered by the treatment T_3 (0.032%). This may be due to the activity of various micro-organisms present in the KAU inoculum. Sulphur content was found to be more for vermi compost even though the result was not significant.

The highest iron content was recorded from T_4 with 10.06 mg/ kg but was found to be on a par with normal composting (T_2 - 8.99 mg/ kg). Zinc was found to be significantly higher for vermi-composting (T_2 - 1.78 mg/ kg) and was found to be at par with T_1 (1.73 mg/ kg). Even though copper and boron contents were found to be higher for T_2 (vermi-composting with 0.93 mg/ kg and 15.02 mg/ kg respectively), the effects were not found to be significant.

A detailed analysis of the cost of production (Table 4) revealed that the highest cost (₹ 3583/-) incurred for production of compost from one ton of *Limnocharis flava* was by composting using *Pleurotus florida* (T_4). This high cost of production might be due to the cost of *Pleurotus*, and urea that was used for enrichment. Normal composting (T_1) registered the lowest cost (₹ 1916/-) as the inputs needed for composting is less. The highest gross return was obtained for T_3- composting using KAU inoculum with ₹ 3126/-. Since the cost of production was more in T_3, the benefit cost ratio (BCR) was only 1.25. The treatment T_2 (vermi composting) registered the highest BCR with 1.53. The gross returns were also found to be ₹ 3115/-. The lowest BC ratio was recorded for T_4 (composting using enriched *Pleurotus florida*) with 0.69 which may be due to the low recovery percentage and higher cost of production.

Table 2. Effect of types of composting on primary and secondary nutrient status of compost from *Limnocharis flava*.

Treatment	N	P	K	Ca	Mg	S
T_1- Normal composting	0.2	0.11	1.75	0.55	0.028	0.0062
T_2- Vermi-composting	1.15	0.11	1.45	0.08	0.028	0.0076
T_3 - Composting using KAU inoculum	0.35	0.14	1.45	0.39	0.032	0.0074
T_4 - Composting using enriched *Pleurotus florida*	1.63	0.19	1.47	0.54	0.027	0.009
CD (0.05)	0.192	NS	NS	0.095	0.003	NS

NS- Not significant

Table 3. Effect of types of composting on micronutrient content of compost from *Limnocharis flava*, mg/ kg.

Treatment	Fe	Mn	Zn	Cu	B
T_1- Normal composting	8.99	2.16	1.73	0.8	14.85
T_2- Vermi-composting	6.42	1.7	1.78	0.93	15.02
T_3 - Composting using KAU inoculum	8.62	1.33	1.06	0.51	14.36
T_4 - Composting using enriched *Pleurotus florida*	10.06	1.71	1.08	0.67	14.78
CD (0.05)	2.33	NS	0.51	NS	NS

NS- Not significant

Table 4. Cost of production of different composts from one ton of *Limnocharis flava*.

Treatment	Cost of production (₹)	Gross returns (₹)	BC ratio
T_1- normal composting	1916.67	2776.55	1.45
T_2- vermi-composting	2033.33	3115.00	1.53
T_3 - composting using KAU inoculum	2500.00	3126.55	1.25
T_4 - composting using enriched *Pleurotus florida*	3583.33	2473.10	0.69

CONCLUSION

All the composting measures tried had converted *Limnocharis flava* to compost. The highest recovery percentage was registered for vermi composting. Highest N, Ca and Fe contents were found to be in T_4- composting using *Pleurotus florida*. The highest BC ratio was recorded for vermi composting (T_2). Hence, for commercial use, *Limnocharis flava* can be profitably converted to vermi-compost.

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Consumer Acceptance of Digital Printed Stoles Inspired from Kalamkari Motifs

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ABSTRACT

Stoles inspired from kalamkari motifs were prepared through digital printing technique on the basis of consumer preferences on silk fabric. Developed stole designs were evaluated by 90 respondents on the basis of design, colour combination, combination of motifs, printing quality, appearance of design and price acceptability. It was found that design 6(B) followed by design 10(A) obtained first and second ranks on the basis of uniqueness of the design, colour combination, printing quality and suitability of combination of motifs whereas stole design 6(B) and design 11(B) obtained first and second rank on the basis of appearance of the design. Majority of the respondents rated the prepared stoles as very good. The largest percentage of the respondents consider the quoted price of stoles as adequate. The price of the stoles ranged between Rs. 1450/- and Rs. 1650/-.

Key words: Acceptance, Consumer, Digital printing, Kalamkari motifs, Stoles.

INTRODUCTION

Kalamkari is an ancient textile art of India flourished more than 3000 B.C (Baral *et al,* 2018). The word Kalamkari is derived from a Persian word where kalam- pen and kari -craftsmanship (Anonymous, 2020). Kalamkari painted with natural dyes is the oldest hand painted and block printed cotton textile in Andhra Pradesh. In Srikalahasthi town the art is done with hand painting and in the town of Machilipatnam block printing style is used (Anonymous, 2017).

Today's fashion isn't limited to apparel; it now encompasses a wide range of accessories. It is diverse in terms of accessories such as stoles, bags, belts, ties, jewellery and other fashion accessories are widely available in the market. A stole is typically narrower than a shawl and wrapped around the shoulders or arms. Stoles are now one of the most fashionable outfits of the global market. Because of their fashionable style and exquisite craftsmanship, women prefer to wear them on a daily basis. Stoles complement a wide range of formal and informal attire (Meenu *et al,* 2016). One of the best ways to add interest to woven fabrics is through printing. Different printing processes, such as screen and digital printing, can be used to create extraordinary and unique designs. Direct to garment printing is another name for digital printing. (Rashmi and Kulloli, 2020).

Digital textile printing has the ability to produce short-run prints with a high turnover rate, which has a significant impact on the mass-customization industry. These technologies can provide designers with an ever-expanding range of creative possibilities, as well as increasingly sophisticated design ideas and decision points (Katherine and Thompson, 2016).

The water based inks used in digital printing are eco-friendly as all of the ink stays on the fibre and doesn't get up in the waste water and need only little water in washing them. As a result, in order to reduce pollution, textile design with digital printing is an environmentally responsible alternative (Rashmi and Kulloli, 2020). The present study was undertaken to prepare the eight most preferred stole designs through digital printing to assess the

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Design 2(A)


Design 6(B)


Design 7(A)


Design 10(A)


Design 11(B)


Design 12(A)


Design 14(B)


Design 15(B)

consumer acceptance of prepared stoles and to study the economic assessment of the prepared stoles.

MATERIALS AND METHODS

The present study was carried out by printing of selected stole designs through digital printing technique on silk fabric using tints and shades of kalamkari art. A total of 90 respondents (college girls) were selected through random sampling technique from three colleges of Punjab Agricultural University, Ludhiana. An interview schedule was developed and employed for obtaining the preferences of the respondents for developed stole designs. On the basis of preferences of the respondents, eight top ranked designs of stoles were selected for printing. The consumer acceptability was studied on the basis of uniqueness of the design, colour combination, printing quality, suitability of combination of motifs and appearance of the design. Frequency, percentage, scoring and ranking were used to get the preferences for different types of stoles.

RESULTS AND DISCUSSION

The digitally printed stoles were assessed on the basis of uniqueness of design, colour combination,

Table 1. Evaluation of printed stoles on the basis of different design parameters. n=90

Design code	Uniqueness of design		Colour combination		Motif Combination		Printing Quality		Appearance of Design	
	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank	WMS	Rank
6(B)	5.47	I	5.57	I	5.43	I	5.60	I	5.43	I
10(A)	5.43	II	5.40	II	5.37	II	5.53	II	5.30	III
11(B)	5.37	IV	5.33	III	5.30	III	5.40	V	5.33	II
15(B)	5.40	III	5.27	IV	5.20	IV	5.47	IV	5.17	IV
12(A)	5.13	VI	5.17	V	5.07	VI	5.37	VI	5.07	V
14(B)	5.20	V	5.13	VI	4.93	VII	5.33	VII	5.03	VI
2(A)	4.93	VIII	4.93	VII	5.13	V	5.50	III	4.93	VII
7 (A)	4.97	VII	4.80	VIII	4.67	VIII	5.03	VIII	4.77	VIII

suitability of combination of motifs, printing quality, appearance of design, general opinion and suitability of price for the prepared stoles. The data given by the respondents were evaluated (Table 1) in the order of top ranked to least ranked.

Evaluation of stoles on the basis of uniqueness of design

The data (Table 1) revealed that first rank in uniqueness of the design was given to the stole design 6(B) with the mean score of 5.47 followed by the stole design 10(A) with a score of 5.43. Design 15(B), 11(B), 14(B) and 12(A) with mean score of 5.40, 5.37, 5.20 and 5.13 were given third, fourth, fifth and sixth rank respectively. Seventh and eighth ranks were given to design 7(A) and 2(A) with mean score of 4.97 and 4.93 respectively.

Evaluation on the basis of colour combination of the design

Design 6 (B) received first rank for the colour combinations of the printed stoles with a mean score of 5.57, while 10(A) got second rank with a mean score of 5.40. Design 11 (B), 15(B), 12(A) and 14(B) were ranked third, fourth, fifth and sixth with a mean score of 5.33, 5.27, 5.17 and 5.13 as shown in table 1. Design 2(A) and 7(A) got the seventh and eighth rank, respectively, with mean scores of 4.93 and 4.80.

Suitability of combination of motifs

On the basis of combination of motifs, the stole design 6(B) with mean score of 5.43 was given first rank followed by design 10(A) and 11(B) were given second and third ranks with mean score of 5.37 and 5.30 respectively. The design 15(B), 2(A) and 12(A) with a mean score of 5.20, 5.13 and 5.07 were given fourth, fifth and sixth rank respectively. Design 14(B) and 7(A) were given rank seventh and eighth with a mean score of 4.93 and 4.67 respectively (table 1)

Quality of printing

Data (Table 1) shows that design 6(B) was given first rank with a mean score of 5.60 on the basis of quality of printing. The design 10(A), 2(A), 15(B) and 11(B) with a mean score of 5.53, 5.50, 5.47 and 5.40 ranked second, third, fourth and fifth places respectively. The design 12(A) and 14(B) ranked sixth and seventh ranks with a mean score of 5.37 and 5.33, respectively whereas design 7(A) ranked eighth with mean score of 5.03.

Appearance of the design

Stole design 6(B) with mean score of 5.43 was given first rank on the basis of appearance followed by design 11(B), 10(A), 15(B) and 12(A) which were given second, third, fourth and fifth ranks with mean score of 5.33, 5.30, 5.17 and 5.07 respectively. Stole design 14(B) and 2(A) were given sixth and seventh rank with mean score of 5.03 and 4.93 respectively. The design 7(A) was given eighth rank with mean score of 4.77.

General opinion of the respondents regarding prepared stoles

The general opinion on the printed stoles was taken from the respondents and categorised into three categories: very good, good, and fair. The data (Table 2) revealed that the stole design 2(A) was considered good by 46.67 per cent of respondents followed by 30 per cent who considered them as very good, only 23.33 per cent of the respondents rated this stole as fair. Majority of the respondents *i.e.,* 86.67 per cent of the respondents considered stole 6(B) as very good whereas only 13.33 per cent considered it as good. Stole design 7(A) was given fair rating by 40 per cent of the respondents followed by 33.33 and 26.67 per cent who considered it as good and very good, respectively. Stole 10(A) was considered very good (73.33%), good (20%) and fair(6.67%) of the respondents. The stole design 11(B) and 12(A) were considered very good by 80 and 60 per cent of the respondents, followed by 16.67 and 33.33 per cent thought they were good; 3.33 and 6.67 per cent of the respondents considered them as fair respectively. Stole 14(B) was considered very good and good by 40 per cent of respondents each and fair by 20 per cent of the respondents. The majority of respondents 66.67 per cent considered stole design 15(B) as very good, followed by 30 per cent who thought it was good and 3.33 per cent considered it fair.

Table 2. General opinion of the respondents regarding the developed stoles. n=90

Design code	Very good %	Good %	Fair %
2(A)	30.00	46.67	23.33
6(B)	86.67	13.33	-
7 (A)	26.67	33.33	40.00
10(A)	73.33	20.00	06.67
11(B)	80.00	16.67	03.33
12(A)	60.00	33.33	06.67
14(B)	40.00	40.00	20.00
15(B)	66.67	30.00	03.33

Table 3. Cost calculation for the prepared stoles.

Stole Design code	Raw Material Cost (Rs)				Calculated Cost and Quoted Price (Rs)		
	Fabric Cost(a)	Printing Cost(b)	Embellishments (c)	Finishing cost (d)	Cost Price (a to d)	Profit Margin (30%) (P)	Quoted Price
2 (A)	400	650	60	50	1160	348	1508
6 (B)	400	700	50	50	1200	360	1560
7 (A)	400	600	50	50	1100	330	1430
10 (A)	400	750	60	50	1260	378	1638
11 (B)	400	650	50	50	1150	345	1495
12 (A)	400	750	50	50	1250	375	1625
14 (B)	400	600	50	50	1100	330	1430
15 (B)	400	750	60	50	1260	376	1638

Table 4. Respondents opinion regarding the suitability of price for prepared stoles. n=90

Design code	Quoted price of stoles(Rs)	High	Adequate	Low
		%	%	%
2(A)	1510	26.67	73.33	-
6(B)	1600	23.33	73.33	03.33
7 (A)	1450	23.33	66.67	10.00
10(A)	1650	40.00	56.67	03.33
11(B)	1500	20.00	76.67	03.33
12(A)	1650	50.00	50.00	-
14(B)	1450	16.67	80.00	03.33
15(B)	1650	43.33	56.67	-

Cost of the printed stoles

The cost of the digitally printed stoles was calculated by doing the sum of raw materials used. The quoted price was calculated by adding 30% profit margin to cost price.

The cost of the stoles included fabric cost, printing cost, embellishment cost and finishing cost. The profit margin given for the stoles was 30% of the cost price. The quoted price was the sum of the cost price and the profit margin. The cost of the stoles varies with the layout of the design and colours used. The cost price and quoted price for stole designs 7(A) and 14(B) was minimum i.e., Rs. 1430/- whereas, it was maximum for stole designs 10(A) and 15(B) *i.e.,* Rs. 1638/-.

Suitability of price of the prepared stoles

The data (Table 4) showed that in design 2(A), 73.33 per cent of the respondents considered the quoted price to be adequate followed by 26.66 per cent who consider it to be high. For stole design 6(B), 73.33 per cent of the respondents were of the view that quoted price was adequate, 23.33 per cent quoted price was high, whereas only 3.33 per cent considered the quoted price of this stole as low. For stole design 7(A), 66.67 per cent of the respondents considered the quoted price as adequate, 23.33 per cent of the view that the quoted price was high and 10 per cent reported it to be low.

The quoted price of the stole design 10(A) was considered adequate (56.67%) followed by 40 per cent and 3.33 per cent of the respondents who considered the quoted price to be high and low, respectively. In case of design 11(B), 76.67 per cent of the respondents considered the quoted price as adequate followed by 20 per cent who ranked it as high and 3.33 per cent considered the quoted price as low. The quoted price of the stole design 12(A) was considered adequate by 50 per cent of the respondents followed by 50 per cent per cent who considered the quoted price to be high and none of the respondents considered design 12(A) as low. The design 14(B), 80 per cent of the respondents considered the quoted price to be adequate followed by 16.66 per cent and 3.33 per cent who consider it to be high and low respectively. For stole design 15(B), 56.67 per cent of the respondents were of the view that quoted price was adequate, 43.33 per cent of the respondents were of the view that the quoted price was high, whereas none of the respondents considered the quoted price of this stole as low.

CONCLUSION

It can be concluded that the designed stoles can be used with both traditional and western attire, making them multifunctional. When compared to least liked stole designs 2(A) and 7(A), which have motifs only at the borders, the majority of respondents thought stole design 6(B) was very nice because of its overall pattern on the stole and unique motif arrangement. This information can be further used effectively by designers who are working for custom designing. The fusion of traditional kalamkari motifs and contemporary design elements used in this study would be great inspiration to the budding designers. The digital printing of kalamkari motifs on silk stoles is a new approach which made traditional art revived. The printing quality of digital printing is very precise, thus making it easy to print intricate kalamkari motifs. There was significant difference in selling price and cost price of the stoles. The cost price of stoles would be lower when produced in mass and profit margin is expected to be higher. Other products like household articles, bags, foot wears etc. can also be developed using similar techniques.

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Creation of Self employment through Coconut tree Climbing at Ariyalur District

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ABSTRACT

The Krishi Vigyan Kendra across the country is making relentless efforts to develop entrepreneurial and self employment skills among the rural youth. The ICAR KVK of Ariyalur District is imposing special emphasis in this line and conducted the six days practical training on climbing of coconut trees using climing device to 160 trainees with the financial assistance of coconut Development Board, Cochin during the year 2017 to 2020. The impact study conducted by the KVK, Ariyalur among the 100 ex-trainees showed that ninety percent of the trainees using the climbing device for climbing of Coconut tree both on their own trees and as a profession to earn income. As this training involves more practical exposure and easiness of climbing device facilitated the trainees to become professional climbers. By these trainings eighty three person became tree climber and thereby a mandays of 24,500 per year created to the youth members. They could earn a sustained income of Rs.22,500/month and secured their livelihood. The correlation analysis of profile characters versus extent of adoption by the respondents also showed that education (0.575**), farm size (0.457**), social participation (0.356**), risk bearing capacity (0.543**) and motivation orientation (0.648**) had highly significant positive impacts over extend of adoption of climbing device for coconut tree climbing.

Key Words: Skill training, Entrepreneurship, Correlation, Income, Employment.

INTRODUCTION

Krishi Vigyan Kendra designs different types of training courses for the farmers, farm women and rural youth which is an important aspect of the entrepreneurship development and considered as part of strategy for growth and development of an organization. Basically, training is intended to help individuals to learn and to bring the desired standard of efficiency, condition and behaviour (Sharmal *et al*, 2013). Rural youth are the backbone of a country. Youth minds are creative and they are capable of handling risk factors such as monsoon management, climatic change adaptation and poverty in an efficient way, using various technologies. Rural youth account for 55 percent of the world youth population. In India, rural youth constitute over two-and-half times of the size of urban youth. They form a vital human resource. Rural youth therefore should be brought into the mainstream of the rural development process in general and agriculture in particular. Rural youth have significant contributions to the local and national economy by being participated in Income Generating Activities (IGA's) such as vegetable production, nursery establishment, crop production, mushroom cultivation, bee keeping, livestock, goatry and poultry, cottage industry and small business etc. Unfortunately, the rural youth community is almost unknown to modern agricultural technology and has been left out from the main stream of economic development (Mondal, 2006).

The total population of Ariyalur District is 7,52,481 of these 3,51,270 are farmers. The youth members (19-35 yr) constitute 36 per cent of the total population and about 30% of them are unemployed or underemployed. ICAR – Krishi Vigyan Kendra (KVK) hosted by CREED, Ariyalur has conducted

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training programmes to unemployed rural youth in collaboration with Coconut Development Board, Cochin. The name of the training was "Coconut tree climbing using climbing device' under friends of coconut trees (FOCT) concepts. The preferred age of the trainees was 18 to 45 yr. In total 160 rural youth were trained during last three years from 2017-18 to 2019-20.

The term coconut can refer to the entire coconut palm, the seed or the fruit, which, botanically, is a drupe, not a nut, weighs 1.2-2 kg. It is a tall perennial tree crop, which, when fully matured, attains a height of about 15m to 30 m crowned by 28 to 32 pinnate leaves, with fruit bunches of varying age, one each in each axil (George, 2018). But in recent days coconut farmers are facing serious problems in coconut harvesting due to the shortage of trained climbers to harvest the nuts and clean the trees annually. It costs high ranging from Rs.50 – 80 per tree for climbing and harvesting. The drudgery is generally perceived as physical and mental strain, agony and monotony and hardship experienced by human being (Tiwari *et al,* 2018) and climbing of coconut tree is the drudgery involved and dangerous work too.

The present study was undertaken to assess the impact of FOCT trainings on income and employment generation to rural youth and its role on reducing problems in coconut harvesting.

MATERIALS AND METHODS

By considering the problem of shortage of trained tree climbers, the Coconut Development Board, Cochin have introduced the training on climbing of coconut trees using a safe and easy to use climbing device. During 2017-18 to 2019-20 eight such a training programmes were conducted with the financial support of Coconut Development Board (CDB) to 160 coconut farmers or youth members to impart the skill of using palm climbing device and management of coconut plantations for sustainable yields. After successful completion of the training they were provided with a palm climbing device, free accidental insurance for one year and a certificate of completion so as to enable him to take this as his profession. These trainees were linked with Coconut Development Board to get regular advices and schemes related to coconut farming. Out of 160 trainees, 100 trainees were selected by using simple random sampling. The information pertaining to tree climber by traditional methods and advanced method of using climbing device was collected by using a well-structured pretested schedule. Farmers adopt them either fully, partially or do not adopt at all. Score 3, 2 and 1 was given for fully, partial and non-adoption respectively. The data were statistically analyzed by using correlation parameters.

RESULTS AND DISCUSSION

Trainees adopted the coconut tree climbing device in two ways one is for harvesting their own coconuts and remaining one as a profession for income generating purpose. The trainees expressed that the device is time saving, simple and safe and reduced the harvesting cost. The device was so designed to attract the youth and non-traditional coconut climbers to take up coconut harvesting as vocation. The small farmers with few numbers of coconut trees were very happy to harvest nuts by their own by using this simple device.

It was observed that 52.0 percent of the trainees were fully adopted the coconut tree climbing device as an income generating activities by climbing others trees for wage. A person could climb 25 to 30 trees in a day and earned Rs.750 to 1000/day. About 38.0 percent of the trainees were partially adopted the device for climbing for wage, only 10.0 percent of the farmers were not adopted this device. About 80 per cent of the trainees were adopted the coconut tree climbing device for earning income and remaining 20 per cent of the trainees adopted the device for harvesting their own coconuts. This might be due to the fact that most of the rural youth trainees were enthusiastic in participation of trainings as it involves more practical exposures and easy to climb

Table 1. Correlation analysis of profile characters and their extend of adoption of coconut tree climbing device.

Sr. No.	Profile character	Correlation Co-efficient ('r' valve)
1	Age	-0.226 NS
2	Education	0.575**
3	Farm size	0.457**
4	Farming experience	-0.279*
5	Family type	0.047**
6	Annual income	-0.279*
7	Social participation	0.356**
8	Mass Media exposure	0.268*
9	Extension agency contact	0.330*
10	Training exposure	0.285*
11	Risk bearing ability	0.543**
12	Motivation orientation	0.648**

* = significant at 0.05 level of probability; ** = significant at 0.01 level of probability

apart from ensuring safety. As Ariyalur district is having limited coconut plantations, the trained climbers preferred to go to the nearby districts also to climb the trees and get income. The problem of coconut growers in harvesting the nuts at high cost (Rs.50-80/tree) using the traditional climbers were solved to the maximum extend as they could use these trained climbers at Rs.25-30/tree.

A perusal of data presented in table 1 revealed that, among the twelve profile characteristics of respondents studied, nine characteristics namely education, farm size, family type, social participation, mass media exposure, extension agency contact, training exposure, risk preference and motivation orientation were significantly correlated with adoption of coconut climbing device. However, age, farming experience and annual income were negatively correlated with adoption of coconut climbing device for nut harvest and crown cleaning.

Education and farm size paves the way to quench the need for information for adoption. Social participation could act as supporting psychological variable to verify and clarify the misconception in adoption of the device. Mass media exposure, extension contact and training exposure facilitated quick acquisition of knowledge and better adoption. This was in consonance with the findings of Sriramana (2014) that the profile characteristics namely age, education, mass media exposure and extension contact were found to be positively significant in terms of knowledge gain and adoption of technologies among the cashew growers.

It was evident from Table 2 that among the methods of climbing, 83 youth members out of 160 persons trained were involved in tree climbing as a profession. Number of trees climbed / month by one person was 750 trees and thereby Rs.22,500 could be earned by a person per month. About 24,500 mandays of employment is being generated per year to the 83 tree climbers. This was mainly due to use of advance method of climber leads easy to climb the tree, without any life accidental risk by using coconut climber over other method of harvesting of coconuts. Whereas, manually climbing the tall trees, experienced body pain,

Table 2. Income and employment generation to youth members of Ariyalur by climbing coconut tree using tree climber .

No. of persons involved in tree climbing as a profession	No. of trees being climbed / month / person	Cost/tree (Rs.)	Income generation/ Person (Rs.)	Employment generation / year (Mandays)
83	750	30	22,500	24,500

muscles catch and with lot of risk while climbing and very difficult to meet out financial needs of a family with meager earnings. Rachna *et al* (2013) also reported that the training programmes related to agriculture and animal husbandry can also play a significant role to alleviate poverty and generate employment opportunity for educated unemployed youth. Hence, the friends of coconut trees trainings designed by the Coconut Development Board and imparted by different KVKs certainly could reduce the risk of tree climbing and body pain besides easing out to climb a greater number of trees per day. This could pave the way for increased income and the employment to the rural youth.

CONCLUSION

The study partially and fully has shown that ninety per cent of the trainees were adopted the coconut tree climbing device. Correlation analysis also indicated that education, farm size, family type, social participation, mass media exposure, extension agency contact, training exposure, risk preference and motivation orientation were significantly correlated with adoption of coconut climbing device. The study concludes that coconut climber equipment is a boon for the coconut harvesters, since it has reduced the drudgery in tree climbing and improved the climbing efficiency there by providing employment opportunity for rural youth, which has helped them to improve their livelihood.

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Direct Seeding Through Seed Drill is Advantageous for Increasing Productivity and Profitability of Rice *(Oryza Sativa)* in Western Parts of Kurnool District of Andhra Pradesh

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ABSTRACT

Krishi Vigyan Kendra, Banavasi conducted thirty front line demonstrations on direct-sown rice with seed drill at farmer's fields of different villages in Kurnool district of Andhra Pradesh from 2017-18 to 2019-20. This DSR method showed an increase in average yield (6151 kg/ha) in comparison to TPP (5482 kg/ha). In the case of DSR, the growth parameters plant height (75.2cm), productive tillers/hill (20.7 no), plants/m^2 (34.1 no), and panicle length (19.1cm) were significantly higher as compared to the TPR method. Comparative economics of DSP and TPP method of paddy cultivation revealed that there was a difference in cost of cultivation of nearly Rs.10,000 to 12,000/ha. The benefit-cost ratio of 2.65 was also much higher than the TPR (1.95). The lower net returns of Rs.61,669/ha and low benefit-cost ratio of 1.95 indicated the non-profitability of paddy cultivation under the TPR method in the Kurnool district. Labour shortage would become a major problem after a lockdown in the agriculture sector. Thus, it could be recommended that direct seeding through seed drill may be advantageous for increasing the productivity and profitability of rice.

Key Words: Direct seeded rice (DSR), Transplanted rice (TPR), Frontline demonstrations, Economics, Labour shortage.

INTRODUCTION

Direct seeded rice (DSR) as a resource conservation technology has several advantages over transplanted rice systems (TPR) (Mohanty, 2014). It helps in minimise water consumption as it does away with raising of seedlings in nursery, puddling and transplanting. Thus, it decreases the labour required to the extent of about 40 per cent and water saving up to 60 per cent from nursery raising, field preparation, seepage, and percolation and evaporation losses. It offers certain advantages *viz*., less labour, less water requirement, less drudgery, early crop maturity (7-10 d), low cost of production, proper placement of seed and fertilizer, increase fertilizer use efficiency, improve soil health for crops and less methane emission, in different cropping systems. (Kaur and Singh, 2017). Evidence from long-term experiments showed that crop yields of paddy are stagnating and sometimes declining (; Ladha *et al,* 2003). The yield through the transplanting method has been limited by a number of factors such as labour intensive and cumbersome and it is a real drudgery to womenfolk. The major operations like nursery preparation and its management, pulling out seedlings, transporting and distribution of seedlings to the main field and transplanting consumes 25-30 per cent of the total cost of cultivation in trans-planted rice. This can be replaced by direct seeding that can reduce labour needs by more than 20% in terms of the working hours required (Santhi *et al,* 1998). The raising of nursery and manual transplanting are both labour intensive and costly prepositions (Das, 2003). Many innovations have contributed to the expanding use of resource-conserving technologies in the country. In this regard, one of the most important technology has been introduced seed-cum-fertilizer drill which can establish crops with a minimum of soil disturbance. This seed-cum-fertilizer drill can take the best advantage of residual soil moisture

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and thereby reduce irrigation requirements can help in improving the timeliness of sowing, can place seed and fertilizer nutrients at suitable soil depths, (Sing *et al,* 2012). Keeping the above facts in view, the present study was undertaken for resource conservation in rice by introducing direct-seeded rice (DSR) at the farmers' fields during 2017, 2018 and 2019 with an objective to study direct-seeded rice over the traditional method of transplanting.

MATERIALS AND METHODS

Kurnool District lies between the northern latitudes of 140 54' and 160 18' and eastern longitudes of 760 58' and 790 34'. The altitude of the district varies from 100 ft above the mean sea level. Frontline demonstrations were conducted to introduce direct-seeded rice (DSR) in Banavasi and Ventapuram blocks (10 demonstrations each year). Beneficiary selection for FLDs on DSP was done through discussion and personal contact with farmers on the basis of certain socio-personal characteristics like socioeconomic status, innovativeness, progressiveness and risk orientation. All the technological intervention was taken as per the prescribed package and practices for improved varieties of rice crops. The seed rate for DSR and TPR was 25 and 75 kg/ha, respectively. The variety sown both in DSR and TPR was BPT-5204. Sowings were done in the first fortnight of August. The recommended dose of fertilizers (240:80:80 NPK kg/ha) was applied in the demonstration field. The grain yield, input cost, net return, and additional returns were recorded and assessed of gaps in the adoption of recommended technology before laying out the frontline demonstrations (FLDs) through personal discussion with selected farmers. During three years of assessment the observations like plant height (cm), panicle length (cm), productive tillers (number), yield (kg/ha), were recorded. The yield data were collected from both the demonstration and farmers practice by random crop cutting method and analysed by using simple statistical tools.

Economic parameters

The cost of cultivation (Rs/ha) was estimated by considering the prevailing charges of agricultural operations and the market price of involved inputs. Over the course of studies, gross returns were obtained by converting the yield into monetary terms at the prevailing market rate. Net returns were obtained by deducting the cost of cultivation from gross return. The benefit-cost ratio was calculated by dividing gross returns per ha by cost of cultivation per ha.

Gross return (Rs/ha) = (Seed yield x Price)

$$\text{Benefit: Cost ratio} = \frac{(\text{Gross returns per ha})}{(\text{Cost of cultivation per ha})}$$

Net returns (Rs/ha) = [Gross return (Rs/ha) - Cost of cultivation (Rs/ha)]

RESULTS AND DISCUSSIONS

Effect of Direct seeded Rice on growth and yield attributes:

The data (Table 1) showed that the highest plant height observed in DSR (75.16, 75.19 &74.98 cm) as compared with TPR (69.84, 69.91 & 69.58 cm) in all three years in both blocks of Kurnool district. A perusal of the data (Table 2) showed that the number of plants/m^2 were found highest in DSR (20.3, 21.8 & 20.5) as compared to TPR (27.4, 27.7 & 27.2) in 2017, 2018 and 2019 respectively. The p-value from table 2 (=0.000) was less than 0.01 in all three years, indicates that there is a significant difference between the two practices with regard to the number of plants/m^2. The data (Table 3 & 4) revealed the panicle length (21.8, 21.7 & 20.5 cm) and a number of productive tillers (20.3, 21.4 & 20.7) were recorded highest in DSR than TPR. These findings were also supported by Roy *et al* (2009) that the increased/optimum plant density under DSR may be attributed to higher plant height and the highest number of effective tillers/hill whereas TPR produced the lowest number of effective tillers/hill. Higher tillering exhibited by the crop as a result of better crop growth underline

Table 1. Effect of direct seeded rice on Plant height (cm).

	2017				2018				2019				Pooled			
Technology Option	Mean	SD	t value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value
DSR	75.16	0.27	5.06	0.003*	75.19	0.43	5.18	0.000*	74.98	0.17	5.14	0.000	75.10	0.36	8.92	0.000*
TPR	69.84	3.14			69.91	3.02			69.58	3.13			69.75	0.35		

** Significant at 0.05% level of probability*

Table 2. Effect of direct seeded rice on No of plants/sq.m

	2017				2018				2019				Pooled			
Technology Option	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value
DSR	34.4	2.2	8.3	0.000*	34.1	1.5	8.30	0.000*	34.3	1.9	7.36	0.000*	34.1	1.9	12.13	0.001*
TPR	27.4	2.5			27.1	1.7			27.2	2.1			27.5	2.07		

** Significant at 0.05% level of probability*

Table 3. Effect of direct seeded rice on No of productive tillers/sq.m

	2017				2018				2019				Pooled			
Technology Option	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value
DSR	20.3	1.2	5.52	0.000*	21.4	1.56	5.87	0.000*	20.5	1.18	5.60	0.000*	20.7	1.32	9.11	0.000*
TPR	16.5	1.7			17.1	1.61			16.4	1.68			16.7	1.49		

** Significant at 0.05% level of probability*

Table 4. Effect of direct seeded rice on Panicle Length (cm)

	2017				2018				2019				Pooled			
Technology Option	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value
DSR	21.8	0.52	12.7	0.000*	21.7	0.77	12.15	0.000*	20.5	0.55	13.31	0.000*	21.3	0.69	19.07	0.000*
TPR	18.26	0.27			18.3	0.32			16.4	0.40			18.3	0.37		

** Significant at 0.05% level of probability*

Table 5. Effect of direct seeded rice on Yield kg/ha

	2017				2018				2019				Pooled			
Technology Option	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value	Mean	SD	t-value	P value
DSR	6151	116.3	8.85	0.000*	6180	146.44	8.30	0.000*	6143	116.3	9.06	0.000*	6151	126	15.59	0.000*
TPR	5490	190.1			5487	202.87			5470	190			5482	195.85		

Table 6. Year wise economic evaluation of Direct seeded Rice

Year	Cost of Cultivation (Rs/ha)		Gross Returns (Rs/ha)		Net Returns (Rs/ha)		B:C Ratio	
	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR
2017	51029	62863	135322	120780	84293	57917	2.651865	1.921321
2018	53450	64500	142140	126201	88690	61701	2.659308	1.956605
2019	54500	65800	147432	131280	92932	65480	2.705174	1.995137
Average	52993	64387	141631	126087	88638	61699	2.67	1.95

sowing may have resulted in a higher number of panicles/m^2. The data (Table 5) showed that the yield was recorded highest in DPR (6151, 6180 & 6143 kg/ha) as compared to TPR (5490, 5487 & 5470 kg/ha). Since the p-value from table 5 (=0.000) is less than 0.01 in all three years, hence it can be concluded that there was a significant difference between the two practices with regard to yield in which improved practice significantly more yield, than that of farmers' practice. This was also supported by Srilatha *et al* (2013) and Singh *et al* (2018).

Economics analysis

Economic performance of direct-seeded rice under frontline demonstration was depicted in (Table 6). The results revealed that the recorded lowest cost of cultivation in DSR in all three years is due to labour charges and also for irrigation. The gross returns from recommended practice (FLD's) were Rs 135322/ha, 142140/ha and 147432/ha as compared to 120780/ha, 126201/ha, and 131280/ha in farmer's practice. The benefit-cost the ratio of rice varieties also recorded higher in recommended practice with 2.66, 2.65, and 2.70 as compared to 1.92, 1.95, and 1.99 in farmer's practice. The higher net returns and B:C ratio in rice demonstration might be due to the higher grain yield of the product in the market. Recommended practice (FLDs) proved beneficial in respect of yield and economics of rice in consecutive blocks of Kurnool District in Andhra Pradesh.

CONCLUSION

The present study revealed that efforts have been made for resource conservation in rice by introducing direct-seeded rice (DSR) gave higher yield and net returns in recommended practice (FLD's) than farmers' practice in the Kurnool district. The highest grain yield was attributed to higher potential with improved technology, timely sowing, nutrient management, weed management, and insect, pest, and disease management in accordance with package and practice. Economic analysis of different parameters revealed that net returns and additional gain were recorded highest with recommended practice (FLD's). Farmers showed a great response in adopting the techniques of direct-seeded rice (DSR along with other recommended technologies of IPM, balanced use of fertilizers, use of herbicides, and irrigation management in the rice field. The study was concluded that direct sowing rice proved beneficial in respect of yield and economics.

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Economic Analysis of Input Subsidies Availed by Farmers in Punjab

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ABSTRACT

Input subsidies are given in the farming sector to encourage the farmers to use the resources judiciously for getting higher yield level of crops. The direct subsidy benefit is realized by the farmers in monetary terms by reduction in price of farm inputs, farm machinery etc. while indirect subsidies are mostly given especially for chemical fertilizers, electric power supply for running tube wells to irrigate crops. Keeping in view the importance of subsidies in agricultural sector, the present study was undertaken to work-out the quantum of input subsidies availed by Punjab farmers with major emphasis on paddy and wheat crops. The data were collected from a representative sample of 180 farmers from all farm categories encompassing one district each selected randomly from three agro-climatic regions of Punjab. The results revealed that the quantum of direct subsidy facility provided by the government departments was mainly availed by medium, large farm category farmers showing disparity in their distribution. Crop-wise subsidy pattern showed that paddy cultivation availed Rs. 8486/-ha subsidy while it was Rs. 5763/-ha in case of wheat crop. The analysis revealed decline in net returns from paddy and wheat crops by about 13 and 11 per cent, respectively due to withdrawal of input subsidies. Fertilizer, power and diesel subsidies availed by large and medium farm category farmers were comparatively higher than being used by their counterparts. The crop-wise analysis revealed major subsidy chunk being used for raising paddy and wheat crops due to higher area under these crops. Major policy option brought out was to lay emphasis on rationalization of subsidies largely in favour of marginal and small farmers while giving with a rider to medium and large category farmers in order to decrease economic disparity in the agricultural sector.

Key Words: Subsidy, returns, farm category, rationalization.

INTRODUCTION

Agricultural subsidy is a way of improving the profitability of input use, in addition to raising physical productivity of inputs, improving efficiency to reduce the cost of inputs and increasing output prices. Subsidy can be considered as a benefit given by the Government to group or individuals as an opportunity to raise productivity and reducing cost (Morris *et al*, 2007; Jayne *et al*, 2009; Bumb *et al*, 2001). The substantial success of green revolution in the country has been assisted by input subsidies especially in food staples (Dyurfeldt *et al*, 2005; Dorward *et al,* 2004).

Subsidies in Indian agriculture can be classified into two broad categories *i.e.,* direct and indirect subsidies. Direct subsidies are implemented through various schemes to the agricultural sector by the government whereas indirect subsidies confine itself to three major inputs *viz.,* fertilizer, irrigation and power. At present input subsidies are the most expensive component of India's food and agricultural policy regime. The cost of agricultural input subsidies as a share of agricultural input almost doubled from 6 per cent in 2003-04 to 11.6 per cent in 2009-10, driven by huge increase in subsidizing fertilizer and electricity. Punjab has been

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in the forefront in adoption of Green Revolution technology and has remained the major contributor of wheat and Paddy to the central pool of food grains rightly garnering the title of food bowl of India. The remarkable progress of Punjab agriculture is credited to the use of inputs like fertilizer, improved seeds, irrigation, plant protection chemicals; machinery, credit and technology back up along with zeal and hard work of its enterprising framers. It is a leading state in ensuring the timely availability and efficient delivery system of these vital inputs require for wheat and paddy of the cropping pattern in the state. Though subsidies as incentives are effective in pursing agricultural growth to a certain extent, but it is also important to use these rationally. So, this study has been devised to have an in-depth analysis of extent and economics of wheat and paddy crops in the state in relation to input subsidies.

MATERIALS AND METHODS

To work out the quantum and distribution of input subsidies among the major crops and farm categories in the state, farm level primary data were collected using randomized sampling technique. One district was selected from each agro-climatic zone of the state and then two blocks were taken from each selected district. For the farm household survey, cluster of villages were selected from each selected block and 180 farm households were selected with probability proportional to size. From five standard categories of operational holdings comprising 29 marginal, 33 small, 55 semi-medium, 48 medium and 15 large farmers across the state were selected.

The data collected from farm households were analyzed to work out the extent and distribution of agricultural input subsidies. While the information on direct subsidies was available in collected farm level data as such, the indirect subsidies on account of fertilizers, electricity/water was estimated from physical use of these inputs. Subsidy on urea, di-ammonium phosphate (DAP) and muriate of potash (MOP) was worked out by dividing the total subsidy on respective fertilizer by the quantity of it released for consumption in country during year 2014-15. Subsidy on electricity was worked out by multiplying the use of electricity units (kwh) with per unit (kwh) subsidy provided to agricultural sector. Subsidy on diesel used during *kharif* 2014-15 (November, 2014 onwards diesel prices are the market prices and hence do not involve the subsidy) was estimated by taking the difference in average cost of procurement and average issue price of diesel for the same period (May, 2014 to October 2014). Tabular analysis and simple statistical tools such as average and percentage were used for the interpretation of the results.

RESULTS AND DISCUSSION

Direct subsidies availed by sampled farmers

The direct subsidy availed by sampled farmers has been shown in Tables 1 and 2. The subsidy was found to vary between Rs. 804/- for marginal farms

Table 1. Direct subsidy availed by sampled farmers. **(Rs/farm)**

Size group/component	Marginal	Small	Semi-medium	Medium	Large	Overall
Crops: seed						
Wheat	241	1561	1455	1677	1267	1322
Crops: Pesticides						
Wheat	11	92	35	93	0	54
Paddy	0	0	19	96	0	31
Farm machinery:	552	39	430	18715	5378	5667
Total subsidy	804	1692	1939	20581	6645	7074

Table 2. Direct subsidy availed by sampled farmers. (Rs/ha)

Size group/component	Marginal	Small	Semi-medium	Medium	Large	Overall
Crops: Seed						
Wheat	161	428	198	109	40	133
Crops: Pesticides						
Wheat	7	25	5	6	0	6
Paddy	0	0	2	6	0	3
Farm machinery:	368	11	58	1212	170	571
Total subsidy	536	464	263	1333	210	713

to Rs. 20581/- for the medium farms, which was mainly due to the high level of farm machinery subsidy availed by the medium farms. The level of subsidies availed by marginal, medium and large farms were the highest for farm machinery while the small and medium farms availed highest subsidy on wheat seed. On per hectare basis, the subsidy was found to vary between Rs. 210/- for large farms to Rs. 1333/- for medium farms, which was mainly due to the high level of farm machinery subsidy availed by the medium farms (Rs. 1212/-). The level of subsidies availed by large and medium farms were the highest for farm machinery, while the marginal, small and semi-medium farms availed highest subsidy on wheat seed. The farmers also availed the subsidy on pesticides use for paddy and wheat crops. Thus, the quantum of direct subsidy facility provided by the Govt. departments was majorly availed by medium, large farm categories farmers followed by farmers from other farm categories. This shows high disparity in distribution of direct subsidy among the farm categories on the selected farms.

Crop-wise cost and returns obtained (with and without subsidy)

Paddy Crop

Cost and returns with and without subsidies from paddy crop have been shown in Table 3. It can be seen that without subsidies there was an overall increase in the cost of growing paddy by Rs. 8486/-ha. The farm category wise analysis revealed that there was increase in total cost of paddy growing by Rs.11268/-ha on large farms followed by medium (Rs. 10009/-ha), semi-medium (Rs. 8504/-), small (Rs. 6753/-) and marginal (Rs. 4994/-) farms. The quantum of increase in cost due to withdrawal of subsidies in paddy crop was significantly higher on large, medium and semi-medium farms as compared to other farm categories which show the greater subsidy benefit realized by these farm categories.

Per farm basis analysis revealed that without benefit of subsidies there was an overall increase in the cost of paddy crop by 24.18 per cent which was Rs. 24272/- per farm in value terms. On the other hand, decline in net returns in paddy growing was 13.06 per cent without subsidies on overall farms. As far as farm size wise increase in cost of production of paddy due to withdrawal of subsidies is concerned, there was the highest increase in cost of paddy production on large farms by 33.57 per cent followed by medium (28.34%), semi-medium (22.80%), small (20.21%) and marginal (12.82%) farms. Thus, subsidy benefit realized in paddy cultivation increased with increase in farm size showing advantage to medium and large category farmers.

Wheat Crop

Cost and returns with and without subsidies in case of wheat crop have been shown in Table 4. It was evident that without subsidies there was an

Table 3. Costs and returns with and without subsidies from paddy crop.

Category	With Subsidies			Without subsidies			Increase in total cost/Decline in net returns		
	GR	TC (A)	NR (B)	GR	TC	NR	Value (C)	% increase in TC (C/A*100)	% decline in NR (C/B*100)
Per hectare									
Marginal	96542	38967	57575	96542	43961	52581	4994	12.82	8.67
Small	96250	33407	62843	96250	40160	56090	6753	20.21	10.75
Semi-med	97125	37298	59827	97125	45802	51323	8504	22.80	14.21
Medium	101622	35316	66306	101622	45325	56297	10009	28.34	15.10
Large	99867	33561	66306	99867	44829	55038	11268	33.57	16.99
Overall	100086	35092	64994	100086	43578	56508	8486	24.18	13.06
Per farm									
Marginal	23170	9352	13818	23170	10551	12619	1199	12.82	8.67
Small	65450	22717	42733	65450	27309	38141	4592	20.21	10.75
Semi-med	160256	61541	98715	160256	75573	84683	14032	22.80	14.21
Medium	468476	162808	305668	468476	208948	259528	46140	28.34	15.10
Large	1159452	389646	769806	1159452	520464	638988	130818	33.57	16.99
Overall	286247	100362	185885	286247	124634	161613	24272	24.18	13.06

Note: GR stands for gross returns, TC stands for total costs and NR stands for net returns.

overall increase in the cost of growing wheat by Rs. 5763/-ha. The increase in total cost or decline in net returns without subsidies was to the tune of Rs.6213/-he in case of small farms followed by medium (Rs. 6211/-), large (Rs. 6062/-), semi-medium (Rs.5759/-) and marginal (Rs. 4892/-) farms. In case of wheat crop, quantum of subsidy benefit realized per hectare was higher on small and medium farms as compared to other farm categories.

Per farm analysis brought out that there was an overall increase in the cost or decline in net returns of growing wheat by Rs. 22647/- per farm without subsidy benefit and it was 22.78 per cent while the decline in net returns for wheat was 11.13 per cent in overall scenario without subsidy benefit. As far as farm size wise increase in cost of wheat growing due to withdrawal of subsidies was concerned, there was highest increase in the cost of wheat growing on medium farms by 24.96 per cent followed by large (24.32%), small (23.88%), semi-medium (22.17%) and marginal (16.69%) .

Therefore, in case of wheat crop also large, medium and semi-medium category farmers got higher per farm subsidy benefit due to more area under wheat cultivation. However, per cent increase in total cost without subsidy was higher on medium, large, small and semi-medium farms and least on marginal farms.

Component-wise quantum of crop subsidy

Fertilizer subsidy

The extent of fertilizer subsidy for all the crops worked out to be Rs.4384/- on large farms followed by Rs. 4180/- on medium, Rs.4069/- on semi-medium, Rs. 3729/- on small and Rs.3375/- on marginal farms. Thus, on per hectare basis, the quantum of fertilizer subsidy benefit availed was higher on large farms as compared to other farm categories. This also infers higher fertilizer use on large farms as compared to other farm categories. Per farm analysis revealed that the quantum of fertilizer subsidy for all the crops realized by the

Table 4. Costs and returns with and without subsidies from wheat crop.

Category	With Subsidies			Without subsidies			Increase in total cost/Decline in net returns		
	GR	TC (A)	NR (B)	GR	TC	NR	Value (C)	% increase in TC (C/A*100)	% decline in NR (C/B*100)
Per hectare									
Marginal	74324	29314	45010	74324	34206	40118	4892	16.69	10.87
Small	72542	26022	46520	72542	32235	40307	6213	23.88	13.36
Semi-med	75285	25974	49311	75285	31733	43552	5759	22.17	11.68
Medium	77513	24888	52625	77513	31099	46414	6211	24.96	11.80
Large	80108	24927	55181	80108	30989	49119	6062	24.32	10.99
Overall	77086	25301	51785	77086	31064	46022	5763	22.78	11.13
Per farm									
Marginal	46824	18468	28356	46824	21550	25274	3082	16.69	10.87
Small	108088	38773	69315	108088	48030	60058	9257	23.88	13.36
Semi-med	227360	78441	148919	227360	95833	131527	17392	22.17	11.68
Medium	471278	151316	319962	471278	189082	282196	37766	24.96	11.80
Large	965305	300376	664929	965305	373414	591891	73038	24.32	10.99
Overall	302947	99434	203513	302947	122081	180866	22647	22.78	11.13

Note: GR stands for gross returns, TC stands for total costs and NR stands for net returns

large farmers was the highest (Rs. 139061/-) as compared to other farm categories due to higher area under crop cultivation. Per farm total subsidy benefit declined with decrease in the farm size and was the lowest (Rs. 5062/-) on marginal farms. Thus, larger share in fertilizer subsidy benefit was enjoyed by large farmers as compared to farmers from other farm categories.

The crop-wise fertilizer subsidies revealed that the quantum of fertilizer subsidy was the highest in case of wheat crop *i.e.,* Rs.17993/-farm followed by paddy Rs.10860/- crop on the sample farms. Thus, nearly 70 per cent of the total subsidy on fertilizers attributed to cultivation of wheat and paddy crops only due to higher area under these crops and, therefore, higher fertilizer use as well. Higher per hectare subsidy in case on wheat crop vis-à-vis paddy was due to higher fertilizer usage in case of wheat especially di-ammonium phosphate (DAP).

Power subsidy

The crop-wise per hectare power subsidy on sample farms revealed that power subsidy in case of paddy crop, which needs frequent irrigations, worked out at Rs.4289/- ha as compared to Rs. 834/- in case of wheat. The crop requiring higher number of irrigations accrued higher proportion of power subsidy realized by the agricultural sector. On per hectare basis, the maximum benefit of power subsidy was realized by large and medium category farmers as compared to other farmer categories since some of the marginal and small farmers did not possess electrical tube wells/ submersible pumps for irrigating their small piece of lands, hence depend upon diesel engines for running tube-wells at farm level. Therefore, power subsidy benefit is largely taken by semi-medium, medium and large farmers.

It was noted that on farm basis in overall scenario, highest power subsidy was worked out

Table 5. Crop-wise and component-wise total (direct + indirect) subsidies on sample farm households in Punjab. (Rupees/ha)

Size group/crops	Marginal	Small	Semi-medium	Medium	Large	Overall
Direct subsidy:						
Seed	161	428	198	109	40	133
Pesticides	7	25	7	12	0	9
Farm machinery	368	11	58	1212	170	571
Total Direct subsidy (A)	536	464	263	1333	210	713
Indirect subsidy:						
Wheat	4492	5104	5266	5920	5956	5412
Paddy	4994	6753	8493	9988	11268	8476
Total indirect subsidy (B)*	3869	4849	5816	7142	8321	6268
Total (A+B)	4405	5313	6079	8475	8531	6981

* Taken together for all the crops

for paddy crop (Rs.12267/-) per farm followed by wheat crop (Rs. 3277/-). Due to higher area under paddy and wheat crops on the sample farms, the power subsidy quantum was higher for these crops as compared to other crops sown on the sample farms. Obviously, the proportion of power subsidy benefit was more on large farms as compared to other farm categories. Hence, major chunk of power subsidy in agricultural sector in Punjab has been galloped by semi-medium, medium and large farmers due to higher area under crop cultivation as compared to small and marginal farmers.

Diesel subsidy

Diesel prices were decontrolled in October, 2014 resulting in withdrawal of subsidy. So, the diesel subsidy could not be worked out for wheat and other *rabi* season crops. The crop-wise diesel subsidy per hectare has shown that the extent of diesel subsidy was Rs. 390/-ha in paddy. Farm category wise analysis shows that in aggregate per hectare diesel subsidy benefit was higher on semi-medium (Rs.159/-), medium (Rs.157/-) and large farms (Rs.150/-) as compared to marginal (Rs. 127/-) and small (Rs. 111/-) farms. The extent of diesel subsidy was higher for paddy crop due to higher generator/ diesel engine use for irrigating the crop particularly in hot summer months. The diesel subsidy benefit was more on marginal farms in case of paddy crop due to higher diesel engine use for irrigating the crop as compared to other farm categories.

The extent of diesel subsidy per farm worked out to be Rs. 1114/- per farm for paddy crop, which was also nearly 74 per cent of the total diesel subsidy on all *kharif* crops grown on the selected farms. In aggregate diesel subsidy realized for all *kharif* crops on large farms was Rs. 4744/- per farm followed by medium (Rs. 2427), semi-medium (Rs. 1168/-), small (Rs. 403/-) and marginal (Rs. 190/-) farms. Thus, higher benefit of diesel subsidy was enjoyed by large and medium farmers as compared to farmers from other farm categories due to higher area under crop cultivation.

Aggregate Subsidies (Direct and Indirect)

Direct subsidies

Direct subsidies are target group based and directly accrued by the respondents. Its benefits are realized by the beneficiaries by receiving farm inputs/ machinery at lower price. The direct subsidies

Table 6. Crop-wise total (direct + indirect) subsidies on sample farm households in Punjab. (Rupees/farm)

Size group/crops	Marginal	Small	Semi-medium	Medium	Large	Overall
Direct subsidy						
Seed	241	1561	1455	1677	1267	1322
Pesticides	11	92	54	188	0	85
Farm Machinery	552	39	430	18715	5378	5667
Total Direct subsidy (A)	804	1692	1939	20580	6645	7074
Indirect subsidy						
Wheat	2830	7605	15903	35996	71771	21270
Paddy	1199	4591	14012	46044	130817	24242
Total indirect subsidy (B)*	5803	17698	42805	110273	263940	62246
Total (A+B)	6607	19390	44744	130853	270585	69320

* Taken together for all the crops

in the agricultural sector are mostly given for the purchase of new seed, pesticides, farm machinery, horticultural plants and livestock. Although the quantum of these subsidies in agricultural sector is quite low but many farmers are realizing its benefits in the country. The quantum of total direct subsidy received per hectare by the sample respondents in aggregate was highest on medium (Rs. 1333/-) category farms followed by marginal (Rs. 536/-), small (Rs. 464/-), semi-medium (Rs. 263/-) and large (Rs. 210/-) farms. Similar situation was observed on per farm basis where the quantum of subsidy benefit realized by medium category farms was Rs.20580/ farm followed by large (Rs. 6645/-), semi-medium (Rs. 1939/-), small (Rs. 1692/-) and marginal (Rs. 804/-) farms (Table 5 & 6). Thus, the higher benefit of direct subsidies was also realized by medium and large category farmers as compared to marginal and small farmers. This shows the disparity in disbursement of direct subsidies.

Indirect subsidies

Indirect subsidies benefits are realized equally by all the beneficiaries in terms of lower purchase price but monetary benefits are accrued by the co-operative/company/ firm producing or marketing it. These subsides are widely prevalent in the agricultural sector of the country. Indirect subsidies are mostly given for fertilizers, irrigation and electric power supplied to the agricultural sector for running submersible pumps/ electric motors for irrigating crops. Also, there are numerous field preparation/ marketing operations undertaken by using tractor and diesel engine is also used to irrigate the crops. These farm operations require adequate quantity of subsidized diesel for operating.

The benefit of indirect subsidies availed by the farmers revealed that per hectare indirect subsidy realized by the large farmers was highest being Rs. 8531/-ha followed by medium (Rs. 8475/-), semi-medium (Rs. 6079/-), small (Rs. 5313/-) and marginal farmers. Similar trend was observed on per farm basis also. Therefore, indirect subsidies benefits were largely accrued by large and medium category farmers as compared to small and marginal farmers. Thus, in totality large and medium farmers availed higher benefits of subsidies as compared to their counterparts.

CONCLUSION

The quantum of direct subsidy facility provided by the government departments was majorly availed by medium, large farm category farmers followed by farmers from other farm categories. This shows high disparity in distribution of direct subsidy among the farmers on selected farms. The higher chunk of subsidy benefit availed by large and medium farm categories vis-à-vis other farm category farmers due to larger land holding size. Also, due to withdrawal of subsidy, there will be nearly 13 per cent decline in net returns for paddy crop and about 11 per cent in case of wheat crop. Subsidy on fertilizers (per hectare basis) worked out to be Rs.4384/- on large farms followed by medium, semi-medium, small and marginal farms. Per farm total subsidy benefit declined with decrease in the farm size and was lowest on marginal farms. Thus, higher share of fertilizer subsidy benefit was enjoyed by large farmers and paddy and wheat crops together constituted nearly 70 per cent of fertilizer subsidy availed on sampled farms. Nearly 63 per cent of total power subsidy was used for irrigating paddy crop only. Obviously, the proportion of power subsidy benefit was more on large farms as compared to other farm categories. The quantum of total direct subsidy received per hectare by the sample respondents in aggregate was highest on medium category farms followed by marginal, small, semi-medium and large farms. It was noticed that indirect subsidies benefits were largely accrued by large and medium category farmers as compared to small and marginal farmers. Hence, it could be said that direct subsidy benefit should be target group based especially for small and marginal farmers. Since major chunk of direct subsidies are taken by medium and large category farmers and hence should be restricted by putting a limit on its disbursement among them. The resultant savings by way of partial withdrawal of direct subsidies to medium and large farmers, the benefit may be given to marginal and small farmers to improve their economic condition for their overall welfare. In case of indirect subsidies, especially fertilizer and power subsidies, these should be continued to marginal and small farmers but should be given to the medium and large farmers with a rider. Nominal charges for power usage by medium and large category farmers in agricultural sector can be one of the options. These policy issues can be helpful in rational use of agricultural subsidies and bridge the farm category-wise gap and thereby reduce economic disparity in the agricultural sector.

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Economics of Production and Marketing of Fine Rice in Kaimur District of Bihar

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ABSTRACT

A study was undertaken to analyze the economics of production and marketing of fine rice variety-Puja in the year 2017. One hundred twenty farmers from twelve villages were randomly selected and were categorized in three categories namely - marginal, small and large. It was found that total cost of cultivation was maximum Rs.72795/-ha for large farmers followed by small farmers Rs. 65458/ha whereas Rs. 62820/-ha by marginal farmers. Return over cost of cultivation was found maximum Rs.2205/- at marginal farm and rest were in loss. Maximum loss of Rs.13195/- was found over total cost in small farm followed by Rs.795/- in large farm due to lower market rate than cost of production.

Key Words: Cost of cultivation, Cost of production, Gross and net return, Cost- Benefit Ratio and Marketing.

INTRODUCTION

In Kaimur district, out of total rice area 1,04,860 ha, 31per cent area was covered by fine rice while mostly area 72,588 ha (69.0%) was covered by non-fine rice due to procurement by government, assured irrigation by canal and tube wells. All farmers (marginal, small, semi medium, medium and large) were growing coarse and fine rice in the district. It has been found that medium farmers had got maximum yield and income/ha followed by small, marginal and landless farmers but lowest yield and income/ha was achieved by large farmers. Pushpa *et al* (2017) reported that per hectare cost of cultivation, yield and gross income were recorded higher by large, medium, small and marginal farmers, respectively but per hectare net return of marginal farmers was more than medium farmers. Highest net return was got by large farmers followed by medium farmers. Because massive cultivation/ production of coarse, medium and fine rice and economic contribution in the development of Kaimur district of Bihar from the last two decades. Medium fine and fine rice had lesser contribution in area, production and income than coarse paddy in the district. Only coarse paddy was being procured on the Minimum Support Price (MSP) under Grade B quality in the district. Medium and fine rice that come under Grade A were not purchased by Govt. at all and that's why farmers were not getting a remunerative price for fine rice. The club classification transcends agro-climatic boundaries, indicating a role for policy to aid growth in the lagging districts. The shifts in credit allocation over the years do not appear to be driving the yield divergence, highlighting the limitations of a macro credit-driven policy (Sinha, 2021). Singh *et al* (2015) reported that during the period when there was a heavy glut of paddy in the grain market, buyers used to pay less than MSP to the farmers. Neetha and Prema (2020) examined the market access to paddy farmers and attempts to quantify the losses to them due to lockdown in the Kerala state during the pandemic period and revealed that 89 per cent of the paddy farmers accessed public procurement system and the paddy marketing channel which involves private traders were totally absent during the pandemic period. On an average, total economic loss due to lockdown for paddy farmer amounted to Rs.3691/-ha. This study was conducted to analyze the economics of fine rice cultivation/production on the different size of

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Table 1. Demography of sample households (categories/ farm size wise).

Type/ Category of Farmers	House-holds (No)	Population				Working population
		Male	Female	Total	> 60 yr	
Marginal	40	168	132	300 (27.62)	30 (27.78)	137 (37.43)
Small	40	191	172	363 (33.43)	33 (30.56)	115 (31.42)
Large	40	240	183	423 (38.95)	45 (41.66)	114 (31.15)
Overall	120	599	487	1086 (100.00)	108 (100.00)	366 (100.00)

Source: Households' survey (analysed primary data), Figures in parenthesis showed percentage

sample farms, analyze the economics of marketing of fine rice and ultimately give suggestions to policy makers for farmers' benefits.

MATERIALS AND METHODS

The primary data were collected from sampled farmers after interviewing them personally by the researcher with pre-tested/ pre-structured schedules during the crop year 2017-2018. At the first stage of sampling two sub-divisions of Kaimur District *i.e.,* Bhabua and Mohania were selected purposively due to massive cultivation of fine rice variety Puja. At the second stage Community Development Blocks lying in the selected sub-division were enlisted with respect to area under fine rice. Out of total 11 blocks , 3 blocks namely Bhabua, Bhagwanpur and Cainpur blocks in Bhabua Sub-Division and 3 blocks Kudra and Ramgarh and Mahania blocks in Mohania Sub-Division were taken in the this study on the basis of greater area coverage under variety Puja. At the third stage of sampling, the villages lying in the selected blocks were enlisted in respect of area under fine rice and its production. Thereafter, two villages from each selected block were taken randomly in the sample. Mokari and Betari villages from Bhabua block, Kaser and Parauti villages from Bhagwanpur block, Damodarpur and Awkhara villages from Chainpur block, Deohaliya and Daharak from Ramgarh block, Bhakhar and Ahinaura from Mahania block as well as Nathopur and Kudra villages under Kudra block were selected. At the ultimate stage of sampling, 10 farmers from each village thus making a total 120 farmers for detailed investigation. Selected farmers

Table 2. Status of rice (paddy) cultivation of sample household.

Sr. No.	Particular	Marginal	Small	Large	Overall
1.	Total area (ha.)	12.80 (15.96)	23.20 (28.94)	44.16 (55.10)	80.16 (100.0)
2.	Production (q.)	522.88 (16.56)	758.06 (24.01)	1876.80 (59.43)	3157.74 (100.0)
3.	Productivity (q./ha)	41.40	32.68	42.50	39.40
4.	No. of household	40	40	40	120
5.	Av. production per household (q.).	13.07	18.95	46.92	26.31
6.	Market rate (Rs./q.)	1500	1500	1500	1500

Source: Analyzed primary data Figures in parenthesis showed percentage

Table 3. Economics of paddy cultivation in different categories of farmers (Rs/ha).

Sr. No	Cost Component	Marginal (Rs.)	Small (Rs.)	Large (Rs.)
I. Variable Cost				
1.	Human Labour (a+b)	16,063	16,418	16,165
	a.Family/ Owned	10,375	10,250	3,500
	b.Hired	5,688	6,168	12,635
2.	Seed	613	608	618
3.	FYM/Compost	500	625	250
4.	Chemical fertilizer (a+b+c+d)	3,726	3,648	3,763
	a.DAP	1,988	1,875	1,913
	b.Urea	1,113	1,200	1,085
	c.MOP	375	400	440
	d.Others (micronutrients)	250	173	325
5.	Plant protection	625	1,125	1750
6.	Irrigation charges	4,813	4,653	4,738
7.	Machinery charges	4,798	4,705	4,905
8.	Total (1-7)	31,138	31,782	32,189
9.	Interest on working capital @8 per cent per annum for 5 m	1,038	1,060	1,073
10.	Harvesting, threshing and winnowing	4,875	4,688	5,125
11.	Total Variable Cost (TVC), 8-10=I	37,051	37,530	38,387
II. Fixed cost				
12.	Depreciation	1,000	1,125	1,500
13.	Land Revenue	35	35	35
14.	Rental value of land for 5 m @ Rs.48000/annum.	20,000	20,000	20,000
15.	Interest on fixed capital @11 per cent per annum for 5 month	3,438	5,725	11,458
16.	Crop insurance(Premium charges)@ 2 per cent of expected value of main product	1,300	1,045	1,440
17.	Total fixed cost(TFC,12-16)=II	25,733	27,930	34,433
18.	Total cost(I+II)=11+17	62,784	65,460	72,820
Output/Return				
19.	Main product(Rs./ha)	61,275	49,020	63,750
	Price(Rs./qN)	1,500	1,500	1,500
	Main product(qN/ha)	40.85	32.68	42.50
	By product(Rs./ha)	3,750	3,250	4,000
	Price(Rs./q)	100	100	100
	By product(q/ha)	37.50	32.50	40.00

Sr. No	Cost Component	Marginal (Rs.)	Small (Rs.)	Large (Rs.)
20.	Gross Return (Main product+By product) in Rs.	65025	52270	67750
21.	Return over variable cost	27974	14740	29363
22.	Return over total cost	2241	(-) 13190	(-) 5070
23.	Benefit-Cost Ratio over			
	variable cost	1.76	1.39	1.76
	Total cost	1.04	0.08	0.93
24.	Cost of production (Rs/q) over			
	variable cost	907	1148	903
	Total cost	1536	2003	1713

were stratified in accordance with their operational holding *i.e.,* marginal up to 1 ha., small (1-2 ha), and large (>2 ha). Semi-medium and medium farmers were merged into large farmers in this study.

RESULTS AND DISCUSSION

The data (Table 1) revealed that out of total population of 1086, maximum population was 423 (38.95%) in large farm size group followed by small farm size group 363 (33.43%). Highest working population was found in marginal farm size group 137 (37.43%) in total working population 366 and lowest for large farmer group 114 (31.15%). Out of 108 who were more than 60 yr old, maximum 45 members (41.66%) were found in large farmers whereas minimum in marginal farmers 30 (27.78%). Table 1 indicated that a long life were found in the members large farmers' families in comparison to small and marginal due to better health management, better income, education and treatment which played a vital role for long life.

Status of paddy

The data (Table 2) indicated that all three farm size groups had cultivated Puja variety of paddy. Large size groups contributed maximum production 59.43% (1876.80q) with maximum area 55.10%. The productivity was found to be 42.5q/ha followed by 41.40q/ha and 32.68q/ha in large, marginal and small category of farmers, respectively.

The data (Table 3) revealed the per hectare variable cost, fixed cost and total cost/cost of cultivation of paddy variety Puja in different size groups of farms viz; marginal, small and large. It included yield, gross income, return (profit) and cost of production over variable and total cost. Yield was achieved maximum 42.50 q on large farm followed by marginal farm 41.40 q. Maximum total cost of cultivation was calculated Rs.72,820/-ha for large farm followed by small farm Rs.65,460/-ha. Highest return over variable cost was found Rs.29,363/-ha in large farm followed by marginal farm of Rs.27,974/-ha whereas minimum Rs.14,740/-ha was for small farm. Returns over total costs (cost of cultivation) were found maximum Rs.2,241/-ha by marginal farm and rest were in loss. Maximum loss of Rs.13,190/- was found over total cost in small farm followed by large farm Rs.5070/-ha due to lower productivity with higher cost. Cost of production on the basis of total cost were found Rs.1536/-q, Rs.2003/-q and Rs.1713/-q in marginal, small and large farm, respectively whereas gross return was highest in large farm Rs.67,750/-ha followed by Rs.65,025/-ha in marginal farm. Costs of production based on total cost were found more than market rate Rs.1500/-q in all size of sampled farm indicated that income through by-product (paddy straw) supported marginal farm to get profit as indicated in table 3. Cost-Benefit Ratio was found 1.04 in marginal, 0.08 in small and 0.93 in large farm on the basis of total cost whereas based on variable cost, cost -benefit ratios were achieved more than 1 in all three farm sizes. The contribution of fixed costs was calculated between 40 per cent and 47 per cent in all sampled sizes.

The data (Table 4) showed that producers'/ farmer's share in consumers' price in marketing of rice variety Puja was 53.57 per cent. They indicated that if consumer spent Rs.100 for rice then farmer got only minimum Rs 53.57 for selling of their paddy. In middleman, Miller's profit ranked first 29.64 percent followed by wholesaler and retailer in the same percentage 5.71 in the distribution of price. Farmers' share in consumer price was only 53.57 per cent due to sale of paddy in the harvesting season and were advised to sell their paddy in rice form for better income.

Table 4. Marketing cost, processing cost and price-spread of fine rice in Kaimur district.

Particular	Puja (Value in Rs.)	
	Value (Rs.)	Value (%)
1.Producer's (Farmer's) share	1,500	53.57
2.Marketing cost	122	4.36
3.Processing cost	28	1.00
4.Miller's profit	830	29.65
5. Wholesalers' profit	160	5.71
6.Retailers profit	160	5.71
7.Price paid by consumer	2,800	100

Source: Farmers and market survey

CONCLUSION

It was noticed during study that no procurement was done of grade –A paddy that were medium fine and fine paddy like Puja by Govt. at all. Only grade –B was purchased to some extent by the government at minimum support price. Farmers sold their fine (Puja) paddy to rice millers and other agencies at the lower rate than cost of production due to storage problem. Mostly farmers were helpless (in stress) or not in position to wait and watch for a long time to get better price after harvesting due to loan repayment and to fulfill their essential need immediately. Minimum Support Price (MSP) must be declared for fine rice also and procured by Central Govt. as well as State Govt. also at village level.

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Effect of Different Crop Establishment Methods on Rice Productivity and Profitability

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ABSTRACT

In order to work out the effect of different crop establishment methods on rice yield and yield attributes, monetary gains, production efficiency, field and growth duration, fuel consumption, time required and cost comparisons for seed bed preparation and sowing, field experiments were conducted with farmers' participatory research mode at Amrik Farm, Hajwana (Kaithal, Haryana, India) during 2012-2016 *kharif* seasons. Seven different crop establishment methods (DSR under *vattar* condition, DSR under dry condition, DSR under ZT condition, DSR puddle drum sowing, DSR un puddle drum sowing, mechanical transplanting un- puddle and manual transplanting in puddle condition) were replicated thrice in RBD. Manually transplanted rice registered maximum grain yield (3654 kg/ha) which was statistically at par to DSR under *vattar* condition. Growth duration of manually transplanted rice in puddle condition was seven days longer than DSR under *vattar* condition. Time saving for seed bed preparation and sowing and fuel consumption reduction in DSR under *vattar* condition was 66.7% and 33.3% as compared to manual transplanting in puddle condition. Highest returns over variable cost (₹ 89019/ha) and B:C ratio(3.59) were achieved under DSR in *vattar* condition.

Key Words: Direct seeded rice, Mechanically transplanted rice, Crop establishment, Rice, Productivity, Puddle

INTRODUCTION

Risotto in Italy to Nasi Goreng in Indonesia, rice is the main food for more than half of the world population (Davla *et al,* 2013), China is the largest producer, accounting for 30 per cent of the production followed by India (24%), Bangladesh (7%), Indonesia (7%), Vietnam (5%) and Thailand (4%) (Anonymous, 2020). In India rice was grown over an area of approximately 43.79 m ha with a total production of 116.42 m t and productivity 2659 kg/ha during 2018-19(Anonymous, 2019).

The most common practice of establishing rice in the rice-wheat cropping system is through puddling followed by manual transplanting. Repeated intensive tillage for puddling leads to soil erosion, organic matter loss, nutrient loss, release of soil carbon to atmosphere, undesirable changes in soil structure, reduced water infiltration and moisture-holding capacity. Crop establishment with traditional flooded irrigation is main reasons for 4.5 m t of methane (a gas which damages the ozone layer 23 times more adversely than CO2) emission in India annually. The size of the workforce in agriculture declined by nearly 30 million between 2004–05 and 2011–12 due to rapid economic growth in Asia in non-agricultural sectors and increased labor wages (Anonymous, 2016). Due to water and labour scarcity, farmers are really concerned about the existing practices of puddling and manual transplanting rice and have started thinking about direct seeding of rice or mechanically transplanted rice in un-puddled condition. Since in direct seeding there is no water at the base of the crop, there is a substantial reduction in methane emissions. These beneficial effects of reduced tillage practices related to soil

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Table 1. Treatments and details of tillage and crop establishment.

Treatment	Treatment description	Tillage (dry)	Tillage (wet)	Crop establishment method
T1	Direct seeded rice (DSR) under vattar condition (un-puddle)	Two harrowings + one cultivator + one planking	-	Sowing with DSR drill
T2	Direct seeded rice (DSR) under dry condition (un-puddle)	Two harrowings + one cultivator + one planking	-	Sowing with DSR drill
T3	Direct seeded rice (DSR) under vattar condition (Zero till)	-	-	Sowing with DSR drill
T4	Direct seeded rice (DSR) in wet condition (puddle)	Two harrowings + one cultivator	Puddling twice + one planking	Sowing with drum
T5	Direct seeded rice (DSR) in wet condition (un-puddle)	Two harrowings + one cultivator + one planking	-	Sowing with drum
T6	Mechanical transplanting rice in un- puddle condition	Two harrowings + one cultivator + one planking	-	Transplanting with machine
T7	Manual Transplanting in puddle condition	Two harrowings + one cultivator	Puddling twice + one planking	Manual transplanting

and water management can enhance environmental quality and improve the natural resource base on which a large portion of agricultural economy depends. The hike in fuel prices also promoted reduced tillage systems for economic reasons as well. These technologies are labour, fuel, time and water saving technologies which are cost effective compared to manually transplanted rice and also help in mitigation of green-house gas emission, and adaptability to climatic risks. Direct seeded rice has received much attention, because of low input demand including labor and water and both of them are going to be scarce in the coming years (Farooq *et al,* 2011)

Direct seeded rice and mechanically transplanted rice has potentiality to increase the productivity of the subsequent non-rice crop i.e. wheat mainly in rice-wheat cropping system, the prevailing cropping system in South Asia. Both the direct seeded methods of rice, being at par, recorded significantly higher mean grain yield and other growth parameters of rice as compared to conventional transplanting or SRI method (Sharma *et al,* 2016). Labour and cost saving of 97 and 80 per cent were observed in direct seeded rice (DSR) as compared to manual puddled transplanted rice in sowing/transplanting (Kumar *et al,* 2015).

The productivity and sustainability of rice-based systems are threatened because of the inefficient use of inputs; increasing scarcity of resources, especially water and labour; changing climate; the emerging energy crisis and rising fuel prices; the rising cost of cultivation and emerging socio-economic changes such as urbanization, migration of labour, preferences of non-agricultural work, concerns about farm-related pollution (Kumar and Ladha, 2011). Keeping in view, the present study was conducted to evaluate different crop establishment methods compared to manual puddle transplanting rice for crop productivity and profitability.

MATERIALS AND METHODS

Site characteristics

Long term field experiments were conducted with farmers' participatory research mode at Amrik Farm, Hajwana (Kaithal, Haryana, India) during 2012, 2013, 2014, 2015 and 2016 *kharif* season. The soil of the experimental field was clay loam in texture, medium in organic carbon (0.48%), medium in available phosphorus (14.0 kg/ ha) and medium in available potassium (191 kg/ ha) with a pH of 8.3. The whole field was laser levelled.

Treatments: The experiment was laid out in randomized block design with seven treatments replicated thrice. The detail of treatments is presented in Table1.

Seeding and seed rate

Scented basmati rice variety CSR-30 was used for the experiment purpose. The seed treated with recommended fungicide @ 20 kg/ha was used for direct drilling as well as for nursery raising. The nursery sowing for manual transplanting in puddle condition and mechanical transplanting in un- puddle condition was done on the day of direct drilling between 10^{th} to 15^{th} of June. Manual transplanting at a spacing of 20x15 cm^2 was done after 30 days of nursery sowing maintaining 2-3 plants per hill, whereas in mechanically transplanted rice the row to row spacing was 23.5cm. The direct seeding of rice was also done maintaining a row spacing of 20 cm. Sowing of direct seeded rice (DSR) under *vattar* condition was done in the evening maintaining sowing depth of 3-5 cm and light planking was done immediately after drilling to avoid loss of moisture. Sowing depth was 2-3 cm in direct seeded rice (DSR) under dry condition and no planking was done after drilling the seed. A light irrigation was applied just after drilling. In drum sowing the treated seed was air-dried in shade prior to sowing for easy dispensing through the holes in the drum seeder. Excess water from field was drained out ensuring the soil surface is moist. Drums were filled with treated seeds ($2/3^{rd}$ full) and pulled across the field maintaining a steady speed for evenly sowing.

Irrigation Management

In DSR under *vattar* condition (un-puddle) after pre-sowing irrigation the first irrigation was applied 10-15 d after sowing depending on the field condition with follow up irrigations at 7-10 d interval. In case of DSR under dry condition (un-puddle) first irrigation was applied just after sowing followed by irrigation at an interval of 3-5 d during crop establishment phase. Subsequent irrigations were applied at an interval of 7-10 d. During active tillering phase *i.e.,* 30-45 DAS and reproductive phase (Panicle emergence to grain filling stage) optimum moisture (irrigation at 2-3 d interval) was maintained to harvest optimum yields from DSR crop (Kamboj *et al*, 2012). Irrigation was not applied for 2-3 d after sowing to allow rooting and anchoring to soil under drum sowing and intermittent irrigation was given till the panicle initiation stage. Under transplanting condition the standing water was held in the field up-to tillering phase and almost 15-20 irrigations were applied depending on the rain.

Fertilizer Management

A fertilizer dose of 75kg N, 30 kg P_2O_5 and 25 kg $ZnSO_4$ /ha was applied in all the treatments except transplanting and drum sowing treatments, where N @ 60 kg/ha was applied. In transplanting 1/3 N and full dose of P and Zn fertilizers were applied at the time of puddling, whereas, in DSR $1/3^{rd}$ N and full dose of P and Zn were drilled at the time of seeding. Remaining $2/3^{rd}$ N was applied in two equal splits at 15 and 50 d after sowing (DAS).Solution of 0.5% FeSO4 was also sprayed.

Pest Management

In zero till treatment existing weeds, prior to the seeding of rice, were killed by application of glyphosate 1.0 % + 0.1 % surfactant 7-10 d before

Table 2. Effect of different crop establishment methods on yield and yield attributing characters (Five years' pooled data).

Treatment	Effective panicles/ m^2	Panicle length (cm)	Grains / panicle	1000 grain weight (g)	Grain Yield (kg/ ha)	Straw Yield (kg/ ha)	Biological Yield (kg/ ha)	Harvest Index (%)
T1	284	25.8	72.4	22.52	3630	5560	9190	39.5
T2	282	26.0	72.0	22.50	3572	5480	9052	39.5
T3	277	26.0	72.0	22.46	3519	5360	8879	39.6
T4	274	26.1	71.2	22.47	3469	5290	8759	39.6
T5	271	25.9	70.0	21.54	3296	5060	8356	39.4
T6	288	26.0	72.2	21.92	3583	5500	9083	39.4
T7	286	26.2	72.8	22.48	3654	5558	9212	39.7
CD (0.05)	9	NS	0.8	NS	192	80	166	-

sowing. Weeds were managed by spraying different herbicides as suggested by Khippal *et al* (2019) and Anonymous (2013). Insects and diseases were controlled by adopting the recommended insecticide or fungicide as per packages of practices for *kharif* crop, CCS Haryana Agricultural University, Hisar.

Yield and yield attributes

Four plants were tagged for recording effective tillers and then converted into per square meter. Panicle length (cm) was measured from ten randomly selected tillers of tagged plants from each plot at harvest and averaged to get length of panicle. The numbers of grains from ten panicles selected at random from each plot were counted. One thousand filled grains from the produce of the net plots were counted and their weight was recorded. Produce of net plots was sun dried and threshed grains thus obtained were winnowed, cleaned and weighed. Dry weight of straw collected from net plots was recorded after sun drying for seven days.

Cost, time and fuel required for seed bed preparation and sowing/transplanting

Fuel consumption was calculated using full tank method for both seed bed preparation and sowing operations. Total time required for these operations in each treatment was measured by adding time spent in each operation and similarly money spent in these operations was calculated by adding the cost incurred in each treatment.

Statistical analysis: The data was analyzed using OPSTAT. Online Statistical Analysis was available on CCSHAU, Hisar website.

RESULTS AND DISCUSSION

Grain yield and yield attributing characters

Manually transplanted rice registered maximum panicle length (26.2 cm), grains per panicle (72.8), grain yield (3654 kg/ha), straw yield (5558 kg/ ha), biological yield (9212 kg/ ha) and harvest index (39.7%) which were statistically at par to mechanically transplanting of rice and direct seeding of rice under *vattar* or dry or zero till condition. The yield was at par among these treatments mainly due to non- significant difference in different yield attributing characters. There was non- significant difference among all the treatments as far as panicle length and 1000 grain weight is considered (Table 2). Almost similar results were also reported by Gill *et al* (2006 [a] and 2006[b]), Gill *et al* (2014) and Sharma *et al* (2016).

Production efficiency, field and growth duration

During experiments, field, growth durations

Table 3.Effect of different crop establishment method on field duration, growth duration and production efficiency (Five years' pooled data).

Treatment	Field duration	Growth duration	Production efficiency	
	Days	Days	Grain (Kg/ha/d)	Bio mass (Kg/ha/d)
T1	143	143	25.39	64.27
T2	143	143	24.98	63.30
T3	144	144	24.44	61.66
T4	144	144	24.09	60.83
T5	144	144	22.89	58.03
T6	126	147	28.44	72.09
T7	120	150	30.45	76.77
CD(0.05)	3	4	1.15	1.81

and production efficiency were affected by crop establishment methods and vary due to variation in climate during different seasons. On mean basis the growth duration of manually transplanted rice in puddle condition and mechanically transplanted rice in un puddle condition was seven and four days longer than direct seeding of rice under *vattar* and dry condition respectively (Table 3). The main field duration was also reduced by 23 and 17 d under manually transplanted rice in puddle condition and mechanically transplanted rice in un puddle condition respectively. Kumar *et al* (2015) also reported the similar results. The longer duration in transplanted rice is due to transplanting shock (Dingkuhn *et al*, 1991). The manually transplanted rice in puddle condition recorded significantly high grain production efficiency (30.45Kg/ha/d) and biomass production efficiency (76.77 Kg/ha/d) due to higher grain yield and shorter main field duration. Almost similar results were also reported by Gill *et al* (2014) and Kumar *et al* (2015).

Time required for seed bed preparation and sowing

Maximum time in seed bed preparation and sowing was required for manual transplanting of rice in puddle condition (1237.5 min/ ha) followed by drum sowing in puddle condition

(812.5 min/ha), whereas minimum time was required in DSR under zero till condition (75 min/ ha). Time saving in DSR under zero till condition was 93.9% as compared to manual transplanting in puddle condition (Fig 1). The time saving in DSR under zero till condition was due to the reason as

Figure 1: Time required for seed bed preparation and sowing/ transplanting
(Five years' pooled data)

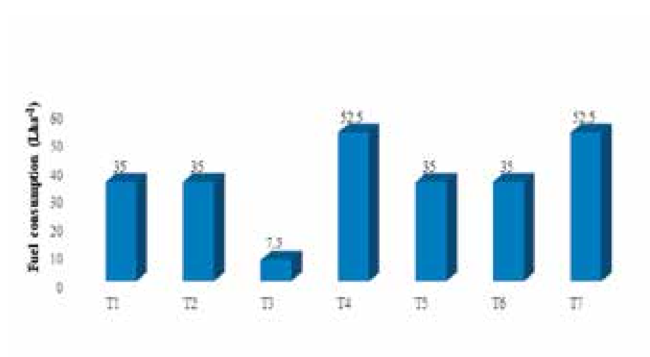

Figure 2: Fuel consumption for seed bed preparation and sowing/ transplanting
(Five years' pooled data)

no operation was required for seed bed preparation before sowing of rice. Afzalinia *et al* (2011) and Khippal *et al* (2018) also reported 73.9 and 88 per cent time saving respectively in zero tillage planting as compare to conventional tillage. Time saving of 66.7 per cent was also registered in DSR under vattar condition and DSR under dry condition.

Fuel consumption

Fuel consumption during seed bed preparation and sowing is presented in figure 2. Both the methods *i.e.,* manual transplanting of rice and drum sowing in puddle condition where puddling was done consumed maximum fuel (52.5 L/ ha) ie 45 L/ ha more than DSR in zero till condition as no operation was needed for seed bed preparation in this crop establishment method. The reduction in fuel consumption in DSR under *vattar* condition and DSR under dry condition was 33.3 per cent as compared to conventional method of transplanting rice. Fuel consumption saving of 77.3 and 91.7 per cent were also reported by Afzalinia *et al* (2011) and Khippal *et al* (2018) respectively in cotton crop using zero tillage method.

Cost comparisons in seedbed preparation and sowing/ transplanting

Maximum cost for seedbed preparation and sowing/ transplanting was recorded in manual transplanting of rice in puddle condition (₹ 10775/ ha) followed by drum sowing in puddle condition (₹ 7775/ ha), whereas minimum cost was observed in DSR under zero till condition (₹ 3680/ha). The reduction in cost for seedbed preparation and sowing was 65.8 and 44.7 per cent in DSR under zero till condition and DSR under *vattar* condition respectively compared to manual transplanting of rice in puddle condition (Fig 3). The cost reduction in DSR under zero till condition was due to the reason as no mechanical operation was needed for seed bed preparation, but ₹ 2000/ha were spent for making the seedbed weed free by spraying herbicide before sowing of rice.

Monetary Gain

Highest returns over variable cost (₹ 89019/ ha) were achieved under direct seeding of rice in *vattar* condition followed by direct seeding of rice in dry condition (₹ 87072/ ha). The lowest returns over variable cost (₹ 80777/ha) were achieved under manual transplanting of rice. Direct seeding of rice under *vattar* condition registered 2.24,4.39, 10.2, 14.81, 6.08 and 10.2 per cent higher returns over variable cost over DSR under

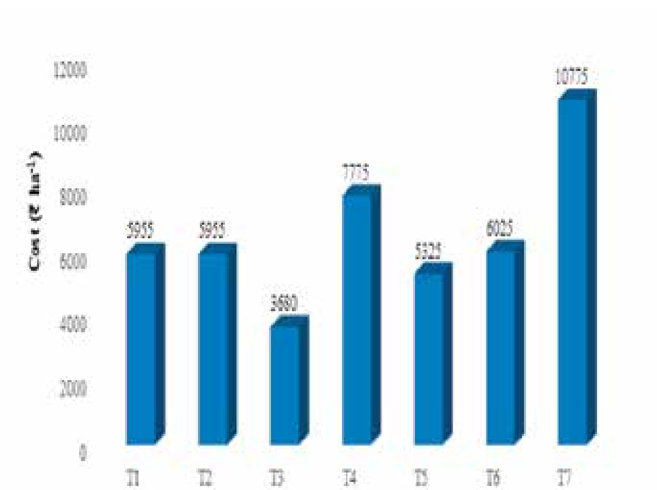

Figure 3: Cost comparisons in seedbed preparation and sowing (₹ ha^{-1}) among different treatments (Mean of five years)

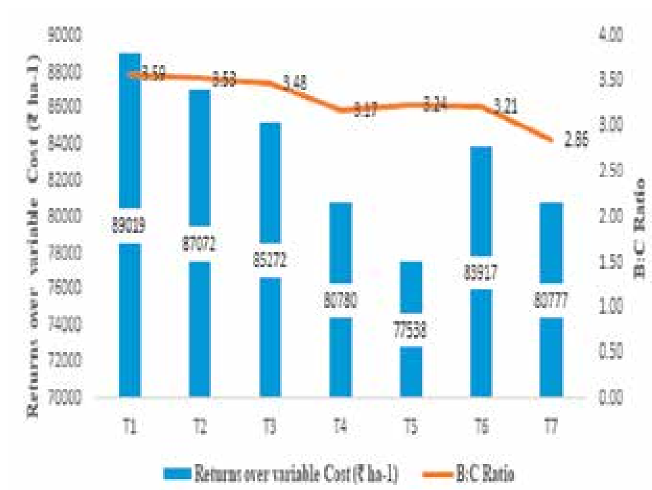

Figure 4: Effect of different crop establishment methods on monetary benefit (Five years' pooled data)

dry condition, DSR under zero till condition, drum sowing in puddle condition, drum sowing in un puddle condition, mechanical transplanting rice in un- puddle condition and manual transplanting in puddle condition, respectively. Maximum (3.59) and minimum (2.86) benefit: cost ratio were also achieved under direct seeding of rice in *vattar* condition and manual transplanting of rice in puddle condition respectively (Figure 4). Swain *et al* (2017) reported that drum sowing of rice was beneficial than conventional method of transplanting rice. Variation in profit may be due to variation in energy requirement, labor cost and fuel consumed in different operations. Similar findings were reported by Prem *et al* (2013), Tripathi *et al* (2014), Gill *et al* (2014), Kumar *et al* (2015), Sharma *et al* (2016), Kumar and Batra (2017). Khippal *et al* (2018, 2016[a], 2016[b], 2016[c]) also reported monetary gains due to adoption of conservation agriculture practices in cotton and sugarcane crop.

CONCLUSION

Based on this long term study, it can be concluded that DSR under *vattar* condition, DSR under dry condition and DSR under zero till condition can be potential alternate methods of crop establishment for rice in comparison to traditional method of transplanting rice under puddle condition. However, weed management and irrigation management are very crucial to attain higher yield under DSR. These methods of crop establishment are most economical as fuel consumption, cost and time in seedbed preparation are reduced without affecting grain yield significantly. Growth duration is also reduced 6-7d enabling timely sowing of succeeding crop.

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Effect of Integrated Nutrient Management on Growth, Yield and Economics of Guava (*Psidium guajava* L.)

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ABSTRACT

A field experiment was conducted at farmers' fields in Khargone during 2018-19 and 2019-20 with a view to assess the effect of integrated nutrient management on growth, yield and economics of guava (*Psidium guajava* L.) cv. Allahabad Safeda. Treatments comprised of T_1 Farmers' practice (RDF 600 g: 400 g : 300 g NPK /tree) and T_2 (50% RDF+ 50 kg FYM + *Azospirillum* 100 g/ tree + *PSB* 100 g/ tree) replicated at ten farmers' field. T_2 recorded significantly higher plant height increment (0.74 m), canopy spread N-S (0.52 m), E-W (0.57 m), shoot diameter (4.24 mm), shoot length (22.65 cm), fruit length (7.43 cm), fruit diameter (7.64 cm), number of fruits/tree (426.84), fruit weight (222.32 g), yield/tree (94.73 kg) and yield/ha (260.65 q). The maximum net return of Rs 264347/- ha and benefit cost ratio of 3.63 were recorded with treatment $T_{2.}$ whereas, the minimum net return of Rs 205325/ ha and benefit cost ratio of 3.33 were recorded in T_1.

Key Words: Guava, Integrated Nutrient Management, Growth, Yield, Economics.

INTRODUCTION

Guava (*Psidium guajava* L.), popularly known as the apple of the tropics, is one of the widely grown fruit crop of tropical & sub-tropical climate including arid and semi-arid regions of India, belongs to the family Myrtaceae. In India, owing to its wider adaptability guava can be grown in diverse soils and agro-climatic regions at comparatively affordable cost of the cultivation. Profuse bearing, nutritive quality of fruits and ability to fetch good profit, have made guava popular among the growers. Guava is cultivated in many countries such as, India, Mexico, Thailand, Spain, Portugal, Southern France, Israel, Panama, Malaysia, Kenya, USA, New Zealand, Philippines, China, Pakistan, Australia and some African countries. The first three ranking countries for guava cultivation are India, Brazil and Mexico (Singh, 2009).

After Mango, Banana and Citrus, the guava stands fourth most important fruit in India (Ray, 2002). In India, guava is grown over an area of 264.9 thousand hectares and production of 4053.5 thousand Mt with a productivity of 15.3 Mt/ha. Its cultivation in India is concentrated mainly in Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and Chhattisgarh. The area and production of guava in Madhya Pradesh are 35.08 thousand hectares and 686.70 thousand Mt, respectively (Horticultural statistics at a Glance 2018). Major guava producing districts in Madhya Pradesh are Khargone, Sehore, Rewa, Vidisha, Katni, Indore and Bhopal.

The concept of integrated nutrient management includes organic, inorganic and bio-fertilizers, which cater to the growing needs of nutrients under intensive cultivation. In integrated plant nutrition to improve the soil fertility and nutrient supply to an optimum level for sustaining the productivity. Guava plant is very hardy with respects to soil and agro-climatic conditions and responds to manuring in terms of increasing fruit production and quality. Experimental results have revealed that guava responds to balanced use of inorganic fertilizers along with organic manures. (Naik and Babu, 2007; Dwivedi *et al*, 2010 and Dutta *et al*, 2009).

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Imbalanced application of chemical fertilizers is a common practice of the farmers, which creates problem of groundwater and environmental pollution through leaching, volatilization, denitrification and wastage. Imbalanced use of fertilizers has created disturbed NPK ratio in soils. The condition of multi-nutrient deficiencies and overall decline in the fertility of soil has been reported due to non- judicious fertilizer use (Chhonkar, 2008). To overcome such problems increasing awareness is needed about an alternate agriculture system comprising integrated plant nutrient management, which would improve and maintain of soil fertility.

MATERIALS AND METHODS

The field experiment was conducted for two consecutive years i.e., during 2018-19 and 2019-20 at ten farmers' fields of district Khargone of Nimar Plains Zone of Madhya Pradesh. Situated at the Latitude of 21.833525 (DMS Lat 21° 50' 0.6900" N) and longitude of 75.614990 (DMS Long 75° 36' 53.9640" E). The maximum temperature ranges from 43 to 46^{o} C during summer season and minimum temperature fluctuates between 6 to 10^{o}C during winter season. The average annual rainfall of the region is 835 mm. The treatments comprised T_1 Farmers' practice (RDF 600 g: 400 g: 300 g NPK /tree) and T_2 (50% RDF + 50 kg FYM + Azospirillum 100 g/ tree + PSB 100 g/ tree) replicated at ten farmers' field.

The whole organic manure was applied as a basal dose on the onset of monsoon along with bio-fertilizers. Then required doses of fertilizers were applied in two split doses in the month of July and August, respectively. Irrigation was made immediately after the application of fertilizers. Nitrogen was applied through Urea and DAP. Phosphorus was given through Diammonium phosphate and Potassium was given through Muriate of Potash. The data on plant growth, yield and yield attributes, cost of cultivation, gross return, net return and benefit cost ratio were analysed as per paired "t" test of significance.

RESULTS AND DISCUSSION

Vegetative Growth

The vegetative growth characters of guava cv. Allahabad Safeda trees have been recorded after applying INM. Attributes of plant height, canopy spread (E-W and N-S), shoot diameter, shoot length, leaf width, leaf length and number of leaves per plant were found greater over T_1. Treatment T_2 recorded significant increase in the plant height increment (0.70 m), canopy spread increment N-S (0.52 m), E-W (0.57 m), shoot diameter (4.24 mm), shoot length (22.65 cm), fruit length (7.43 cm) and fruit diameter (7.64 cm) over T_1 (Table 1). The beneficial effect of these treatments might be due to improvement in the physical, chemical and biological properties of the soil, which might have stimulated soil micro-biological activities.

Table 1. Effect of integrated nutrient management on growth of guava (average of two years).

Treat-ment	Plant height increment (m)	Canopy spread in-crement (m) N-S	Canopy spread increment (m) E-W	Shoot diam-eter (mm) at 90 days	Shoot length (cm) at 90 days	Fruit Length (cm)	Fruit Di-ameter (cm)
T_1	0.53	0.29	0.36	3.32	18.60	6.12	7.22
T_2	0.74	0.52	0.57	4.24	22.65	7.43	7.64
***t*-value**	7.2146	12.8813	12.7673	9.215	30.3489	10.5117	3.5931

The means of T_1 and T_2 are significantly different at $p < 0.05$.

Table 2. Effect of integrated nutrient management on yield of guava (average of two years).

Treatment	Number of fruits/ tree	Fruit weight (g)	Yield/tree (kg)	Yield/ha (q)	Cost of cultivation/ ha (Rs)	Gross return/ha (Rs)	Net return/ ha (Rs)	B:C Ratio
T_1	377.18	200.91	75.68	209.80	88395	293720	205325	3.33
T_2	426.84	222.32	94.73	260.65	100563	364910	264347	3.63
***t*-value**	**4.2491**	**5.5306**	**13.8258**	**18.3313**	**8.7898**	**18.3314**	**13.6828**	**4.5067**

The means of T_1 and T_2 are significantly different at $p < 0.05$.

Leaf is the factory for the conversion of solar energy into the chemical energy through photosynthesis. The adequate supply of nutrients resulted in the proper utilization during the process of photosynthesis resulted in increase of shoot length and shoot diameter. It may be concluded that the increased production of photosynthesis (food material) brought about an increase in the vegetative growth parameters. The present findings corroborated with those of Athani *et al* (2007b), Naik and Babu (2007), Ram *et al* (2007), Ram and Pathak (2007), Dutta *et al* (2009), Shukla *et al* (2009), Dwivedi *et al* (2010) and Dwivedi (2013) who found that vermicompost with FYM and inorganic fertilizers resulted increase in the vegetative growth.

Yield Parameters

It was evident (Table 2) that the highest value for fruits/tree (426.84), fruit weight (222.32g), yield/ tree (94.73 kg) and yield (260.65 q/ha) were due to components of T_2 which created better nutritional environment resulted in improved soil health through improved physico-chemical conditions and stimulated soil microbiological activities. Ram *et al* (2007) found that application of different fertilizers, organic manures and biofertilizer improved the vegetative growth, number of fruits and yield of guava cv. Allahabad Safeda. The similar effects was recorded by Dwivedi (2013).

Economics

The economics of different treatments were significantly influenced by their components. The maximum net profit/hectare was obtained from T_2 (Rs. 264347/ha), while it was least under T_1 (Rs. 205325/-ha). Benefit: Cost ratio were also towards the higher range in the T_2. Higher income was due to higher fruit yield in the T_2. Shukla *et al* (2009) observed that the combined application of 50% dose of recommended NPK + 50 kg FYM + 250 g *Azotobactor* recorded for significantly higher net returns/ha with higher B: C ratio. Similar findings have been reported by Athani *et al* (2007b), Dwivedi *et al* (2010) and Binepal *et al* (2013).

CONCLUSION

The results of present experiment on integrated nutrient management of guava cv. Allahabad Safeda revealed that the application of 50% RDF+ 50 kg FYM + *Azospirillum* 100 g/ tree + *PSB* 100 g/ tree was the most appropriate dose of integrated nutrient management for obtaining maximum growth, yield and net returns from guava.

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Effect of Integrated Nutrient management on Yield of Black Pepper

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ABSTRACT

The nutritional need of black pepper is unique for its proper spike setting, uniform berry formation, ripening etc. An experiment was conducted with the objective of studying the effect of integrated Nutrient management system on the yield of black pepper. The inorganic fertilizers *viz.,* urea, Rajphos, muriate of potash was used as source of nitrogen, phosphorus and potassium, respectively. The experiment was laid out in randomized block design with five treatments replicated four times. Results revealed that application of 100% Recommended dose of fertilizers (50:50:100 g NPK/ Vine/year) + Azospirillium + phosphate solubilizing bacteria (25g each) + Arbuscular Mycorrhizal Fungi (50 g) has showed a superior performance on yield and yield attributing components.

Key Words: Black Pepper, Bio-fertilizers, Nutrient management, yield.

INTRODUCTION

The nutritional need of Black Pepper is unique for its spike setting, uniform berry formation etc. High rainfall in the black pepper growing areas made the soil less productive due to leaching and erosion loses of nutrient and has effect on growth of the crop (Sadananadan, 2000). Soils of Black pepper growing areas are low in pH, high nitrogen, phosphorus and medium to low potassium (Patnaik, 1987). The intensive agriculture demands more use of fertilizers and chemicals, which are not only costly but also cause soil and water pollution. It is therefore, necessary to supply the plant nutrition in an integrated way and to maintain the overall balance, flow of nutrients, better productivity, ecological health, economics and sustainability. In Kerala the current nutritional recommendation is 50:50:100 g NPK/Vine in two splits during May-June and August-September.

The blanket recommendation for fertilizers across the growing areas without relevant soil and plant nutritional status may cause nutritional imbalance and deficiencies. Site specific management is suggested for refined fertilizer strategies like INM for sustaining yield and the environment as indicated by Srinivasan *et al* (2011). Use of bio fertilizers is now getting momentum as a part of nutrient management. Azospirillium, phosphate solubilizing bacteria (PSB) and Arbuscular Mycorrhizal Fungi (AMF) are some of the popularly used bio fertilizers. Integrated nutrient management (INM) enhances the soil productivity through a balanced use of soil nutrients, Chemical fertilizers combined with biofertilizers. INM including recommended dose of fertilizers and use of suitable biofertilizers will improve the soil fertility as indicated by Parthasarathy *et al* (2008).

MATERIALS AND METHODS

The inorganic fertilizers *viz.,* urea, Rajphos, Muriate of Potash were used as source of nitrogen, phosphorus and potassium, respectively. The experiment was laid out in randomized block design with five treatments replicated four times (Table1).

All the required inorganic and organic and inorganic manures were applied in two equal splits during May-June and September-October month (Table 2)

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Table1: Treatment details.

Treatment	Detail
T_1	100% Recommended dose of chemical fertilizers (50:50:100 g NPK /vine/year)- control
T_2	T_1+ Azospirillum (25 g/plant)+ Phosphate Solubilizing bacteria (25 g/plant)
T_3	T_2+ Arbuscular mycorrizhal fungi (50 g/plant)
T_4	75% Recommended dose of chemical fertilizers + Azospirillum (25 g/plant)+ phosphate Solubilizing bacteria (25 g/plant) + Arbuscular mycorrizhal fungi (50 g/plant)
T_5	50% Recommended dose of chemical fertilizers + Azospirillum (25 g/plant)+ Phosphate Solubilizing bacteria (25 g/plant) + Arbuscular mycorrizhal fungi (50 g/plant)

Table 2. Sources of Nutrients for Black pepper.

Treatment	**Sources of nutrients**
T1	50:50:100 g NPK /vine/year
T2	50:50:100 g NPK /vine/year + Biofertilizers (Azospirillum and PSB)
T3	50:50:100 g NPK /vine/year + Biofertilizers (Azospirillum ,PSB and AMF)
T4	37.5:37.5:75 g NPK /vine/year + Biofertilizers (Azospirillum ,PSB and AMF)
T5	25:25:50 g NPK /vine/year + Biofertilizers (Azospirillum ,PSB and AMF)

Observations were recorded on yield and yield attributing characters. Yield parameters were recorded in one meter column of vine at one meter above the ground. The harvested spikes were threshed , dried in open sun and dry weight was taken as yield per vine.

Soil samples were collected and air dried in shade, ground to pass through 2mm sieve and analysed for organic carbon, total nitrogen, available phosphorus, available potassium. Organic carbon of soil was analysed by Walkley and Black (1934) wet oxidation method. Total nitrogen by Macro Kjeldahl method, the available phosphorus was estimated (Bray-1) following the procedure outline by Jackson (1973) and available Potassium was determined in the 1N NH_4OAC Flame Photometrically

RESULTS AND DISCUSSION

Effect of INM on Yield attributes

The yield attributes were significantly influenced by different treatments Table 3. Treatment T_3 recorded highest yield of 2.5 kg /vine followed by $T_{2.}$ Number of spikes ranged from 188 to 215, length of spike 14.9 to 16.5, number of berries/spike ranged from 81 to 85. The Arbuscular Mycorrhizal Fungi might have increased the availability and absorption of all essential nutrients which led to more uptake and accumulation of potassium in leaf tissues, thereby improving photosynthetic efficiency, translocation and accumulation of carbohydrates as reported by Morard (1974). Sadanandan and Hamza (1995) reported that fertility and productivity can be improved by use of bioinoculants.

Table 3. Results of yield and other parameters.

Treatment	Yield (kg/vine)	Yield parameters		
		Number of spikes	Length of spikes(cm)	Number of berries/spike
T1	2.3	188	14.9	81
T2	2.4	212	15.9	84
T3	2.5	215	16.5	85
T4	2.44	210	15.4	83
T5	2.43	192	15.2	82
C.D.(0.05)	0.036	1.678	0.261	1.119
SE(m)	0.012	0.555	0.086	0.37
SE(d)	0.017	0.785	0.122	0.523
C.V.	1.113	0.614	1.253	1.001

Effect of INM on soil analytical parameters

Significant difference was observed in nutrient management practice in organic carbon (%,), available potassium (kg/ha) and nitrogen. Organic carbon was more in T_3 (1.0%) as compared to T_2(0.9%), T_4(0.89%), T_5(0.87%) and T_1(0.69%). The increase in organic carbon was due to high amount of organic matter accumulation due to use of biofertilizers. The available nitrogen and potassium increased in T_3 as compared to other treatments (Table 4).

The average net return was high in T_3 (Rs.113678/ha/yr) followed by T_2 (112100/ha/yr), T4 (111000/ha/yr), T_5 (99900/ha/yr) and T_1 (930000/ha/yr). This implies that there was an advantage of yield increase, additional income and hence result in higher income.

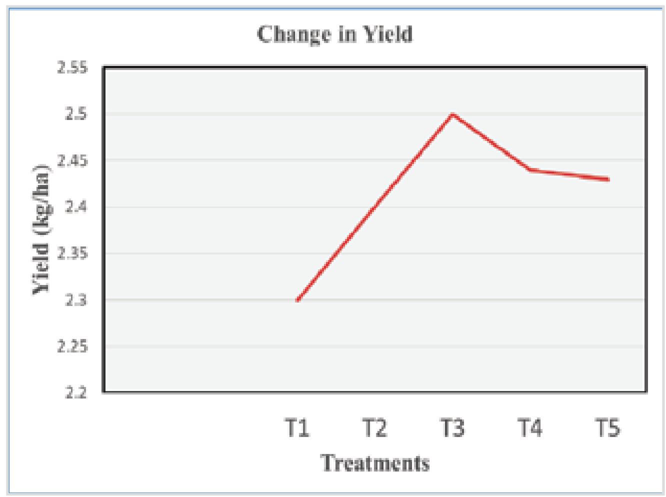

Fig.1 graph showing variation in yield level.

Table 4. Result of Soil components.

Treatment	Organic Carbon (%)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
T1	1.0	440	35	220
T2	0.9	561	21	248
T3	0.89	698	20	331
T4	0.87	555	22	245
T5	0.69	450	23	237

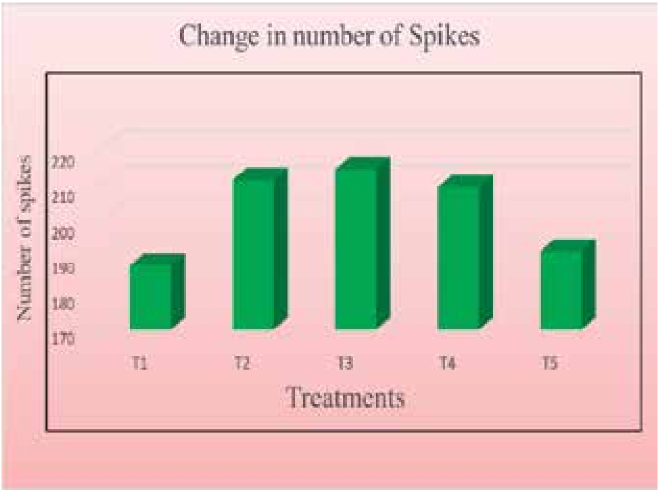

Fig. 2. Graph showing variation in number of spikes

Fig. 3. Graph showing variation in length of spikes

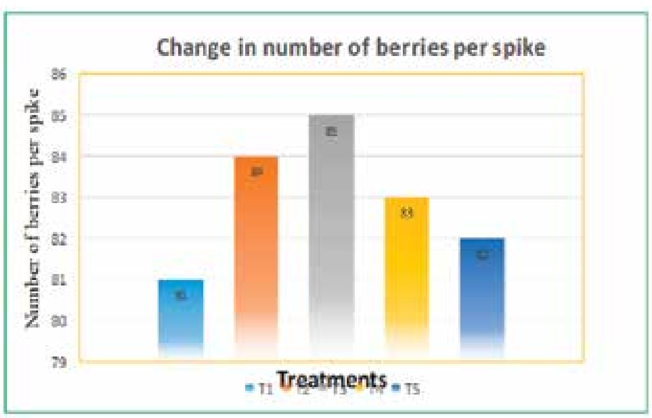

Fig. 4. Graph showing variation in number of berries per spike

CONCLUSION

The Present study indicated that yield and soil parameters differ significantly by use of different nutrient management treatments. Hence, farmers should follow integrated nutrient mnagement practices with all possible combinations in Black Pepper for better yield and returns

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Effect of Rumen Fluid Inoculation on Performance of Calves

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ABSTRACT

A biological experiment was conducted at the cattle yard of NDRI on 12 crossbred calves (KF) for 26 wk to study the effect of rumen fluid (RF) inoculation on performance and feed intake. In the first month, half of the calves were fed control diet and the other half were given 8 ml of strained RF in addition to the control diet *i.e.,* 4 ml in milk and 4 ml inoculated orally. Almost throughout the experimental trial, the weekly growth rates of both groups were found to be statistically similar. The overall body weight gain was higher in RL inoculated group G2 (543.70g/d) than Control group G1 (496.95g/d). Daily weight gain was also better when RF was inoculated, though these differences were statistically non-significant. It can be concluded that RF inoculation during the 1st month of life slightly improved growth performance of young calves up to 6 months.

Key Words – Rumen fluid, inoculation, Calves, Body weight, feed intake.

INTRODUCTION

Feeding usually accounts for above 60 per cent of the total expenses involved in rearing of cattle. Success of dairying in terms of profitability can be improved by reducing the feed costs, without compromising the performance. But, in general, for a very young calf the milk proteins are highly digestible (92-98%) and the plant proteins (85-94%) somewhat less digestible (Moran, 2002). Well known is the fact that, young calves have undeveloped rumens and are functionally monogastric at birth and must undergo physiological changes before they can digest high fiber feeds. Therefore, if the stage of fully developed rumen or rumen digestion can be brought about earlier, it will improve animal performance as well as digestion of plant-based feed will increase. Researchers have investigated inoculating newborn calves with rumen fluid and have found it to improve average daily gain (ADG), and health (Muscato *et al,* 2002 and Todd *et al,* 2003). The rumen fluid can be used in fresh form as well as in the form of frozen ice cubes and stored at 15°C. Thus, ruminal fluid supplementation could be a practical tool for producers in improving calf performance. Baldwin states: “gut growth is not simply a function of energy substrate supply or dietary chemical composition, but rather a plexus of nutritional and physiological inputs” (Baldwin *et al,* 2004). The uniqueness of rumen development is highlighted by the lack of similar developmental changes in the small intestine in response to weaning.

Keeping the above-mentioned points in view, the present study was designed to study the effect of rumen fluid inoculation on growth performance and feed intake of calves.

MATERIALS AND METHODS

An experiment was conducted on the crossbred calves (Karan Fries) from 1 wk to 6 months of age, maintained at Institute’s herd, in the calf section of the Cattle Yard of NDRI, Karnal, Haryana, to study the effect of rumen fluid inoculation on crossbred calves. Twelve, one-week old crossbred calves (KF) were selected as and when born and divided randomly into 2 groups with 6 calves (3 males & 3 females) in each group. The feeding plan for Group I was control diet throughout the experiment and the calves of Group II were supplemented with SRL in addition to the basal diet.

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Table 1. Basal diet.

Age group	Whole milk	Skim milk	Concentrates	Fodder
0-5 d	1/10th of body wt.	Nil	Nil	Nil
6-30 d	1/10th of body wt.	Nil	qs	Nil
1-2 m	1/15th of body wt.	1/25th of body wt.	0.120 kg (120 g)	*ad.lib*
2-3 m	1/25th of body wt.	1/15th of body wt.	0.250 kg (250 g)	*ad.lib*
3-4 m	Nil	6.5 kg	0.650 kg (650 g)	*ad.lib*
4-5 m	Nil	6.5 kg	1.000 kg (1000 g)	*ad.lib*
5-6 m	Nil	5.0 kg	1.500 kg (1500 g)	*ad. lib*

qs – offered *adlib* and intake was measured

From one week of age to one month of age, half the calves (6 calves) were fed basal diet and the other half (6 calves) in addition to the basal diet, were orally inoculated with freshly strained rumen liquor. The basal diet was the regular diet followed in the cattle yard, NDRI, Karnal. The rumen fluid given to the calves was obtained on a daily basis, from fistulated healthy adult cattle maintained in the cattle yard. The collected rumen liquor was strained using 4 layers of muslin cloth to obtain strained rumen liquor (SRL) and then this fresh SRL was given to the calves. This SRL was given to calves in a daily dosage of 8 ml/calf. The daily dose of 8 ml was divided into 2 equal parts of 4 ml each. Out of which one-part was mixed with milk and fed whereas the other half was taken in a syringe without needle and given orally to the calf 30 minutes after feeding of milk. RF inoculation was done once daily in the morning. Water was supplied to the calves not before 20 minutes after rumen liquor inoculation. Calves whose rumen liquor was to be collected for analysis were separated from others and allowed to drink water only after rumen liquor collection.

Calves from birth till 5 days were housed in calving pens and from 6th day onwards, they were shifted to another shed. The calves were housed according to their age groups for convenience of feeding, to avoid bullying of younger calves by older calves and to ease other managemental practices. Throughout the experimental period similar managemental conditions were maintained.

All calves in the age group of 0-5 days were housed in one pen, where they received the first feed of colostrum. The quantity of colostrum fed per day was 1/10th of the body weight. It was ensured that the colostrum fed to the calves were from their respective dams. Both colostrum and the liquid diet (whole milk and skim milk mixed together) were fed to calves in 2 equal parts, i.e., twice a day at 8:00 hrs in the morning and 16:00 hrs. in the afternoon at an interval of 8-10 hours. Liquid diet was provided individually to each calf. Care was taken that the temperature of the liquid diet was as close to the body temperature as possible. Liquid diet was provided to animals in aluminum utensils. The hands of the attendant and the tub used for feeding were cleaned before and after every feed. General management was the same as being practiced at NDRI, Karnal. Throughout the experimental period, the managemental practices for all calves were similar.

Parameters estimated

Composition of skim milk, roughage and concentrate feed were estimated by proximate analysis. Individual calves were weighed on weekly basis from birth to sixth month of age. Daily feed intake (whole milk, skim milk, roughage and concentrate) of each calf was recorded from birth to six months of age.

Table 2. Proximate composition of constituents of milk replacer, skim milk, roughage and concentrate used for the trial.

Ingredients	DM %	CP %	CF %	EE %	Ash %
Skim milk (as is basis)	7.78	2.04	0.00	0.56	0.58
Concentrate (DM basis)	91.22	22.52	9.88	3.17	6.57
Roughage (DM basis)	17.62	3.12	4.84	0.35	1.42

RESULTS AND DISCUSSIONS

Proximate composition of the concentrate and roughage fed to the calves was analyzed (Table 2).

Effect of RL inoculation on Body weight gain:

Weekly body weights were taken at the end of 1^{st} week of life onwards. Initial body weights at the beginning of the experiment were similar (P>0.01) for both treatment groups i.e., 31.65 kg and 29.52 kg for G1 and G2 treatment groups.

The data presented here shows that throughout the experiment, the Rumen liquor inoculated group showed numerically higher ADG (g) except in the 2^{nd}, 3^{rd}, 15^{th}, 16^{th}, 18^{th}, 20^{th}, 22^{nd}, 23^{rd} and 24^{th} weeks. Also, in the 9^{th} week (beginning of the 3^{rd} month) and in the 17^{th} week the ADG of the group G2 (rumen liquor inoculated group) were about 49% and 31% higher than the corresponding mean ADG of G1 group. But the differences were statistically non-significant which could be due to the large individual variations among calves in the same treatment group. These findings are in agreement with the observations made by Todd *et al* (2003), who obtained a non-significant improvement due to large variation within group, in performance of calves inoculated with a daily dosage of 8 ml of fresh rumen fluid stored as ice cubes and fed after mixing with milk. Similarly, Cersosimo *et al* (2019) showed that calves when inoculated with rumen fluid from 3-6 weeks of age did not show any significant difference in Average Daily body weight gain when compared to uninoculated calves. Our results were contrary with the findings of Belanche *et al* (2019) who found 2.2 times higher weight gain among the fresh rumen fluid inoculated goat kids during the 8^{th} week of age than the other groups. They also found that the weaning shock in the form of weight loss and health problems was less among the inoculated kids.

The overall ADG (g) of the treatment groups over the period of 26 weeks of experiment was 496.95 ± 25.28 and 543.70 ± 17.36, for G1 and G2, respectively. The overall average ADG of G2, over the whole experiment is numerically higher by 9% but again, is significantly not different. Our observations can be corroborated with the findings of Muscato *et al* (2002) who conducted 4 different trials involving rumen fluid inoculation in day old calves upto 6 weeks of age, at a dose rate of 8 ml/ day, mixed in the milk fed to the calves. The experiment involved inoculation using fresh ruminal fluid, ruminal fluid supernatant, ruminal fluid cells, and autoclaved ruminal fluid. Other than fresh ruminal fluid, others were stored at -15°C until use. Significantly better weight gains were seen in calves inoculated with fresh rumen fluid. Improved weight gains were seen in inoculated animals of all other groups but the difference was not significant.

Also, Dengpan Bu *et al* (2020), found that at the end of the experiment, no significant difference was noted in any of the measurements of animal growth including BW and ADG. The weekly average of the above measurements was also similar between the inoculated and the control calves and between the two groups of each treatment. Our results are also in agreement with studies conducted decades ago (Hardison *et al,* 1957; Hibbs and Conrad, 1958; Bryant and Small, 1960; Schonhusen *et al,* 2003) and recent studies (Yu *et al,* 2020).

Table 3. Average Daily Body Weight Gain (g/day).

Age (week)	G1 (Control)	G2 (RL)
2	200.34 ± 79.12	78.89 ± 54.43
3	229.38 ± 97.97	155.22 ± 40.17
4	181.64 ± 66.28	275.82 ± 51.24
5	126.97 ± 91.53	258.57 ± 101.64
6	247.01 ± 82.97	387.80 ± 96.18
7	397.49 ± 108.45	433.72 ± 39.87
8	381.21 ± 70.52	492.88 ± 54.59
9	369.94 ± 56.00	551.00 ± 67.77
10	490.08 ± 81.78	591.81 ± 29.50
11	360.47 ± 74.47	633.90 ± 37.34
12	574.46 ± 172.07	744.33 ± 51.02
13	573. 00 ± 63.24	584.99 ± 67.82
14	593.94 ± 88.64	651.58 ± 86.69
15	747.91 ± 95.74	744.30 ± 150.01
16	592.66 ± 119.64	557.57 ± 143.60
17	609.18 ± 105.70	799.55 ± 92.39
18	786.73 ± 142.42	725.51 ± 112.03
19	650.45 ± 136.85	701.63± 74.97
20	725.40 ± 65.16	705.77 ± 71.43
21	445.61 ± 159.17	592.86 ± 114.16
22	763.09 ± 83.08	679.59 ± 42.36
23	756.87 ± 110.11	625.13 ± 65.72
24	643.45 ± 166.47	519.18 ± 68.41
25	577.04 ± 84.70	605.95 ± 71.86
26	598.56 ± 66.26	807.52 ± 239.46

Effect of RL inoculation on Dry matter intake

The overall mean monthly total dry matter intake (kg) of both the groups over the period of 6 months (Table 4).

The data in the table 4 showed that dry matter intake in calves belonging to both groups was similar and the difference was non-significant. This may be due to the fact that the animals were fed the liquid feed with comparable dry matter and fixed amount of concentrate with *ad libitum* forage. Each calf was fed whole milk as well as concentrate in the same quantity as per its allowance, according to age and body weight. So, the DM intake in terms of whole milk, skim milk, and concentrate was similar in all groups. Therefore, the only difference in DM intake could be through roughage which was fed *adlib*. and roughage having a DM content of 17.62 per cent, showed insignificant difference in DM intake in kg though there was difference in the quantity fed. These findings are in agreement with the observations made by Conrad *et al* (1950) where he found in both the trials conducted by him, that the feed intake was higher, though statistically non-significant, in uninoculated group of calves than the Rumen fluid inoculated calves.

Table 4. Total mean monthly dry matter intake (kg/month).

Age (Month)	G1 (Control)	G2 (RL)
1st	13.57 ± 0.72	12.55 ± 0.34
2nd	21.15 ± 1.09	20.86 ± 0.31
3rd	40.67 ± 1.28	41.64 ± 0.47
4th	80.81 ± 0.17	80.75 ± 0.07
5th	118.67 ± 0.25	118.70 ± 0.15
6th	146.72 ± 0.50	146.66 ± 0.20

Also, Cersosimo *et al* (2019) showed that calves when inoculated with rumen fluid from 3-6 wk of age did not show any significant difference in Dry Matter Intake when compared to uninoculated calves. Similarly, Dengpan Bu *et al* (2020), found that at the end of the experiment, no significant difference was noted in any of the measurements of feed intake and feed conversion ratio. The weekly average of the above measurements was also similar between the inoculated and the control calves and between the two groups of each treatment. On the contrary, Belanche *et al* (2019) showed that during the post weaning period the fresh rumen fluid inoculated kids had a higher forage intake (up to +44%) than the other groups.

CONCLUSION

It was concluded that the inoculation of rumen liquor in calves during the first month of life slightly improved growth performance of young calves up to 6 months of age. These results suggest that under typical farm conditions, when calves are repeatedly inoculated with fresh strained rumen fluid from healthy adult cattle, it probably yields limited benefits to their growth.

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Ethephon - A Best Alternative for Hand Thinning to Improve Fruit Set, Colour and Shelf Life of Apple

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ABSTRACT

A field experiment was carried out to study the effect of hand and chemical blossom thinning on fruit set, colour development, shelf life and return bloom of Red Delicious apple fruit at the experimental farm, Division of Fruit Science, SKUAST-K, Shalimar. The experiment consisted of twelve treatments replicated three times with a single plot size in a randomised block design. Three methods of thinning *viz.,* hand thinning, chemical thinning (NAA and Ethephon) and water thinning were tried at full bloom. Maximum fruit set (70%) was recorded in control while minimum (34%) was recorded in combined spray of NAA 10 ppm and Ethephon 150 ppm. Maximum pronounced fruit colour (4.0) and return bloom score (8.0) was recorded with fruits obtained from trees treated with 150 ppm Ethephon. Maximum percentage of A grade fruits (83.75%) was recorded with 60per cent hand thinning and with Ethephon 150 ppm (80%) whereas minimum percentage of A grade apples were found with control (59%). Among treatments, Ethephon at 150 ppm and 60per cent hand thinning were most effective in improving fruit quality attributes. Hand thinning being time and labour consuming practice was not possible in commercial horticulture. However, Ethephon 150 ppm was the best alternative for hand thinning and as such can be advocated to the orchardists for getting quality fruit of apple.

Key Words: Apple, Thinning, fruit set, return bloom, shelf life.

INTRODUCTION

Apple occupies a prominent place among all the temperate fruits in Jammu and Kashmir with an annual production of 18.82 Mt from an area of 1.65 lakh hectares (Anonymous, 2018). A healthy apple orchard under an integrated cultural programme of pruning, fertilization and soil management produces heavy bloom, sometimes more than double the crop required. This results in poor quality fruit with unsatisfactory colour development and effect the return bloom. Thinning of blossom reduces fruit set which helps in maintaining a balance between vegetative and reproductive growth to ensure good crop year after year (Kunwar,1988). Keeping in view the importance of thinning, an experiment was carried to study the effect of hand and chemical thinning on fruit set, colour development, shelf life and return bloom of Red Delicious apple.

MATERIALS AND METHODS

The study was carried at the experimental farm of the Division of Fruit Sciences, SKUAST Kashmir, Shalimar. The orchard is situated at an altitude of 1590 m above mean sea level and is located between 37^0 $75^/$ N latitude and 74^0 $50^/$ E longitude. It is surrounded by Himalayan Ranges on Southeast and Northeast side. The climate in general is of temperate type. Winters are severe extending from December to March and temperature often goes below freezing point during this period. The experiment was laid out in Randomized Block Design with three replications. Following treatments were given at full bloom stage, T1: Control (unsprayed), T2: Hand thinning treatment where 45 per cent flowers/cluster were removed, T3: Hand thinning treatment where 60 per cent flowers/cluster were removed, T4: Water

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Table 1. Effect of hand and chemical blossom thinning on fruit grade at the time of harvest.

Treatment	Percentage of fruit in different grades		
	A	B	C
T1 (Control)	59.00	26.00	15.00
T2	81.00	10.25	8.75
T3	83.75	11.00	5.25
T4	61.00	26.50	12.50
T5	62.50	26.00	11.50
T6	64.00	28.00	8.00
T7	70.00	25.00	5.00
T8	65.00	29.00	6.00
T9	64.50	28.50	7.00
T10	80.00	15.50	4.50
T11	66.50	26.50	7.00
T12	70.00	25.00	5.00
LSD at 5%	0.94	1.04	0.53
± $S.E_{(diff.)}$	0.45	0.50	0.25

A = > 6. cm diameter, B = 5.0 – 6.0 cms and C = < 5.00 cm

spray, T5: NAA@5ppm, T6: NAA@10ppm, T7: Ethephon@75ppm,T8:NAA@5ppm + Ethephon @75ppm, T9: NAA@10 ppm + Ethephon @ 75ppm, T10: Ethephon@150ppm, T11: NAA@5ppm + Ethephon @150ppm, T12: NAA@10ppm + Ethephon @150ppm. Observations were recorded on colour, grading of fruits, fruit set, return bloom and shelf life. Colour of fruit skin was recorded on the basis of 1-4 scale as suggested by Blanpied *et al* (1975). Fruits were graded into A, B and C on the basis of fruit size, colour and defects (Anonymous, 2004). Bloom intensity in the following year was observed by visual assessment on a scale of 1-9.

RESULTS AND DISCUSSION

The best results in terms of percentage of 'A' grade fruits were obtained in case of 60 per cent hand thinning which recorded 83.75 per cent 'A' grade fruits as compared to 59.0 per cent in case of control. Thinning with Ethephon 150ppm resulted in corresponding decrease in B and C grade fruits. The highest (15 %) C grade fruits were recorded under control. Hand thinning and Ethephon treatments increased the quality of A grade fruits. These findings were in agreement with the results of Mekjell and Lars (2011). The trees treated with Ethephon 150ppm and 60 per cent hand thinning were significantly higher in colour scoring with 4.00 and 3.66 pts, respectively as against 1.66 pts recorded under control. However, there was not significant difference in colour development between untreated and NAA treated trees. These findings were in agreement with those of Greene (1976); Jones *et al* (1988) and stopar *et al* (2004). Larrigaudiere *et al* (1996) also reported that application of Ethephon was quite effective in the activity of Phenylalanine- ammonia lyase enzyme in Ethephon treated fruits seems to be the determining factor for colour development. All the thinning treatments increased bloom intensity in the next year. Maximum return bloom (8.00 pt on scale of 1-9). This pronounced effect of all the thinning

Table 2. Effect of hand and chemical blossom thinning on fruit bloom intensity and initial fruit set in the next year of Red Delicious.

Treatment	Red colour score	Return bloom (1-9)	Initial fruit set (%)
T1 (Control)	1.66	2.50	78.66
T2	3.33	5.00	79.00
T3	3.66	6.00	81.00
T4	2.00	5.00	80.00
T5	2.00	5.00	79.00
T6	2.33	5.50	78.00
T7	3.00	7.00	78.33
T8	2.33	6.00	79.5
T9	2.66	5.30	78.00
T10	4.00	8.00	80.00
T11	2.33	6.00	79.00
T12	2.66	6.50	79.50
LSD at 5%	0.58	0.18	NS
± $S.E_{(diff.)}$	0.27	0.08	-

treatments could be attributed to that in control, the seeds of young developing fruits produce gibberellins which are known to inhibit flower bud formation for the following year. Further, a heavy crop is a drain on the tree and consumes all the available nutrients. Since feeding the fruit assumes priority over all other functions, the flower buds for the following year suffers and tree is likely to produce fewer blossoms the next year. These findings were in agreement with the findings of Schupp (2003) and McArteny *et al* (2007) .The maximum physiological loss in weight (9.60%) was observed in fruits treated with Ethephon 150 ppm under ambient conditions whereas the minimum (8.30%) was recorded in NAA 10 ppm and control. Similar trend in case of percentage loss in firmness and shrinkage was found at the end of 30 days. This could be attributed to the fact that softening of fruits from Ethephon treated fruits involve hydrolysis of cellulose cell walls and cell wall degradation and attacking pectins cementing the middle lamella and cellulosic walls may be responsible for soft consistency of Ethephon treated fruits (Rai et al. 1987). Similar findings were observed by Macartney and Wells (1995).

CONCLUSION

The findings revealed that hand thinning and Ethephon 150 ppm proved to be most effective in improving fruit set, colour, A grade fruits and return bloom. Hand thinning being time and labour consuming practice is not possible in commercial horticulture. Therefore, Ethephon 150 ppm was best alternative for hand thinning and as such can be advocated to the orchardists.

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Table 3. Effect of hand and chemical blossom thinning on shelf life of Red Delicious.

Treatment	Per cent loss reduction at the end of 30 days storage		
	Loss of weight	Firmness	Size (diameter)
T1 (Control)	8.30	21.96	6.60
T2	9.50	25.43	7.20
T3	9.50	26.50	7.40
T4	8.50	23.71	6.70
T5	8.70	23.31	6.80
T6	8.30	22.25	7.00
T7	9.00	26.00	7.00
T8	9.20	25.25	7.20
T9	9.25	24.36	7.30
T10	9.60	27.08	7.60
T11	9.25	26.63	7.20
T12	9.30	26.80	7.40
LSD at 5%	0.05	0.13	0.10
± S.E. $_{(diff.)}$	0.02	0.06	0.05

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Evaluation of Insecticides as Seed Treatment Against Termite in Groundnut

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ABSTRACT

A field experiment comprised of nine insecticides was conducted at Rajasthan Agricultural Research farm during *kharif* 2018 to 2020. The seeds of groundnut variety RG 510 were sown in the field on the last week of June during *kharif,* 2018 to 2020 in the plots measuring 6.0 x 4.0 m^2 keeping 0.45 and 0.10 m row to row and plant to plant distance, respectively. The recommended package of practices was followed to raise the crop. Imidacloprid 600 FS @ 6.5 ml per kg seed treatment was significantly superior over all other treatments with lowest plant mortality against termite and highest pod yield followed by fipronil 5 SC (7.33%) and imidacloprid 17.8 SL (9.00%). The maximum production was recorded in imidacloprid 600 FS with 18.81 q/ha followed by fipronil (16.35q/ha) and imidacloprid 17.8 SL (16.0q/ha) whereas, clothianidin 50WDG, thiamethoxam 30 FS and thiamethoxam 25 WDG were found next best treatments.

Key Words: Imidacloprid, seed treatment, termite, plant mortality, pod yield.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is grown in tropical and sub-tropical regions and in the continental part of temperate countries. The seed (kernels) contains up to 50 per cent of a non-drying oil, 40-50 per cent fat, 20-50 per cent protein and 10-20 per cent carbohydrate (Mehta, 2002). Groundnut is attacked by more than 100 insect-pests right from planting stage to its storage. The annual yield loss in groundnut due to insect-pests is approximately 15 per cent (Dhaliwal *et al*, 2010; Jasrotia *et al,* 2016). Among the insect-pests inflicting damage to groundnut, the defoliators such as, the groundnut leaf miner (GLM), the red-headed hairy caterpillars (RHC), the tobacco caterpillar, the gram pod borer, Bihar hairy caterpillar and termites are the most important in India reported by Atwal and Dhaliwal (2008).

Termites damage the seedlings by cutting either just below or above the soil surface. In mature plant, termites feed on root system and inside the stems, which directly kills the plant or indirectly lowers yield through decreased translocation of water and nutrients. Severely infested plants wilt, dry up and can be easily pulled up. It inflicts heavy damage to the crop cultivated in sandy loam soil and damage the crops right from sowing till harvest Infestation is particularly serious in dry season. The problem is more predominant in rainfed areas than irrigated. Use of undecomposed FYM under un-irrigated conditions can also increase the chances of termite attack.

Termites that belong to the families Hodotermitidae, Kalotermitidae, Rhinotermitidae, Termitidae Macrotermes, Microcerotermes, Microtermes, Odontotermes, Procornitermes, and Syntermes) cause great loss in agriculture (UNEP Report, 2000). Out of 300 species of termites known so far from India, about 35 species have been reported damaging agricultural crops and buildings. The major mound-building species in India are *Odontotermes obesus, Odontotermes redemanni,* and *Odontotermes wallonensis*, and the subterranean species are *Heterotermes indicola,*

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Table 1. Detail of insecticides.

Sr. No.	Treatment	Dose/ kg seed
1	Thiamethoxam 25 WDG	3.2 g
2	Imidacloprid 17.8 SL	4.0 ml
3	Acephate 50% +Imidacloprid 1.8%	4.0 g
4	Fipronil 5 SC	10.00 ml
5	Thiamethoxam 30 FS	3.0 ml
6	Imidacloprid 600 FS	6.5 ml
7	Clothianidin 50 WDG	2.0g
8	Fipronil 40% + Imidacloprid 40%	3.0 g
9	Chlorantraniliprole 18.5 SC	2.0 ml
10	Control	-

Coptotermes ceylonicus, C. heimi, Odontotermes horni, Microtermes obese, and Microcerotermes beesoni (Rajagopal, 2002). Application of chemical insecticides is still regarded as the most preferred pest management strategy among the farmers for termite management with seed treatment. Hence, a study was conducted to evaluate 10 insecticides as seed treatment against termite in groundnut.

MATERIALS AND METHODS

The experiment was laid out in randomized block design with ten treatments including control, each replicated thrice under All India Network project on soil arthropod pests at Rajasthan Agricultural Research Station, Durgapura, Jaipur. The seeds of groundnut variety RG 510 were sown in the field on the last week of June during *kharif,* 2018 to 2020 in the plots measuring 6.0 x 4.0 m^2 keeping 0.45 and 0.10 m row to row and plant to plant distance, respectively. The recommended package of practices was followed to raise the crop.

Recommended dose of insecticides were used for the seed dressing and mixed thoroughly with hands after wearing hand gloves. Treated seeds were allowed to dry on the plastic sheet at least for 2 to 3 hr under the shade and treated seeds were used for sowing within few hours. Observations were taken on initial plant population just after the germination and plant mortality due to whitegrub at harvesting time. The data on groundnut pod yield were also recorded treatment wise at harvesting time.

RESULTS AND DISCUSSION

The plant mortality due to termite in different insecticidal treatment was significantly low as compared to control at harvesting time. The minimum per cent plant mortality was recorded in plots treated with imidacloprid 600 FS (6.67%) followed by fipronil 5 SC (7.33%) and imidacloprid 17.8 SL (9.00%) which were found significantly superior over rest of the treatments (Table 2). Highest plant mortality occurred in control plots (89.33%) followed by treated with Acephate 50% + imidacloprid 1.8% and fipronil 40% + imidacloprid 40% but significantly superior than control in 2018. Similar trends were also observed during the years 2019 and 2020. Rest of the treatments was found in the middle order of efficacy with respect to plant mortality. The pooled results also showed that the minimum plant mortality as recorded in the treatment imidacloprid 600 FS (8.28%) followed by fipronil 5 SC (10.52%). Maximum plant mortality as recorded in control (72.51%). The decreasing trend of efficacy with increasing per cent plant mortality of the tested treatments was found to be in the order of imidacloprid 600 FS, Fipronil 5SC, imidacloprid 17.8 SL, clothianidin 50WDG, thiamethoxam 25 WDG, thiamethoxam 30 FS , fipronil 40% +

Table 2. Evaluation of insecticides as seed dresser against termite in groundnut crop.

Sr No.	Treatment	Dose/ kg seed	Plant mortality (%)			
			2018	2019	2020	Mean
1	Thiamethoxam 25 WDG	3.2 g	13.67 (21.28)	16.11 (23.60)	14.85 (22.61)	14.87 (22.67)
2	Imidacloprid 17.8 SL	4.0 ml	9.00 (17.29)	12.13 (20.27)	11.62 (19.92)	10.91 (19.24)
3	Acephate 50% +Imidacloprid 1.8%	4.0 g	23.00 (28.36)	24.73 (29.76)	20.62 (26.74)	22.78 (28.48)
4	Fipronil 5 SC	10.00 ml	7.33 (15.59)	11.51 (19.48)	12.74 (20.89)	10.52 (18.65)
5	Thiamethoxam 30 FS	3.0 ml	15.33 (22.69)	17.03 (24.34)	19.67 (26.04)	17.34 (24.57)
6	Imidacloprid 600 FS	6.5 ml	6.67 (14.88)	8.67 (17.07)	9.51 (17.95)	8.28 (16.63)
7	Clothianidin 50 WDG	2.0g	12.33 (20.32)	13.55 (21.58)	15.40 (23.08)	13.76 (21.74)
8	Fipronil 40% + Imidacloprid 40%	3.0 g	20.33 (26.75)	22.63 (28.39)	22.89 (28.53)	21.95 (27.91)
9	Chlorantraniliprole 18.5 SC	2.0 ml	21.67 (27.53)	22.94 (28.57)	23.23 (28.78)	22.61 (28.38)
10	Control	-	89.33 (71.11)	63.49 (53.03)	64.72 (53.54)	72.51 (59.22)
	SE(m)	-	1.721	1.768	1.599	2.159
	C.D. at 5%	-	5.15	5.29	4.78	6.46
	C.V. %	-	11.21	11.50	10.32	13.97

imidacloprid 40% , chlorantraniliprole,and acephate 50% + imidacloprid 1.8%, respectively.

The maximum production was recorded in imidacloprid 600 FS with 18.81 q/ha followed by fipronil (16.35q/ha) and imidacloprid 17.8 SL (16.0 q/ha) whereas, clothianidin 50WDG, thiamethoxam 30 FS and thiamethoxam 25 WDG were found next best treatments with 15.09, 13.43 and 13.17 q/ha pod yield, respectively. All these treatments were significantly superior over check in the pooled result. The present finding were corroborated with Singh *et al* (2004) that imidacloprid 600 FS @ 10 ml/kg seed was most effective with the minimum plant damage (4.18%) in pearl millet. Sundriya and Acharya (2012) mentioned that imidacloprid 70 WS @ 10 g/kg as seed treatment gave effective control of termite in wheat. These reports strongly support the present conclusion. Maximum plant stand (77.7 plants/m2) and minimum infested tillers (5 tillers/plot) due to termites and maximum grain yield (42.2 q/ha) was obtained in imidacloprid @ 2.0 ml/kg followed by chlorpyriphos @ 5 ml/kg seed, whereas carbaryl found least effective (Mishra *et al,* 2007). Gadhiya (2012) reported that

Table 3. Pod yield of groundnut .

Sr. No.	Treatment	Dose/ kg seed	Pod yield (q/ha)				ICBR ratio
			2018	2019	2020	Mean	
1	Thiamethoxam 25 WDG	3.2 g	13.93	14.05	11.55	13.17	1:19.22
2	Imidacloprid 17.8 SL	4.0 ml	16.03	15.80	16.19	16.00	1:20.24
3	Acephate 50% +Imidacloprid 1.8%	4.0 g	9.30	12.55	12.49	11.44	1:21.12
4	Fipronil 5 SC	10.00 ml	17.30	16.15	15.60	16.35	1:22.73
5	Thiamethoxam 30 FS	3.0 ml	13.06	13.65	13.60	13.43	1:20.98
6	Imidacloprid 600 FS	6.5 ml	18.46	18.20	19.77	18.81	1:24.80
7	Clothianidin 50 WDG	2.0g	14.26	15.20	15.81	15.09	1:10.08
8	Fipronil 40% + Imidacloprid 40%	3.0 g	11.33	13.00	12.87	12.40	1:4.50
9	Chlorantraniliprole 18.5 SC	2.0 ml	10.23	12.85	12.52	11.86	1:5.62
10	Untreated check	-	3.47	5.35	5.88	4.90	-
	SE(m)	-	0.938	0.933	1.136	0.555	
	C.D. at 5%	-	2.80	2.79	3.40	1.66	
	C.V. %	-	12.75	11.81	14.30	9.18	

insecticidal seed treatments of fipronil 5 SC @ 5 ml/kg, imidacloprid 600 FS @ 3 ml/kg and bifenthrin 10 EC @ 2 ml/kg seeds were found highly effective in suppression of termites damage in wheat.

CONCLUSION

The groundnut seed should be sown after treatment with Imidacloprid 600 FS @ 6.5 ml//kg seed for the control of termite.

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Factors Influencing Adoption of Mushroom Production in Gujarat

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ABSTRACT

Mushroom farming is increasingly becoming attractive to marginal and small farmers because it is simple, low cost, labor intensive and eco friendly profession and can provide employment in both rural and semi urban areas. The study was conducted in four districts of Gujarat in order to assess the knowledge gained and technology adopted by the trainees and analyzes the factors influencing adoption of mushroom production technologies. The data were collected from 244 farmers through structured questionnaires and was analyzed by using the suitable statistical methods. It was observed that pre training knowledge score was not much satisfactory. However, the knowledge score gained by participants after training was more satisfactory in all aspects. Except farming experience, all the variables *i.e.,* age, education, land holding, family income, farming experiences, achievement motivation, economic motivation and knowledge of mushroom production technology were positively and significantly correlated with adoption of mushroom production technology.

Key Words: Adoption, Independent Variables, Oyster Mushroom, Production, Technology.

INTRODUCTION

The oyster mushroom (*Pleurotus spp*) due to its tremendous stability of cap and stem, cooking qualities and longer shelf life plays a very significant role to eradicate malnutrition, alleviate poverty and create employment opportunity for rural unemployed folk specially the tribal farming community (Kumari *et al,* 2018) .It is one of the high value crops that can be grown alongside other crops as a diversification option for both small holder and large scale farmers. Mushroom cultivation in Gujarat is negligible during last few years although there is a considerable increase in its demand. Nearly 50% per cent of Gujarat farmers belong to the small and marginal category. Their socio-economic level is quite low for a sustained livelihood. It is a well established fact that the rural unemployed individuals specially the tribal farmers can be developed, as entrepreneurs through organizing vocational training programmers on regular basis (Pradhan *et al,* 2016). Keeping in view the above fact, as many as 15 residential training programmes each of five days duration on oyster mushroom cultivation were organized by the Gujarat Vidyapith KVK for the farmers of different districts of Gujarat state. In this context the study was conducted by KVK with the objectives to ascertain the level of knowledge and adoption level of recommended oyster mushroom cultivation technologies by the trainees and to find out the relationship between socioeconomic characteristics and adoption of oyster mushroom production technologies by the ex-trainee farmers.

MATERIALS AND METHODS

The study was conducted in four districts (Valsad, Bhavnagar, Gandhinagar and Surat) of Gujarat. In all 244 farmers trained by the KVK in mushroom production technology during last three years were selected at random. The study used both qualitative and quantitative data collected by survey. Data were also collected using semi-structured questionnaires which were administered to trainees before and after training as well as in subsequent year after completion of the training in order to assess the knowledge gained and technology

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Table 1. Distribution of respondents according to their overall extent of knowledge of oyster mushroom production technologies by the ex-trainee farmers. N=244

Categories	Frequency	Percentage
Low (Mean -0.5 S.D.) (Below 4)	34	13.93
Medium (Between low and High) (Between 5 to 9)	58	23.77
High (Mean + 0.5 S.D.) (Above 9)	152	62.30

Mean =23.80±16.64

adopted by the trainees. For measuring knowledge and adoption level of ex trainee farmers, knowledge test was constituted. Similarly for measuring adoption level, adoption quotient was calculated using formula developed by (Sengupta, 1967). The data were then analyzed using appropriate statistical tools like Mean (X), Standard Deviation (SD) etc. In order to ascertain the existence or non existence of the relationship between independent variables and adoption of mushroom production technology, correlation of coefficient (r value) was worked out.

RESULTS AND DISCUSSION

Socio-economic profile of mushroom farmers

It was evident from the data that the age of participants was between 20 to 56 yr. More than half of trainees were in age group of 26-40 whereas 38.3 per cent were above 40 yr of age. With respect to education indicated that 45 per cent studied up to primary level followed by middle level (35%) and matriculate level (20%). It was also inferred that 68.3% were small and marginal farmers remaining farmers were having more than 1 ha farming land. Majority of trainees belonged to farming background and depend on farming as their main source of income, and were possessed more than 25-30 yr of farming experience. As many as 86 per cent of the respondent farmers possessed very good knowledge regarding different aspects of mushroom production technology. It was observed that pre training knowledge score was not satisfactory. However, the knowledge score gained by participants after training was more satisfactory in all aspects. About 66 per cent and 69 per cent of them belonged to medium category of achievement motivation and economic motivation, respectively.

Level of Knowledge and Adoption of mushroom production technology

The data regarding knowledge level of recommended technology of mushroom production revealed that 62.30 per cent of the respondents acquired very good knowledge belonged to higher scored category followed by 23.77 per cent belonged to medium category and 13.93 per cent of the respondents were fall in to low level of knowledge. So far adoption level regarding recommended technology of mushroom production is concerned 56.15 per cent of the respondents were belonged to higher scored category followed by 31.96 per cent belonged to medium category. Only 11.89 per cent and low level of adoption category,

Table 2. Distribution of respondents according to their overall extent of adoption of oyster mushroom production technologies by the ex trainee farmers N=244

Categories	Frequency	Percentage
Low (Mean -0.5 S.D.) (Below 5)	29	11.89
Medium (Between low and High) (Between 6 to 9)	78	31.96
High (Mean + 0.5 S.D.)(Above 9)	137	56.15

Mean =28.30±18.16

Table 3. Relationship between socioeconomic characteristics and adoption of oyster mushroom production technologies by the ex trainee farmers. N= 244

Variable	Independent variable	Correlation Coefficient ('r' value)
1.	Age (X1)	.5374*
2.	Education (X2)	.4005*
3.	Land holding (X3)	.4287*
4.	Family income (X4)	.7625*
5.	Farming experience (X5)	-.3388*
6.	Achievement motivation (X6)	.3746*
7.	Economic motivation (X7)	.3371*
8	Knowledge of crop (X8)	.4702*

Significant at 0.05 level of probability

respectively. The findings were in line with the findings of (Tiwari *et al,* 2018).

The relationship between independent variables and dependant variables when tested it was observed that all the variables i.e. age, education, land holding, family income, farming experiences, achievement motivation , economic motivation and knowledge of mushroom production technology were positively and significantly correlated with adoption of mushroom production technology .Only Farming experiences found to have negative but significant relationship with adoption of mushroom production technologies.

Age and farm size

Age had a negative effect on adoption of mushroom production. This implies that the older the person was, having had more year of experience in the diversification of farm. This can be attributed to the fact that as people grew older they tend to be more risk bearer hence want to engage in new ventures to raise their income. The older people were more willing to start mushroom production majorly because it was not considered as an enterprise that requires a lot of energy and can even be practiced out with people with disabilities. It can be viewed as the more educated a person is more ready to learn therefore, they get information on new production technology. The farm families having education possess an aptitude both for adoption of new enterprise/technology and improvement in livelihood. People with larger pieces of land under crop production are more risk averse and are mostly producing what has previously been grown. People with smaller pieces of land were willing to try out new crops that will enable then get the most from their small pieces of land. Thus, farm size plays significant role in adoption of mushroom production technology by the farmers. Negative but significant correlation of farming experience with the adoption of mushroom technology reflected that increase in the experiences lead to increase pragmatic decision-making ability of the respondents.

Income

Income is one of the most important factors in our farming system. Irrespective of categories, farmers strive hard to get more and more from the available resources they have. Large farm holders try to increase benefit by investing more in new enterprise like mushroom whereas small farmers desire to have more income by investing less with adoption of low cost –high return enterprise like mushroom. Pride of being early in doing something new in their locality is the important reason for significant relationship of achievement motivation .Economic motives inspired the farmers to get maximum returns through optimum utilization of available resources with them. Thus, both achievement motivation and economic motivation had significant relationship with the adoption of mushroom production technology by the trainees.

The knowledge score gained by participants after training was more satisfactory about mushroom production. This has created interest amongst trainees to try out it. Thus, knowledge had significant relationship with the adoption of mushroom production technology by the trainees(Acharya *et al,* 2018).

CONCLUSION

Since it does not require access to land, mushroom cultivation is a viable and attractive activity for both rural farmers and peri-urban dwellers. Indirectly, mushroom cultivation also provides opportunities for improving the sustainability of small farming systems through additional income. Frontline extension system may come up with strategies that include mushroom production as an integral component in all extension programmers, training, demonstration etc. It will ensure the capacity building of farmers which lead to adopt this low external input and high return enterprise.

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Farmers Need to Adopt Recommended Package of Practices for Realizing Higher Benefit from Greengram in Alwar District of Rajasthan

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ABSTRACT

The cluster front line demonstrations on Green gram were conducted by Krishi Vigyan Kendra, Navgaon Alwar during *Kharif* 2018 and 2019 covering 20 ha each in two village of Alwar District during both the seasons. The improved technologies consisted of improved high yielding variety IPM 02-14, pre and post emergence herbicides, use of bio fertilizers as a seed treatment and plant protection measures for insect and pest management. The result revealed that the highest grain yield (792.5 kg/ha), average net return (Rs. 31795/ha), B:C ratio (2.84), average increase in yield (26.5 per cent)and net return increase (47.65 per cent) were obtained in demonstrated plot compared to farmer's practice. The average technology gap of 407.5 kg/ha whereas the average extension gap of 166 kg/ha with average technology index 33.95 per cent were recorded. There is a need to further disseminate the improved technologies among the farmers with effective extension methods like training and demonstrations. The farmers' should be encouraged to adopt the recommended package of practices for realizing higher benefit.

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INTRODUCTION

Pulses are very important in nutritional food security of India. Among pulses green gram is most important *Kharif* pulse crop of India. It is third most important pulse crop of the country after chick pea and pigeon pea. Green gram is a protein rich staple food. In addition to being an important source of human food and animal feed, Green gram also plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. The green gram production among pulses was 1304423 t from the area of 2326561 ha with productivity of 5.61 q/ha in Rajasthan in the year 2019-20. Whereas, in Alwar district total production of *kharif* green gram was 90 t from the area of 190 ha with productivity of 5.01 q/ha (Agricultural Statistics at a Glance, 2020). The CFLD is an important tool for transfer of latest package of practices in totality to farmers and the main objective of this programme is to demonstrate newly released crop variety, production and protection technologies and management practices at the farmers' field under real farming situation. Through this practice, the newly improved innovative technology having higher production potential under the specific cropping system can be popularized and simultaneously feedback from the farmers may be generated on the demonstrated technology (Singh *et al*, 2012). Greengram has strong root system and have capacity to fix the atmospheric nitrogen into the soil and improves soil health and contributes significantly to enhancing the yield of subsequent crops (Meena *et al*, 2012). The cluster front line demonstration (CFLD) is an important method of transferring the latest package of practices in totality to farmers. Further, these demonstrations are designed carefully where provisions are made for speedy

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TABLE 1. Practices followed on demonstrated plot and farmers plot.

Sr. No.	Intervention	Demonstration Plot	Famer's Plot	Critical inputs	
				2018	2019
1	Land Situation	Rainfed	Rainfed	-	-
2.	Variety	IPM 02-14	Samrat, Local	Seed	Seed
3.	Sowing time	Onset of Monsoon	Onset of Monsoon	-	-
4.	Method of sowing	Line Sowing	Broadcasting	-	-
5	Seed Treatment	Seed treatment with PSB, Rhizobium and *Trichoderma*	No seed treatment	Rhizobium, PSB and *Trichoderma*	Rhizobium, PSB and *Trichoderma*
6	Seed Rate	12 kg/ha	15 kg/ha	-	-
7	Spacing	30 cm x 10 cm	Broadcasting	-	-
8	Manures & Fertilizers	20:40, $N:P_2O_5$	20:40, $N:P_2O_5$	-	-
9	Weed management	Application of herbicides Pendimethalin and Imazethypr	Manual weeding	Weed management by using heribicide Pendimethalin 1.0 kg a.i./ha as pre emergence and Imazethypr 50 g a.i./ha as at 25 DAS	Weed management by using heribicide Pendimethalin 1.0 kg a.i./ha as pre emergence and Imazethypr 50 g a.i./ha as at 25 DAS
10	Plant protection	Application of Imidachloprid and Emamactin Benzoate	No measures	Spray of Imidachloprid 8 ml/l for sucking pest and spray of Emamactin Benzoate 300 gm a.i./ha for pod borer	Spray of Imidachloprid 8 ml/l for sucking pest and spray of Emamactin Benzoate 300 g a.i./ha for pod borer

dissemination of demonstrated technology among farming community through organization of other supportive extension activities, such as field days and farmers convention. During demonstration, the scientists study the factors contributing to higher crop production, field constraints, generate production data and feed-back information (Meena and Dudi, 2018). Keeping in view, the present study was undertaken to increase the green gram productivity by conducting the CFLDs in Alwar district of Rajasthan.

MATERIALS AND METHODS

A total of 40 FLDs were conducted at farmers' field namely Bamboli and Sonagadh village of Alwar District of Rajasthan during kharif seasonof 2019 and 2020, respectively under rainfed conditions. Each demonstration was conducted on an area of 0.5 ha, and 0.4 ha area adjacent to the demonstration plot was kept as farmers' practices. The package of improved technologies like required seed rate, line sowing, nutrient management, seed treatment and whole packages were used in the demonstrations. The variety of green gram IPM-02-14 was used during 2018and 2019, respectively and details used for the present study with respect to CFLDs and farmers' practices are given in Table 1. In farmer's plots, farmer's traditional practices were practiced.

TABLE 2. Grain yield performance of cluster front line demonstration on green gram.

Year	Variety	Yield (Kg/ha)		Percent increase over farmers' practices	Technology gap (Kg/ha)	Extension gap (Kg/ha)	Technology Index (%)
		RP	FP				
2018	IPM 02-14	830	669	24.06	370	161	30.83
2019	IPM 02-14	755	584	29.28	445	171	37.08
Av.		792.5	626.5	26.50	407.5	166	33.95

The soil of the area under study was sandy loam and medium to low in fertility status. The pH of the sol varied from 6.8 to 7.4. The spacing was 30 cm between rows and 10 cm between plants. The thinning was done invariably 25-30 days after sowing to ensure recommended plant spacing with in a row because excess population adversely affects growth and yield of crop. Sowing time was First week of July to Second week of July with a seed rate of 12kg/ha. Just after sowing pre emergence application of Pendimethalin @1.0 kg a.i/ ha was done to manage the weed population in early stage of crop. Farmers of these villages generally used to grow green gram in *kharif* season without adoption of any proper scientific technology with locally available seeds having low productivity. The method demonstrations on seed treatment with bio-fertilizers were conducted at each village to make aware the farmers about its effects and benefits on pulse crop production. All other plant protection measures were taken in consideration for pest and disease management. Yield gap analysis was assessed prior the programme. The yield parameters were observed along with grain yield. The economic parameters were calculated based on the prevailing market prices of inputs and minimum support prices of outputs. The data output were collected from both CFLDs as well as control plots and finally the extension gap, technological gap, technological index along with the benefit-cost ratio were calculated using the following formula as given by Samui *et al* (2000).

Technology Gap= Potential Yield - Demonstration Plot Yield

Extension Gap = Demonstration Plot Yield - Farmer's Plot Yield

Technology Index (%) = (Pi-Di)/Pi*100

Where Pi= Potential Yield of i^{th} crop; Di= Demonstration yield of i^{th} crop

B:C = Gross income (Rs./ha) / Cost of cultivation (Rs./ha)

RESULTS AND DISCUSSION

Comparison of production technologies

The perusal of data (Table 1) indicated that farmers generally did not use recommended and improved technologies. A wide gap in use of improved varieties seed due to its non availability was observed and farmers generally use local varieties seeds. In farmer's practices broadcast method of sowing with higher seed rate against the recommended line sowing and optimum seed rate was used. Farmers also did not practice seed treatment with *Rhizobium* culture, which is important component in increasing the yield and yield attributes of pulses (Kumar and Elamathi, 2007). Data in table 1 further indicated that farmers did not apply any recommended fertilizer and if applied, only urea was given to the crop at the time of sowing. Weed management and plant protection measure also showed a full gap in adoption under farmer's practices over recommended practices of application of Pendimethalin as pre emergence and Imazethypr as post emergence herbicide @ 25 DAS as well as application of Imidachloprid for sucking pest and Emamectin Benzoate for pod

TABLE 3. Economics of cluster front line demonstration of greengram

Year	Cost of cultivation (Rs/ha)		Gross Return (Rs/ha)		Net Return (Rs/ha)		Additional Return (Rs/ha)	Net return Increase over FP (%)	B:C Ratio	
	RP	FP	RP	FP	RP	FP			RP	FP
2018	17015	16525	52905	39900	35890	23375	12515	53.54	3.11	2.41
2019	17600	15500	45300	35040	27700	19540	8160	41.76	2.57	2.26
Average	17307	16012	49102	37470	31795	21457	10337	47.65	2.84	2.33

borer at the time of pod development. The similar observations for gap in improved technologies and farmers practices were observed by Burman *et al* (2010), Kumar *et al* (2014 and Kumar *et al* (2020) in different crops.

Seed yield

The productivity of green gram under improved production technology ranged between 755 to830 kg/ha with mean yields of 792.5 kg/ha (Table 2). The productivity under improved technology was 830 and 755 during 2018 and 2019, respectively as against a yield range between 584to 669 kg/ha under farmers' practice. In comparison to farmer's practice, there was an increase of 24.06 and 29.28 per cent in productivity of green gram under improved technologies in 2018 and 2019, respectively. The increased grain yield with improved technologies was mainly because of line sowing, use of seed treatment with biofertilizers and Trichoderma, nutrient management, weed management and plant protection measures. The findings were in line with Meena *et al* (2012), Patel *et al* (2013), Raj *et al* (2013) and Kumar *et al* (2020).

The results revealed that the variety IPM-02-14 was found suitable for the villages in both the years. The improved technologies adopted by the farmers reflected the enhancement of the growth. The inoculation of seeds with *Rhizobium*, PSB and *Trichoderma* enhanced the nodule formation along with yield than farmer's practice of non-inoculated seeds. Verma et al (2017) conducted different kind of seed treatments in mungbean and found that seed treatment increased the seed yield of mungbean. The improved packages and practices had been observed better than traditional one as farmers' practice. Similar observations were reported by Singh *et al* (2012).There were less infestation of pest and diseases. During 2018 and 2019 in the plots where insect pest attacks were found had been managed by use of Imidachloprid and Imamectin Benzoate pesticides which made the farmers aware about use of Chemical pesticides too.

Gap analysis

The study (Table 2) revealed that an extension gap of 161 to 171 kg/ha was found between demonstrated technology and farmers' practice and on average basis the extension gap was 166 kg/ha. The extension gap was highest (171 kg/ ha) during 2019 and lowest (161 kg/ha) during 2018. The adoption of high yielding varieties, improved technologies, seed inoculation, weed management and appropriate plant protection measures in demonstrations might be the reason which resulted in higher grain yield than the traditional farmers'practices.

The data also depicted a wide technology gap of 370 and 445 kg/ha during 2018 and 2019 respectively and this might be attributed to dissimilarity in the soil fertility status and weather conditions. These findings were similar to the findings of Patel *et al* (2013), Gaur and Jadav (2020) and Kumar *et al* (2020). The average technology gap of both the years was 407.5 kg/ha. The difference in technology gap in different years was due to better performance of recommended varieties with different interventions and more feasibility of recommended technologies

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during the years. Similarly, the technology index for the demonstrations was in harmony with technology gap. The Technology index shows the feasibility of the technology at the farmer's field. Higher technology index reflected the inadequate transfer of proven technology to growers and insufficient extension services for transfer of technology. On the basis of two years results, average 33.95 per cent technical index was recorded, which was30.83 per cent in 2018 and 37.08 per cent in 2019, respectively. The findings of the present study were in close conformity with the findings Rai *et al* (2016).This indicates that a gap existed between technology evolved and technology adoption at farmer's field. Therefore, the awareness, method demonstrations and adoption of improved varieties with recommended scientific package of practices have increased during both the years of study. These findings were in the conformity of the results of study carried out by Chandra (2010), Meena and Dudi (2018), Meena and Singh (2016), Meena and Singh (2017), Khedkar *et al* (2017). The similar results were also observed by Kumar *et al* (2014), Bairwa *et al* (2013) and Kumar *et al* (2020).

Economics

The results of economic analysis of green gram production revealed that average cost of cultivation increased in demonstration practice (Rs 17307/ha) as compared to Farmers practice plot check (Rs16012 /ha). It was observed that front line demonstrations recorded higher gross returns (Rs 49102/ha) and net returns (Rs 31795/ha). The average benefit cost ratio of demonstration plot (2.84) was also more than the farmers' practice (2.33). Average net return increased over farmers practice by 47.65 percent and average additional return was Rs 10337 /ha. The higher additional returns obtained under demonstrations could be due to improved technology. The results were in line with the findings of front-line demonstrations on pulses Gauttam *et al* (2011), Lathwal (2010), Chaudhary (2012), Meena and Dudi (2018) and Kumar *et al* (2020).

CONCLUSION

The Cluster frontline demonstrations on green gram conducted at Alwar district of Rajasthan during 2018 and 2019 at the farmers' field indicated that the adoption of improved technologies significantly increased the yield of the crop and also the net returns to the farmers. There was 26.50 per cent increase in yield observed in demonstrated plot over farmers plot. There is a need to further disseminate the improved technologies among the farmers with effective extension methods like training and demonstrations. The farmers' should be encouraged to adopt the recommended package of practices for realizing higher returns. Horizontal spread of improved technologies may be achieved by the successful implementation of front line demonstration and various extensions activities like training programme, field day, exposure visit organized in CFLDS programmes in the farmers' fields.

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Foliar Application of Arka Banana Special as Micronutrients Increase Yield of Banana

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ABSTRACT

A study on effect of foliar application of micronutrients mixtures in banana (*Musa* spp.) for growth and yield characters was conducted at Krishi Vigyan Kendra, Ramanathapuram at Tamil Nadu. There were four technology options *viz.,* TO1: No application of micronutrients, TO2 foliar application of micronutrients (0.5 % $ZnSO_4$, 0.2 % $FeSO_4$, 0.2 % $CuSO_4$ and 0.1 % borax @ 3rd, 5th and 7th months after planting (TNAU), TO3: foliar application (spraying) of 0.3 % Arka banana special @ 4 sprays at monthly interval starting from 5th month after planting (IIHR) and TO4: spraying (foliar application) of 2 % Banana Sakthi @ three sprays at monthly interval starting from 4th month after planting (NRCB). The local banana Muppattai used in this study. The experiment was conducted in Randomized Block Design (RBD) with five replications. The results revealed that among the technological options, TO3 recorded the highest values in all the growth and yield characters *viz.,* plant height, pseudostem girth, number of leaves per plant, bunch weight, hand weight, number of fingers per bunch, number of hands per bunch, number of fingers per hand, finger length, finger girth, weight of finger and yield per ha. It was followed by TO4 whereas the TO1 recorded the lowest values in all the characters. Regarding cost economics, TO3 recorded the highest BC ratio of 3.31 with the net profit of Rs. 1,70,750/ha and it was followed by TO4 whereas TO1 registered the lowest B:C ratio (2.92) and net profit (Rs.1,35,200/ha). TO3 (foliar application of 0.3 % Arka banana special) registered 15.0 percent yield increase over the control. It was concluded that from the present study, foliar application of 0.3 % Arka banana special recorded the highest yield coupled with higher B:C ratio and net profit.

Key Words: Arka banana special, Banana Sakthi, Foliar application, Micronutrients, Yield.

INTRODUCTION

Banana is one of the major fruit crops in India, occupies 8.03 lakh hectares with the production of 29.7 MT and 37 t of productivity per ha (Chhuria *et al,* 2016). India stands first place in both area and production of banana and contributes more than 20 percent of world production. In Tamil Nadu banana is cultivated in an area of 1.18 lakh ha with the production of 56 lakh tonne and with a productivity of 47.9 t/ha. Balanced nutrition is very important for high yield, quality and resistance to diseases in banana. It is a high nutrient requiring crop. Banana requires a continuous supply of nutrients at proper growth stages for enhanced yield and productivity. Many earlier studies revealed that the yield of banana be increased by 21 to 60 per cent with adoption of improved production technologies such as introduction of improved variety, recommended dose of fertilizer application and plant protection. Banana crop requires large amount nutrients and it exhausts both the major and micronutrients for its growth, development and yield (Thangaselvabai *et al,* 2009) (Hazarika and Ansari, 2010), especially nitrogen and potassium. The nutrient requirement should be replenished to maintain soil fertility and to sustain the productivity. Several workers reported that the application of micronutrients is enhanced the various processes, growth and yield parameters of banana. Foliar spray of nutrients is a contingent measure for the crop which suffers from nutrient

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Table 1. Influence of micronutrients application on growth and yield of banana.

Treatment details	TO-1	TO-2	TO-3	TO-4	SEd	CD (P=0.05 %)
Plant height (cm)	278.40	290.80	312.20	309.45	13.83	25.410
Pseudo stem girth (cm)	64.78	68.65	72.50	70.14	3.58	6.945
Number of leaves per plant	8.64	8.70	9.20	8.80	1.16	3.201
Number of hands / bunch	8.60	8.70	9.10	8.90	NS	NS
Number of fruits /hand	10.10	10.30	11.25	10.75	NS	NS
No. of fruits per bunch	109.50	112.30	120.80	115.20	5.24	10.123
Hand weight (kg)	1.58	1.68	1.83	1.74	0.103	0.214
Bunch weight (kg)	11.95	12.47	14.25	13.58	1.924	3.875
Finger length (cm)	9.40	9.80	10.50	10.25	0.527	1.025
Finger girth (cm)	7.05	7.24	7.60	7.35	0.541	0.978
Finger weight (g)	87.50	88.40	92.50	90.25	2.562	4.954
Yield (t/ha)	19.10	20.80	22.61	21.90	1.589	3.142

deficiencies. In Ramanathapuram district, banana is cultivated 20 – 50 ha area particularly Nainarkovil and Kamuthi blocks. These areas micronutrient disorders are very common and farmers are unaware about to reduce the disorders as well as getting low yield and income. With this background, the present On Farm Testing was undertaken to find out the effect of foliar application of micronutrient mixtures in banana (*Musa* spp.) for growth and yield.

MATERIALS AND METHODS

The study was conducted at Krishi Vigyan Kendra, Ramanathapuram district, Tamil Nadu during 2017-2018 to find out the influence of foliar application of micronutrient on banana. There were four technology options were imposed *viz.,* TO1: No application of micronutrients (control), TO2 : foliar application of micronutrients (0.5 % $ZnSO_4$, 0.2 % $FeSO_4$, 0.2 % $CuSO_4$ and 0.1 % borax @ 3rd, 5th and 7th months after planting (TNAU), TO3: foliar application (spraying) of 0.3 % Arka Banana Special @ 3rd, 5th and 7th months after planting, TO4: spraying (foliar application) of 2 % Banana Sakthi @ three sprays at monthly interval starting from 4th months after planting. The trial was laid out in a Randamized Block Design (RBD) with four technology options and replicated five times. Arka banana special was purchased from Indian Institute of Horticultural Research, Bengaluru and Banana Sakthi purchased from National Research Centre for Banana, Tiruchirapalli, Tamil Nadu. Before implantation of the OFT, group meetings, trainings and field visits were conducted and trained the farmers for the foliar application of micronutrient mixtures in banana. The local banana cultivar “Muppattai’ (ABB) was used for this study. The spacing of 2.0 x 2.0 m was adopted as per the recommendation of Crop Production Guide, 2013. Planting was taken up during the month of June and in an area of one hectare. Different biometric and yield parameters such as pseudostem height (m), pseudostem girth (cm), number of leaves per plant, bunch weight (kg), number of hands per bunch, hand weight (kg), number of fruits per hand, number of fruits per bunch, yield per ha (g/ha), finger length (cm), finger girth (cm), finger weight (g), net profit (Rs.) and benefit cost ratio were recorded. The data were analysed with appropriate statistical method was suggested by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Foliar application of micronutrients significantly influenced the growth and yield of banana (Table 1). The results revealed that among

Table 2. Cost economics on foliar application of micronutrients in banana.

Treatment details	Yield (t/ha)	Gross cost (Rs.)	Gross expenditure (Rs)	Net profit (Rs.)	BC ratio
TO 1	19.10	2,05,300	70,100	1,35,200	2.92
TO 2	20.80	2,14,400	70,800	1,43,600	3.02
TO 3	22.61	2,44,500	73,750	1,70,750	3.31
TO 4	21.90	2,29,950	71,500	1,58,450	3.21

the four technology options, TO3 (foliar application of Arka banana special) recorded the highest values in growth, yield and cost benefit ratio than other technology options. The highest pseudostem height (312.20 m) was recorded in TO3 (foliar application of 0.3 % Arka banana special) and it was followed TO4 (foliar application of 0.2 % banana Sakthi) of 309.45 cm; whereas the lowest (278.40 cm) pseudostem height was noticed in TO1 (control). The highest pseudostem girth was recorded in TO3 (72.50 cm) followed by TO4 (70.14 cm) and the lowest girth was noticed in TO1 (control) of 64.78 cm. In this context, Kumar and Jeyakumar (2001) also reported that increased pseudostem height and girth with application of micronutrients. The pseudostem girth was proportionately increased to give strength to the plant to withstand the bunch weight. The application of micronutrients through both soil and foliar application which resulted in the maximum pseudostem girth, pseudostem height and numbers leaves reported by Krishnamoorthy and Hanif (2017). The number of leaves per plant (9.20) was found to be highest in TO3 (17), followed by TO4 of (8.80); whereas the lowest (8.64) number of leaves was noticed in TO1 (farmer practices). Similar finding was also reported by Yadlod and Kadam (2008).

The important yield traits *viz.,* traits like number of fruits per hand (11.25) and number of fruits per bunch (120.80) were found to be highest in TO3 followed by TO4; whereas the lowest values was observed in TO1 (farmer practices). The highest hand weight was registered in TO3 (1.83 kg) followed by TO4 (1.74 kg) whereas the lowest hand weight was noticed in farmer practices (TO1) of 1.58 kg. Krishnamoorthy and Hanif (2017) also stated that foliar application of micronutrient increased fruits per bunch under Pudukottai condition of Tamil Nadu. Regarding bunch weight, the highest weight was exhibited in TO3 (14.25 kg) which was superior to the rest of the treatments. The lowest bunch weight was observed in TO1 of 11.95 kg (farmer's practices). This might be due to the fact that foliar application of micronutrients had significantly positive influence on the yield parameters through many physiological manipulations. This was in conformity with the findings of Pathak *et al* (2011), where they registered higher finger weight and bunch weight owing to the application of micronutrients in banana. Kumar and Jeyakumar (2001) also observed the foliar application of different micronutrients registered the highest bunch weight in Robusta (AAA). In the present study, the highest yield was registered in TO3 (22.61 t/ha), followed by TO4 (21.90 t/ha); whereas the lowest yield was recorded found in TO1 (19.10 t/ha). This might be due to balanced nutrient management with timely application of foliar micronutrients which enhanced the bunch weight and there by yield. The micronutrient accelerates in the metabolism and also mobilization of source produced photosynthesis from the leaves to sink (Jyothi *et al,* 2020). Jagadeeswari *et al* (2018) reported that foliar application of banana special during fruit development stage resulted in increased banana productivity under Virudhunagar district conditions of Tamil Nadu. Bindu (2019) reported that there was an increased yield of 20.6 t/ha in Nendran banana due to application of micronutrient than farmers' practice (14.8 t/ha).

Economics

Data on the influence of foliar application of micronutrients on the economics of banana cultivation are depicted in Table 2. The gross cost of cultivation almost similar for three technological options but local practice recorded the lowest in gross cost. Among the technological options, TO3 exhibited the highest yield with a net profit of Rs. 1,70,750/ha and benefit to cost ratio of 3.31. This was followed by TO4 (Rs. 1,58,450/ha; 3.21) while the farmers' practices recorded the lowest net profit of Rs. 1,35,200 per ha with the benefit cost ratio of 2.92. Similar finding was also reported by Jyothi (2020) who reported that the foliar application of Arka banana special under G9 banana, recorded the net profit of Rs. 2,35,000/- with the B:C ratio of 2.54. It was revealed from the study that the performance of foliar application of Arka banana special and fetches higher yield (22.61 t/ha) and income when compared to the farmers' practices (19.10 t/ha).

CONCLUSION

The present study concluded that foliar application of Arka banana special to banana cv. Muppattai at Ramanathapuram district was more beneficial due to enhanced yield. TO3 registered the highest yield (22.61 t/ha) and fetches higher net profit of Rs. 1,70,750//ha with benefit to cost ratio of 3.31 when compared with farmer practices. TO3 performed better and recorded an increased yield of 12.0 per cent with good market preference over the farmers' practices. Hence from the present study, it was concluded that application of Arka banana special as micronutrients application to the banana significantly increased yield of banana. This technology will be promoted as Front Line Demonstrations (Large scale demonstration) during ensuing season at Ramanathapuram district.

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Genetic Variability, Heritability, Genetic Advance and Genetic Divergence for Yield and its Contributing Traits in Gladiolus (*Gladiolus grandiflorus* L.)

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ABSTRACT

The experiment on 12 genotypes of gladiolus (*Gladiolus grandiflorus* L.) was conducted to work out the genetic variability, heritability, genetic advance and genetic divergence effects of their various attributes on spike yield. The analysis of variance revealed that mean squares due to treatments were highly significant for all characters. The magnitude of phenotypic coefficient of variation was higher than corresponding genotypic coefficient of variation for all the characters. Expected genetic advance expressed as per cent of mean ranged between 4.90 to 38.63per cent. The highest of genetic advance was recorded for number of cormels per plant (38.63%) and lowest for number of spikes per plant and number of spikes per hectare (4.90%).High genetic advance coupled with high heritability was recorded for the characters of number of cormels per plant, number of sprouts per corm, number of leaves per plant, vase life (days), plant height (cm), days taken for complete sprouting, number of spikes per plant, length of spike (cm), number of spikes per ha (lac), duration of flowering (days) and corms yield per ha (q) provide greater scope for further improvement of these traits in advance generations. Phenotypic and genotypic coefficient variations were highest for number of cormels per plant (26.95 and 22.48) and lowest for duration of flowering (days) (11.01 and 9.99). Heritability and genetic advance indicate that the additive nature of gene action and reliability of those characters for selection and emerged as ideal traits for improvement through selection.

Key Words*:* Gladiolus, Genetic Variability, Heritability, Genetic Advance, Genetic Divergence, Spike, Yield.

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) is sword lily because of its sword shaped leaves. India has suitable agroclimatic conditions and commercially cultivated in West Bengal, Himachal Pradesh, Sikkim, Karnataka, Uttar Pradesh, Tamil Nadu, Punjab and Delhi. In the eastern states like Tripura, Assam, Manipur, Meghalaya and Nagaland, this flower has established itself as a commercial proposition. There is a sizeable area under gladiolus in Jammu-Kashmir, Andhra Pradesh and Gujarat also. There are over 180 known species of the gladiolus today, but only a few of them are found in most gardens. The orchids like flowers of the Butterfly gladiolus and recently a strain of miniatures have also been introduced. The flowers open from the bottom to up. The flowers may be frilly, ruffled or plain, solid colored or multicolored and they come in every shade and color combination imaginable.

Gladiolus plants are unbranched leafy, leaves basal and cauline, sword shaped, less frequently linear or cylindrical. Flowers showy in one sided spike, irregular, borne in two spathe valves, perianth segments six, united basically into curved, funnel form tube, the upper three segments larger than lower

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Table 1. Analysis of variance (mean square) for twelve characters in gladiolus.

Sr. No.	Character	Replication	Treatment	Error
	d.f.	**2**	**11**	**22**
1	Days taken for complete sprouting	5.03	55.81**	1.12
2	Number of leaves per plant	0.02	4.09**	0.02
3	Number of sprouts per corm	0.01	0.44**	0.02
4	Plant height (cm) 9	1.34	131.61**	1.09
5	Duration of flowering (days)	0.83	21.06**	1.41
6	Length of spike (cm)	0.30	45.35**	1.55
7	Number of spikes per plant	0.09	0.30**	0.06
8	Number of florets per spike	0.32	9.52**	1.36
9	Number of spikes per ha (lac) 9	0.13	0.45**	0.10
10	Number of corms per plant	0.07	0.63**	0.08
11	Vase life (Days)	0.29	4.62**	0.29
12	Corms yield per ha (q)	30.01**	11.12**	4.13

**Significant at 1 % probability level, Here Mean Sum of Squares of Treatments was significant for all characters.

three, stamens 3, filaments not united, borne below the throat, style branches three entire, fruit, a three valved capsule and the winged seeds are arranged in two rows in each locule. Gladiolus produce flowers with their beautiful spikes, from October to March in plains and from June to September in hills in India. Improvement of any crop is a continuous process and in gladiolus also there is scope to improve the existing cultivars or genotypes. Since the gladiolus is highly heterozygous, it becomes more essential to evaluate. Though many genotypes of Gladiolus can be grown in particular agroclimatic region but all are not suitable for cut flower purpose ,garden display or exhibition purposes. Hence, there is a need to evaluate some of the promising varieties of gladiolus with extended vase life in this area so that suitable variety could be recommended for commercial cultivation under Eastern Plain Zone of Uttar Pradesh. Therefore, an investigation was undertaken to study the performance of elite gladiolus varieties identified under Eastern tract of Uttar Pradesh.

MATERIALS AND METHODS

The study was undertaken to work out the status of genetic variability, heritability and genetic advance effects of their various attributes on yield per plant among12 gladiolus genotypes namely Pacefica, Regency, Tiger Flame, Yellow stone, Praha, Shagun, Pink Friendship, Novalux (check), Promise, True love, Spic & span and Wind song at field experiment under present investigation was conducted during *Rabi* 2018-19 at the Main Experimental Station, Floriculture, A.N.D.U.A.& T., Kumarganj, Ayodhya (U.P.). Geographically, it is situated in typical saline alkali belt of Indo-gangetic plains of eastern U.P. at 26.47-0 N latitude, 88.120 E longitudes and at an altitude of 113 meter from mean sea level. The region enjoys sub humid and subtropical climate receiving a mean annual rainfall of about 1215 mm out of which about 85 per cent is concentrated from mid June to end of September. The winter months are cold and dry and occasional frost occurs during this period. Westerly hot wind starts from the month of March and continues up to onset of monsoon.

The experiment was laid out in Randomized Block Design. The observation was recorded on 17different traits *viz*., days taken for complete sprouting, number of leaves per plant, number of sprouts per corm, plant height (cm), duration of flowering (days), length of spike (cm), number of spikes per plant, number of florets per spikes, number of spikes per hectare, number of corms/ plant, vase life (days), corms yield per hectare (q), variability for different characters and heritability in broad sense (h^2) was calculated using the formula suggested by Burton and de Vane (1953). Expected genetic advance (aG) was estimated by the method suggested by Johnson *et al* (1955). The genetic divergence among ten genotypes of gladiolus was worked out using Mahalanobis's (1936) D^2 statistics.

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant difference among the genotypes for all the characters presented in Table 1. Days taken for complete sprouting varied from 19.00 to 31.33. Maximum days taken for complete sprouting was noticed in variety Promise (31.33) followed by Tiger flame (31.00) and Yellow Stone (28.33), while minimum in variety Pacefica (19.00) and the mean for this character was 24.94. Number of leaves per plant varied from 5.63 to 8.90. The maximum number of leaves per plant was observed in variety (8.90) followed by Wind Song (7.95) and Promise (7.64), while minimum in variety Pacefica (5.63). Number of sprouts per corm varied from 1.20 to 2.45. The maximum number of sprouts per corm was observed in variety Novalux (2.45) followed by Pink Friendship (2.35) and Praha (2.26), while minimum in variety Spic and span (1.20). The height of plant ranged from 30.40 cm to 50.26 cm. Height was higher in variety Yellow stone (50.26 cm) followed by Novalux (48.12 cm) and Tiger flame (45.40 cm) while Shagun (30.40 cm) was shortest one and the mean for such character was 58.64. the results were in agreement to Sidhu and Arora (2000), Rai *et al* (2000) and Basavaraddy (2004). The longest duration of flowering was observed for the variety Praha (29.48 days) followed by Spic and span (29.16 d) and Promise (28.63 d) and shortest for the variety Shagun (21.26 d). The length of spike ranged from 20.00 cm to 35.33 cm. The longest spike was observed for the variety Tiger flame (35.3 cm) followed by Novalux (35.0 cm) and Pacefica (33.0 cm) and shortest for the variety Shagun (20.0 cm). The number of spikes per plant varied from 1.20 to 2.1. The number of spikes per plant was maximum in case of variety Pink Friendship (2.13) followed by True love (2.06) and Yellow stone (1.93), while minimum number of spikes per plant in case of variety Spic and span (1.20). The number of florets per spikes varied from 10.20 to 15.63. The number of spikes per plant was maximum in case of variety Pacefica (15.63) followed by True love (15.43) and Promise (15.30), while minimum number of spikes per plant in case of variety Shagun (10.20). The number of spikes per hectare varied from 1.49 to 2.66 lakh. The maximum number of spikes was observed variety Pink Friendship (2.66 lakh) followed by True love (2.58 lakh) and Tiger flame (2.41 lakh) and minimum number of spike variety Spic and span (1.49 lakh). For the character spike yield per hectare and number of spikes per hectare results are in accordance with Nair and Shiva (2003). Total number of corms produced per plant was recorded highest in variety Pink friendship (2.53) followed

Table 2. Mean performances of quantitative characters of gladiolus varieties.

Varieties	Days taken for complete sprouting	No. of leaves per plant	No. of sprouts per corm	Plant height (Cm)	Duration of flowering (Days)	Length of spike (Cm	No. of spike per plant	No. of florets per spike	No.of spikes per ha (lac)	No. of corms per plant	Vase life (Days)	Corms yield per ha (qt)
Pacefica	19.0000	5.6300	2.1267	34.5667	24.2000	33.0000	1.6333	15.6333	2.0400	1.4667	6.6500	34.7900
Regency	19.3333	7.2900	1.6867	44.6333	26.2000	30.2667	1.8333	14.1333	2.2900	1.6000	7.1833	39.9533
Tiger flame	31.0000	5.9000	2.0467	45.4000	21.6800	35.3333	1.9333	12.0000	2.4133	2.4333	7.3000	37.3733
Yellow stone	28.3333	7.2867	2.0100	50.2667	26.7333	31.0000	1.9000	13.6333	2.3733	2.3000	6.6667	37.2133
Praha	19.0000	5.1000	2.2667	36.4667	29.4867	29.1667	1.5333	13.3667	1.9167	1.4000	5.5000	37.4967
Shagun	26.3333	5.6200	2.0667	30.4000	21.2667	20.0000	1.3000	10.2000	1.6200	1.4667	5.2333	40.9067
Pink friendship	25.3333	7.6833	2.3500	45.2000	25.9000	28.6667	2.1333	12.2667	2.6633	2.5333	8.0000	37.2500
Novalux (check)	24.0000	7.1167	2.4567	48.1333	24.7300	35.0000	1.6333	14.6000	2.0400	1.4000	8.1667	41.4467
Promise	31.3333	7.6400	1.9333	35.4333	28.6300	30.6667	1.8333	15.3000	2.2900	2.3000	4.7500	39.2900
True love	27.0000	8.9000	2.2500	35.5667	25.0633	29.6667	2.0667	15.4333	2.5800	2.4333	5.5000	38.2900
Spic and span	22.6667	5.9467	1.2000	32.3333	29.1667	29.8333	1.2000	11.8667	1.4967	1.8000	6.0000	40.5367
Wind song	26.0000	7.9567	1.3667	39.4667	24.4500	30.8333	1.2667	11.3000	1.6233	1.7000	8.5000	38.1233
Mean	24.9444	6.8392	1.9800	39.8222	25.6256	30.2861	1.6889	13.3111	2.1122	1.9028	6.6208	38.5558
C.V.	5.2649	2.0380	7.4890	2.6235	4.6267	4.1107	14.8086	8.7746	14.7403	14.9466	8.1599	5.2716
F ratio	32.3572	210.3153	20.1725	120.5810	14.9790	29.2585	4.7315	6.9803	4.6519	7.7736	15.8163	2.6912
F Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0001	0.0011	0.0000	0.0000	0.0231
S.E.	0.7582	0.0805	0.0856	0.6032	0.6845	0.7188	0.1444	0.6743	0.1798	0.1642	0.3119	1.1735
C.D. 5%	2.2238	0.2360	0.2511	1.7691	2.0076	2.1081	0.4235	1.9778	0.5272	0.4816	0.9148	3.4417
C.D.1%	3.0225	0.3208	0.3413	2.4045	2.7287	2.8653	0.5756	2.6881	0.7166	0.6545	1.2434	4.6778

by Tiger flame (2.43) and True love (2.43) while variety Praha (1.40) had produced lowest number of corms produced per plant. The vase life of spike varied from 4.75 days to 8.50d. The variety Wind song (8.50 d) had maximum vase life in the laboratory when kept in vases with 4 % sucrose solution followed by Novalux (check) (8.16 d) and Pink friendship (8.00 d). The variety Promise (4.75 d) had minimum vase life. Similar results were observed by Singh *et al* (2000) and Nagaraju and Parthasarathy (2001). The corm yield per hectare ranged from 89.61 to 228.87q. The highest spike yield was observed variety Novalux (check) (41.44 q) followed by Shagun (40.90 q) and Spic and span (40.53q) and lowest spike yield variety Pacefica (34.79q).

Heritability

The estimates of heritability varied from 54.13 to 98.55 per cent. The highest heritability estimates in broad sense were observed for the characters number of leaves per plant (98.55%) followed by plant height (cm) (97.56%), days taken for complete sprouting (91.29%), length of spike (cm) (90.40%), number of sprouts per corm (87.58%), vase life (days) (83.26%), duration of flowering (d) (82.29%), number of corms per plant (69.58%), number of florets per spike (66.66%) and number of spikes per plant (56.52%). The lowest estimate of heritability in broad sense was noticed for number of spikes per ha (lac) (54.13%). Burton (1953) pointed out that heritability in combination with intensity of selection and amount of variability present in the population influences the genes to be obtained from the selection.

Genetic advance

The high range of genetic advance was recorded for plant height (cm) (13.42), days taken for complete sprouting (8.36) and length of spike (cm) (7.48). The medium range of genetic advance was observed for duration of flowering (days) (4.78), number of leaves per plant (2.38), vase life (d) (2.26) and corms yield per ha (q) (1.89). Rest of characters showed low to very low genetic advance *i.e.,* number of corms per plant (0.74), number of sprouts per corm (0.72), number of spikes per ha (lac) (0.52) and number of spikes per plant (0.43). The expected genetic advance was expressed as per cent of mean. It is the unit of measurement of the magnitude of genetic advance. Therefore, this cannot be avoided and to facilitate the comparison of genetic improvement in various parameters in per cent of mean. Expected genetic advance expressed as per cent of mean ranged from 4.90% to 38.63%. The highest genetic advance as percentage of mean was recorded for number of corms per plant (38.63%) followed by number of sprouts per corm (36.56%), number of leaves per plant (34.82%), vase life (34.09%), plant height (cm) (33.70%), days taken for complete sprouting (33.50%), number of spikes per plant (25.61%), length of spike (cm) (24.71%), number of spikes per ha (lac) (24.65%), number of florets per spike (20.83), duration of flowering (days) (18.66) and corms yield per ha (qt) (4.90%). Similar work was also reported by Kumar (2012) and Maurya (2011). The study of genetic divergence among the 12 varieties of gladiolus was carried out using Mahalanobis D^2 statistics. The 12 genotypes were grouped into four different non over lapping cluster (Table 4). Cluster 1 had highest number of genotypes (9) followed by cluster 2,3,4 (1). The distribution pattern of genotypes among different clusters also indicating that there is no geographical parallism in the grouping genotypes indicating that genotype of different geographical origin may group together or vice- versa.

The estimates of inter and intra cluster distances represented by D^2 values are given in (Table 5). The intra cluster D^2 values ranged from 0.00 (cluster 2,3 & 4) to 18.71 (cluster 1). The maximum inter-cluster distance was observed between 2 to 4 (31.02) which suggested that members of these two clusters were genetically very diverse to each other. Inter- cluster values between cluster 2 and cluster 3 (24.75), cluster 1 to 2 (22.50), cluster 1 to 4 (31.02), cluster 1 to 3 (24.75), cluster 3 to 4 (31.02) were very high. The minimum inter- cluster D^2 values was recorded in case of cluster 4 and 1

Table 3. Genetic parameters of different quantitative characters of gladiolus varieties.

Character	Mean	Range	Coefficient of variation (%)		Heritability (Broad sense)	Genetic Advance in per cent of Mean
			Phenotypic	Genotypic		
Days taken for complete sprouting	25	19-31	17.82	17.02	91.29	33.50
Number of leaves per plant	6.83	5.10-8.90	17.15	17.03	98.55	34.82
Number of sprouts per corm	1.98	1.20-2.45	20.27	18.96	87.58	36.56
Plant height (cm)	39.82	32.33-50.26	16.77	16.56	97.56	33.70
Duration of flowering (days)	25.62	21.26-29.48	11.01	9.99	82.29	18.66
Length of spike (cm)	30.28	20.00-35.33	13.27	12.62	90.40	24.71
Number of spikes per plant	1.68	1.20-2.13	22.00	16.54	56.52	25.61
Number of florets per spike	13.31	10.20-15.63	15.17	12.39	66.66	20.83
Number of spikes per ha (lac)	2.11	1.49-2.66	22.11	16.26	54.13	24.65
Number of corms per plant	1.90	1.40-2.53	26.95	22.48	69.58	38.63
Vase life (Days)	7	5-9	19.88	18.14	83.26	34.09
Corms yield per ha (qt)	38.55	34.79-41.44	6.59	3.96	36.06	4.90

Table 4. Clustering pattern of ten genotype of gladiolus on the basis of Mahalanobis D² statistics.

Cluster	Number of genotypes	Name of germplasm in cluster
1	9	Regency(2), pink friendship(7), novalux(8), yellow stone(4), promise(9), tiger flam(3), praha(5), pacefica(1), spic and span(11)
2	1	Wind song(12)
3	1	Shagun(6)
4	1	True love(10)

Table 5. Average intra and inter clusters D² values for four clusters in gladiolus cultivars.

Cluster number	**Cluster-1**	**Cluster-2**	**Cluster-3**	**Cluster-4**
Cluster-1	**18.71**	22.50	24.75	24.85
Clucter-2		**0.00**	23.87	17.37
Cluster-3			**0.00**	31.02
Cluster-4				0.00

(17.37). The higher inter-cluster distance indicated greater genetic divergence between the varieties of these clusters while lower inter –cluster values between the clusters suggested that the genotypes of the clusters were not much genetically diverse from each other.

The intra-clusters mean

The intra-clusters mean for seventeen characters in gladiolus is given Table 6. Cluster 3 had maximum mean values corms yield per ha (q) (40.91), cluster 4 showed mean values for the days taken for complete sprouting (27.0), number of florets per spike (15.43), number of spikes per ha (lac) (2.58), number of corms per plant (2.43), number of spikes per plant (2.07), number of sprouts per corm (2.25) and number of leaves per plant (8.90) cluster 1 showed mean values for the plant height(cm) (41.38), duration of flowering (days) (26.30), length of spike (cm) (31.44). Cluster 1 showed minimum mean values for the days taken for complete sprouting (24.44), cluster 2 days taken for complete sprouting (1.37), number of spikes per plant (1.27), number of spike per ha (lac) (1.62), corms yield per ha (qt) (38.12), Cluster 3 plant height (cm) (30.40), duration of flowering (days) (21.27), length of spike (cm) (20.00), number of florets per spike (10.20), number of leaves per plant (5.62), vase life (Days) (5.23) and number of corms per plant (1.47).Similar finding were recorded by Patil and Apte (2002), Sheikh and Khanday (2008) and Bhatia and Grewal (2009) for genetic divergence in gladiolus, Santhosha (2020) in chilli and Dhillon *et al* (2017) in sunflower.

A perusal of Table-7 showed that some characters zero contribution in duration of flowering (days), number of spikes per plant, number of florets per spike and number of spikes per hectare (lac) very low towards the divergence while number of leaves per plant was found for highest contribution (42.42%) followed by plant height (cm) (27.27%) and vase life (days) (12.12%) corms yield per ha (q) (6.06%), number of corms per plant & days taken for complete sprouting (3.03%) number of sprouts per corm (1.52%) for total divergence among the available genotypes of gladiolus.

CONCLUSION

It can be concluded that selection of genotypes based on characters like days taken for complete sprouting, number of leaves per plant, number of sprouts per corm, plant height (cm), duration of flowering (days), length of spike (cm), number of spikes per plant, number of florets per spike, number of spikes per ha (lac), number of corms per plant, vase life and corms yield which are showing high GCV, PCV, heritability and genetic advance will give potential parent in breeding programme

Table 6. Intra cluster group mean for seventeen characters in gladiolus genotype:

Number of cluster	Days taken for complete sprouting	Number of leaves per plant	Number of sprouts per corm	Plant height(cm)	Duration of flowering (days)	Length of spike (cm)	Number of spikes per plant	Number of florets per spike	Number of spike per ha (lac)	Number of corms per plant	Vase life (Days)	Corms yield per ha (qt)
I	24.44	6.62	2.01	41.38	26.30	31.44	1.74	13.64	2.17	1.91	6.69	38.37
II	26.00	7.96	1.37	39.47	24.45	30.83	1.27	11.30	1.62	1.70	8.50	38.12
III	26.33	5.62	2.07	30.40	21.27	20.00	1.30	10.20	1.62	1.47	5.23	40.91
IV	27.00	8.90	2.25	35.57	25.06	29.67	2.07	15.43	2.58	2.43	5.50	38.29

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Table 7. Per cent contribution of seventeen characters towards total genetic divergence in gladiolus.

Sr. No.	Source	Times ranked 1st	Contribution (%)
1.	Days taken for complete sprouting	2	3.03
2.	Number of leaves per plant	28	42.42
3.	Number of sprouts per corm	1	1.52
4.	plant height (cm)	18	27.27
5.	Duration of flowering (Days)	0	0.00
6.	Length of spike (cm)	3	4.55
7.	Number of spikes per plant	0	0.00
8.	Number of florets per spike	0	0.00
9.	Number of spikes per hectare (lac)	0	0.00
10.	Number of corms per plant	2	3.03
11.	Vase life (days)	8	12.12
12.	Corms yield per ha (q)	4	6.06

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Higher Levels of Phosphorus Affects Production and Productivity of Pigeonpea (*Cajanus cajan*) under Rainfed Condition

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ABSTRACT

A field experiment was carried out during rainy (kharif) season of 2015-16 and 2016-17 to study the effect of levels of phosphorus on production, productivity and profitability of pigeonpea under rainfed condition. Plant height (215.87 cm), branches per plant (17.06), pods length (5.41cm), pods/plant (188), grains/pod (4.33), 100 seed weight (11.37g), grain yield (12.20q/ha), stalk yield (45.6q/ha), harvest index (21.07%), net return (Rs70312.50) and benefit: cost ratio (3.51) were significantly higher at 60 kg P_2O_5/ha. Result revealed that P level 60kg/ha gave 58.44 , 31.18 and 4.27 per cent higher grain yield and 68.91, 35.93 and 3.70 per cent higher net return, respectively as compared to application of phosphorus levels 28 kg/ha, 40 kg /ha and 50 kg/ha. The trend of phosphorus levels to pigeonpea showed that higher dose of phosphorus gave maximum production and profitability as compared to lower dose of phosphorus application (Singh et al 2012).

Key Words: Pigeonpea, Phosphorus, Growth, Yield, Profitability, Production, Economics, Rainfed.

INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) is one of the major pulse crops of India. At present long and medium duration pigeonpea is cultivated mostly on marginal land as mono/mixed crop either with imbalance fertilizer dose or without fertilizer under rainfed condition of Jharkhand. The evolution of new varieties of pigeonpea have provided the opportunity for multiple cropping in irrigated as well as rainfed areas. During the past the prices of phosphorus are increasing due to decrease in government subsidy on fertilizer, especially of phosphorus (P) and potassium (K). It has created imbalance of P nutrition and soil P reserve. Therefore, it is necessary to apply P in balanced amount for improving the productivity and profitability of pigeonpea. The organic based resources, farmyard manure is important source of organic manure, which not only provides balanced nutrition to the plants but also sustains crop productivity provides good substrate for growth of microorganisms, maintain favourable nutritional balance and soil physical properties Mahetele and Kushwaha (2011) but their availability is seriously constrained due to its alternative use as fuel.

Inoculation of pulses with PGPR and rhizobium causes growth stimulation of plant and enhances crop yields. The synergism has also been reported between rhizobium species and PSB in urdbean (Prasad *et al*, 2002) . The productivity of pigeon can be increased by inoculation of bioculture prepared from rhizobium, phosphate solubilizing organism (Govindan and Thirumurugan, 2005). Under present scenario where food and nutritional security are under threat, it has become imperative to ameliorate the soil plant-atmosphere as a whole rather than feeding the crop alone. The present investigation was undertaken to achieve maximum productivity without deteriorating the soil fertility with the optimum use of inorganic fertilizer in medium duration pigeonpea.

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Table 1. Effect of levels of phosphorus on plant height, branches/plant, pods length, pods/plant, grain/ pod and 100 grain weight of pigeonpea.

Treatment	Plant height (cm)	Branches / plant	Pod length (cm)	Pods / plant	Grain/pod	100 grain weight (g)
P_2O_5 (kg/ha)						
28	203.37	10.03	4.65	157.56	3.71	9.96
40	205.80	11.31	4.92	168.57	3.88	10.31
50	215.00	16.62	5.35	184.50	4.31	11.35
60	215.87	17.06	5.41	188.00	4.33	11.37
CD(P=0.05)	3.31	2.316	0.188	10.784	0.252	0.474
SEM $\pm$	1.12	0.782	0.064	3.642	0.085	0.160
CV%	1.50	16.061	3.530	5.897	5.933	4.215

MATERIALS AND METHODS

The field experiment was conducted during the *Kharif* season of 2015-16 and 2016-17 at farmers' field. The soils were sandy loam with PH 5.3 to 6.5, organic carbon 2.2 to 5.3 g/ kg, available N 122.3 to 147.6 kg/ha, available P 3.4 to 6.2 Kg/ha and available K 58.1 to 312.4 Kg/ha. The treatment consisted of four levels of Phosphorus (28,40,50 and 60 kg P_20_5/ha). In all four treatments with eight replications were tested in randomized block design. All the doses of phosphorus treatments and recommended doses of nitrogen (25 Kg/ha) and potassium (25kg/ha) were applied as basal dose. The pigeonpea cultivar ICPL 87119 (Asha) was shown on 28th July 2015 and harvested on 5th February 2016. Harvest index (%) was calculated based on the formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Net return were calculated by subtracting cost of cultivation from gross return.

Benefit: cost ratio was calculated by dividing the gross return with cost of cultivation. For economic analysis the prevailing prices of the input and produce during the period of the experiment were considered.

RESULTS AND DISCUSSION

Growth and yield attributes

Phosphorus levels exerted significant effect on plant height and yield indices of pigeonpea. Application of 60 kg P_20_5/ha significantly enhanced plant height and yield indices *viz.,* plant height (215.87 cm), branches/plant (17.06), pod length (5.41cm), pods/plant(188) and grain/pod (4.33) and found superior as compared to application of P_20_5 28,40 and 50 Kg/ha. P_20_5 60kg/ha followed by P_20_5 50 kg/ha viz plant height (215 cm), branches/ plant (16.62), pods length (5.35 cm), pods/plant (184.5) and grain/pod (4.31). Singh *et al* (1994) has reported superiority of SSP to DAP.

Grain yield, stalk yield, 100 seed weight and harvest index (%)

Application of P_20_5 60 Kg/ha significantly increased the grain and stalk yields, 100 seed weight and harvest index % over application of P_20_5 28,40 and 50 kg/ha. This might be owing to supply of adequate quantities and balanced proportion of plant nutrients to the crop as per need which increased availability of these nutrients to plant resulting in favorable increase in plant height, yield attributing characters and finally grain and stalk yield. It is reported that higher grain yield of pigeonpea at 18:46:20:20 kg N, P, K and S/ha (Goud and kale, 2010) . Result revealed that the grain yield (12.2 q/

Table 2. Effect of levels of phosphorus on grain yield, stalk yield, harvest index, net return and benefit: cost ratio of pigeonpea.

Treatment	Grain yield (q/ha)	Stalk yield (q/ha)	Harvest index (%)	Net return (Rs/ha)	Benefit: cost ratio
P_2O_5 (kg/ha)					
28	7.70	33.70	18.62	41625	2.59
40	9.30	41.00	18.44	51725	2.86
50	11.70	45.50	20.40	67800	3.56
60	12.20	45.60	21.07	70312.50	3.51
CD(P=0.05)	0.178	0.44	1.293	12896.75	0.696
SEM±	0.060	0.15	0.437	4355.79	0.235
CV%	16.56	10.22	6.28	21.20	21.207

ha) stalk yield (45.6 q/ha) 100 seed weight (11.37g) and harvest index (21.07%) found maximum when P_20_5 applied as 60 kg/ha as compared to application of P_20_5 28,40,50 kg/ha. Result showed that P level 60 kg/ha gave 58.44, 31.18 and 4.27 per cent higher grain yield over P level 28,40 and 50 kg/ha. It was reported that grain yield and phosphorus status in pigeonpea- wheat system influenced by phosphorus levels (Katyal *et al,* 1999). The stalk yield (45.6 q/ha) and 45.5 q/ha found at par when P_20_5 applied as 60 and 50 Kg/ha respectively and it was 35.31 per cent higher as compared to lower dose of P_20_5 application (28 kg/ha) (Kumar and Rana, 2007. It was reported that the greater value of stalk yield at higher dose of P owing to significantly higher value of dry matter /plant besides the other growth and yield parameters of pigeonpea under rainfed condition (Sarkar *et al* ,1997).

Economics

Application of phosphorus level 60 Kg/ha fetched higher net return (Rs. 68500/ha) and benefit: cost ratio (3.42) as compared to phosphorus level 28, 40 and 50 kg/ha. The net return was 68.91%, 35.93% and 3.70% higher at P level 60 kg/ha as compared to P level 28,40 and 60 kg/ha, respectively. It was reported that higher monetary returns at higher fertility level in pigeonpea + greengram intercropping system[8]. It was also reported that the maximum net return and benefit: cost ratio under combined inoculation of rhizobium + PSB together with 60 kg P_2O_5 application (Singh and Yadav, 2008).

CONCLUSION

The investigation results conclude that the application of higher dose of phosphorus level (60 kg/ha) gave maximum grain yield (12.20 q/ha) as compared to lower dose of phosphorus levels (28 kg/ha) gave lowest grain yield (7.70 q/ha). The yield gap between higher and lower levels of phosphorus found 58.44% which influence the net return gap by 68.91%. It was reported that the improvement in nutrient status of the soil may be ascribed to more biomass (leaves, root, etc) added by pigeonpea and improvement in fertility status of the soil through addition of fertilizers (Sarkar et al 1997).

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Integrated Disease Management Practices for the Control of Bacterial Blight in Pomegranate in Karnataka

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ABSTRACT

Pomegrante (*Punica granatum* L.) is mainly grown in states of Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Changing climatic scenario and intensive cultivation practices led to outbreak of bacterial blight disease caused by *Xanthomonas axonopodis* pv. *punicae* in pomegranate leading to heavy losses ranging from 30-50 per cent depending on the pathogenic load in orchard and aberrant climatic conditions. Pomegranate orchards at Bagalkote district in Karnataka are severely affected by bacterial blight disease to the tune of 40 per cent. For the management of bacterial blight of Pomegranate, Integrated Disease Management (IDM) practices developed by UAS, Dharwad were demonstrated under Front Line Demonstration (FLD) by ICAR-Krishi Vigyan Kendra, Bagalkote at Kaladagi village during the year 2016-17 and 2017-18. Method demonstration in farmers' pomegranate orchard at Kaladagi village comprised of sanitation practices including removal of infected shoots, pasting of stem and branches with Bordeaux mixture @ 1% foliar spray of copperoxychloride @ 3g/l, streptocycline @ 0.5g/l, *Pseudomonas fluorescens* @ 5g/l against oily spot disease of pomegranate, which benefited growers. The incidence of bacterial blight in pomegranate and yield in IDM demonstrated and Farmers' Practice fields during the year 2016-17 and 2017-18 were recorded. Percent Disease Incidence (PDI) in IDM demonstrated fields was 26.35 with yield of 13.50 t/ha and BC ratio of 5.69. However, the disease incidence in farmers' practice orchard was 38.95, with yield 9.75 t/ha and BC ratio 3.31. In IDM demonstrated orchards there was reduction of disease by 32.34 per cent and increase in the yield levels by 38.46 per cent.

Key Words: Bacterial Blight, Bagalkote, Pomegranate, Integrated Disease Management.

INTRODUCTION

The pomegranate (*Punica granatum* L.) has emerged as commercially important fruit, owing to its enormous medicinal and nutritional properties, built-in ability to tolerate heat and drought, low resource input demanding nature and high returns on investment (Singh *et al*, 2012). India is one of the largest producers of pomegranate in the world. During 2017-18, pomegranate was cultivated over 234 thousand ha with an annual production of 2845 thousand Mt and productivity of 12.15 Mt/ ha in India. At present, Maharashtra is the leading state in acreage covering about 62 per cent of area under pomegranate. The other important states next to Maharashtra with respect to pomegranate cultivation are Karnataka, Gujarat and Andhra Pradesh (Anonymous, 2018). In Karnataka, area under pomegranate is 25.97 thousand ha with a production of 268.2 thousand metric tons. Bagalkote district has diversified cropping patterns among agricultural and horticultural crops, where in pomegranate is one of the important fruit crops of the district grown over an area of 2298 ha with production of 25034.8 t/ha and productivity 10.89 t/ha (Kammar et al, 2019).

Bacterial blight (*Xanthomonas axonopodis* pv. *punicae*) in recent years has become one of the most serious diseases of pomegranate in all the major growing areas resulting in enormous losses to growers. Under epidemic conditions

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Table1. Technology Integrated Disease Management.

Spray Schedule	Time of Sprays	Plant Protection Chemicals Sprayed
1st	Immediately after pruning	Bordeaux Mixture (1%)
2nd	Seven days after 1 st Spray	*Pseudomonas fluorescens* talc based formulation @ 5g/lit
3rd	Eight days after 2nd spray (When new flush come out)	copper oxy chloride 50 WP (3g/lit)+bronopol (0.5g/lit) along with spreader sticker
4th	Fifteen days after 3rd spray (at flower bud initiation)	Streptocycline (0.5g/lit)+carbendazim 50WP (2g/lit) along with spreader sticker
5th	Fifteen days after 4th spray	captan 50 WP (2.5g/lit)+bronopol (0.5g/lit) along with spreader sticker
6th	Fifteen days after 5th spray (at initiation of fruit setting)	Streptocycline (0.5g/lit)+thiophanate methyl 70 WP (1g/lit)
7th	Seven days after 6th spray	*Pseudmonas fluorescens* talc based formulation @ 5g/lit
8th	Seven days after 7th spray	Bordeaux Mixture (1%)
9th	Fifteen days after 8th spray (at 50 % fruit setting)	Streptocycline (0.5g/lit)+Carbendazim 50WP (2g/lit) + Neem Seed Kernal Extract (50g/lit) along with spreader sticker
10th	Fifteen days after 9th spray (at 100 % fruit setting)	Bordeaux Mixture (1%)
11th	Fifteen days after 10th spray	Captan 50 WP (2.5g/lit)+Bronopol (0.5g/lit) along with spreader sticker
12th	Fifteen days after 11th spray	Streptocycline (0.5g/lit)+Thiophanate methyl 70 WP (1g/lit)
13th	Fifteen days after 12th spray	Bordeaux Mixture (1%)
14th	Fifteen days after 13th spray	Streptocycline (0.5g/lit)+ copper oxy chloride 50 WP (3g/lit)+ Neem Seed Kernal Extract (50g/lit) along with spreader sticker
15th	Fifteen days after 14th spray	*Pseudomonas fluorescens* talc based formulation @ 5g/lit

blight resulted in yield losses up to 80 per cent. Bacterial blight pathogen survives in infected plant stems, buds and plant debris in soil up to one year. Apparently healthy planting material may carry the blight pathogen in latent form, particularly in buds, resulting in infection of new plants (Hingorani and Mehta, 1952; Hingorani and Mehta, 1959). Bacterial blight of pomegranate has been effectively managed by adopting Integrated Disease Management (IDM) practices developed by University of Agricultural

Table 2. Bacterial blight disease incidence in IDM and Farmers' Practice Pomegranate Orchard.

Parameter Average Percent Disease Incidence %	2016-17	2017-18	Pooled	Average Percent disease reduction over control (%)
Demo (IDM)	30.30	22.49	26.35	32.34
Check (FP)	41.35	37.70	38.95	
SE (m)	0.65	0.58	0.54	
CD @ 5%	2.08	1.86	1.73	
CV (%)	5.74	6.12	5.23	

Sciences, Dharwad (Benagi and Ravikumar 2009). Pomegranate is the major fruit crop of Kaladagi Village of Bagalkote District, hence, the technology developed by UAS, Dharwad was demonstrated under front line demonstration in farmers field with an objective of disease reduction and fruit yield enhancement.

MATERIALS AND METHODS

KVKs are playing a proactive role in transfer of technology at field level with beneficial impacts. The details of technology intervened through ICAR-Krishi Vigyan Kendra, Bagalkote with the farmers of Kaladagi Village of Bagalkote District under Front Line Demonstration (FLD) in the year 2016-17 and 2017-18 is depicted in table1.

The FLD was conducted in ten farmers' pomegranate orchard in an area of 4 ha replicated ten times in a randomized block design. The spray schedule was followed for Kesar/Bhagwa variety in demonstration plots and farmers own practice was considered as check. The observations on bacterial blight incidence were recorded after the spray schedule in IDM demonstration plots and Farmers Practice was followed. Per cent disease incidence (Wheeler, 1969) on fruit was calculated by applying the formula given below.

Number of Infected fruit

Per cent disease incidence (%) = x 100

Total number of fruits observed in a set

Incidence of bacterial blight disease on pomegranate in IDM demonstrated plots and farmers practice were recorded. Fruit yield and economics were also worked out for the same.

RESULTS AND DISCUSSION

Management practices demonstrated in IDM demo plots/orchards with different spray schedule showed reduction in disease incidence and increase in yield levels. The incidence of bacterial blight on pomegranate and yield in IDM demonstrated orchard and farmers' practice orchard during the year 2016-17 and 2017-18 were recorded and pooled data is presented in table 2 and 3. Percent Disease Incidence (PDI) in IDM demonstrated orchard was 26.35 per cent, while PDI in farmers practice orchard was 38.95 per cent. The fruit yield in demonstration orchard was 13.50 t/ha while with farmers own practice the fruit yield was 9.75 t/ha and there was 38.46% increase in fruit yield and disease reduction by 32.34 per cent in IDM demonstrated orchards as compared to farmers practiced orchard. The present findings are also in conformity with the results of Ravikumar *et. al* (2011), who reported the devastating nature of bacterial blight of pomegranate in Bellary, Bijapur and Bagalkot districts on all the varieties, irrespective of age of the plant during late summer and *kharif* season. The disease incidence was more in *mrigbahar* when compared to *ambiabahar* and *hastbahar* seasons because of environmental factors like rainfall and temperature (Rani and Verma, 2001; Dhandar *et*

Table 3. Yield in IDM and Farmers Practice Pomegranate Orchard.

Parameter (Net Returns Rs/ha)	2016-17	2017-18	Pooled	Average Percent increase in yield (%)
Demo (IDM)	13.65	12.36	13.50	38.46
Check (FP)	9.80	9.05	9.75	
SE (m)	0.49	0.31	0.28	
CD @ 5%	1.58	1.01	0.88	
CV (%)	13.34	9.30	7.48	

al, 2004;). The incidence of bacterial blight is less with use of NSKE and *Pseudomonas fluorescens*, use of plant products and bioagents against the pathogen were cost effective essentially required to minimize the use of chemicals and is considered as one of the components in the integrated disease management (Sharma *et al*, 2008). Pooled data of two years revealed that the cost of cultivation in demonstration plots was Rs. 2.14 lakh while the gross income obtained from selling of produce was Rs. 1.22 lakh. The net profits in demonstrated plots were appreciably high with cost benefit ratio of 5.69. The cost of cultivation in farmers' practice was Rs. 2.35 lakh while the gross income obtained from selling of produce was Rs.7.86 lakh.

Most of the farmers do not follow correct plant protection measures. Hence, the effectiveness of different spray schedule with chemical fungicides, antibiotics, NSKE and bio-agent *Pseudomonas fluorescens* was shown to the farmers through demonstration orchards. Trainings, method demonstrations and literature on IDM practices in pomegranate was provided to the farmers to impart knowledge on pomegranate diseases and management practices. The measurable results were increase in yield level and income of the farmers, their knowledge and skill on management practices improved as a result of KVK intervention (Sudha *et al*., 2019 and Santosh *et al*., 2018).

CONCLUSION

The result shows that the IDM practices brought down the bacterial blight infection significantly up to 32.34 % and enhanced productivity of pomegranate. It was inferred from the present study that bacterial blight disease of pomegranate could be managed to have profitable return using Integrated Disease Management Practices developed by UAS, Dharwad which is a boon to pomegranate growers.

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Impact of Mission Organic Value Chain Development Scheme on Yield of Aromatic Black Rice

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ABSTACT

The present study was carried out during 2020-21 in 18 villages of Thoubal and Bishnupur districts of Manipur to analyze the impact of Mission Organic Value Chain Development Scheme on crop yield and income of aromatic black rice growers. One hundred and eighty respondents were interviewed using a pre tested interview schedule. An increase of 5.21 and 5.24 per cent was observed in respect of grain yield and straw yield, respectively after registering of aromatic black rice growers to MOVCDS. There was a significant increase in the gross income (25.07%) and net income (41.47%) of aromatic black rice growers after joining the MOVCDS. In respect of production problems, scarcity of organic manure and inadequate financial assistance provided for off-farm inputs (biofertilizers, biopesticides and neem cake) were accorded first and second ranks by the aromatic black rice growers. With respect to the marketing problems, inaccessible to organic produce outlets was assigned first rank by the aromatic black rice growers, followed by lack of access to reliable market information, regulation and distribution channels (Rank II) was assigned the second rank by the aromatic black rice growers.

Key Words: MOVCDS, Crop yield, Net income, Problems, Suggestions.

INTRODUCTION

The Mission Organic Value Chain Development for North Eastern Region (MOVCD-NER) is a Centrally sponsored scheme established by the Ministry of Agriculture and Farmers Welfare. It was implemented for promoting organic cultivation practices among farmers and values chain creation in the North Eastern States. Phase I was implemented from 2017-18 to 2019-2020 covering 2000 ha. The scheme was implemented by Manipur Organic Mission Agency (MOMA) in Manipur aiming at promotion and production of certified organic commodities focusing on export-oriented crops *viz.,* Black Aromatic Rice, Ginger, Tamenglong Orange, King Chilli, Kachai Lemon and Pineapple. The MOMA is conducting various production and extension activities, such as providing training on organic cultivation and identification of farmer cluster groups through which the organic practices, the information and technical know-how is expected to be tickled down (Reddy, 2018).

The black aromatic black rice is a native to the north-eastern region of India. The black colour of the grain which give the crop a distinct feature is primarily due to its anthocyanin content.Various studies have reported that the aromatic black rice have superior nutritional values such as higher contents of minerals, proteins, high antioxidants, and perceived to have various health benefits. It is high time to know the impact of MOVCDS on the crop yield and income of the beneficiary farmers, hence this study was undertaken with the objective to analyse the impact of MOVCDS on crop yield and income of aromatic black rice growers and document the problems faced by the aromatic black rice growers.

MATERIALS AND METHODS

The study was carried out during 2020-21 in all the talukas of Thoubal and Bishnupur districts of Manipur, where the first phase of Mission was implemented from 2017-2018 to 2019-20 (phase

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1). Lilong, Thoubal, and Kakching from Thoubal districts and Nambol, Bishnupur, and Moirang) from Bishnupur district were selected for the research study. Three villages from each of the sampled six talukas were randomly selected for the study. From each of the selected 18 villages, ten beneficiaries aromatic black rice growers were randomly selected for the study. Thus, the total number of beneficiary aromatic black rice growers sampled for the research study was 180. All the beneficiary farmers had obtained the benefits/incentives from MOVCDS since the inception of the scheme. The grain and straw yield obtained by the aromatic black rice growers before joining the scheme was also documented to compare the crop yield obtained before and after joining the MOVCDS to know the impact of MOVCS on crop yield. The respondents were asked to mention the problems and suggestion for effective implementation of MOVCDS.

RESULTS AND DISCUSSION

Impact of MOVCDS on crop yield

The aromatic black rice growers had obtained a slight increase in the grain yield (11.50 q/acre) after registering under MOVCDS, as compared to the grain obtained by them before they joined MOVCDS (27.25q/ha) (Table 1). There was an increase of 5.21 per cent in grain yield after registering to MOVCDS. The black rice growers could harvest a slight increase in the straw yield (6.67 t/ha) after registering to MOVCDS when compared with the straw yield before registering to MOVCDS (6.32t/ha) (Table 1). There was an increase of 5.24 per cent in straw yield after the aromatic black rice growers registering to MOVCDS. The student 't' test value indicated that there was a non-significant increase in both grain yield (0.69) and straw yield (0.71) by the respondents before and after registering to MOVCDS.

Impact of MOVCDSon gross income of aromatic black rice growers

The gross income from the grain yield earned by the aromatic black rice growers after registering to MOVCDS (Rs.1,66,750/ha) was much higher than the gross income obtained from grain yield before registering to MOVCDS (Rs. 1,22,625/ha) (Table 1). There was an increase of 26.46 per cent of gross income obtained from grain yield after the respondents registering for MOVCDS. The student 't' test value (2.09) indicated a significant increase in the gross increase obtained from grain yield before and after registering for MOVCDS by aromatic black rice growers. A slight increase in the gross income from straw yield of aromatic black rice growers after registering to MOVCDS (Rs.11,680/ha) as compared to before registering to MOVCDS (Rs11,070/ha) was observed. There was an increase of 5.22 per cent in gross income obtained from straw yield by the aromatic black rice growers after registering to MOVCDS, however the 't' value was non-significant increase in the gross income obtained from straw yield of the aromatic black rice growers when compared to before and after registering to MOVCDS.

The data (Table 1) further revealed that there was a substantial increase in the total gross income of aromatic black rice growers after registering to MOVCDS(Rs.1,78,430/ha) as compared to the total gross income of the respondents before registering to MOVCDS (Rs. 1,33,695/ha). There was an increase of total gross income of the aromatic black rice growers by 33.46 per cent. A significant difference was observed between the total gross income obtained by the aromatic black rice growers before and after registering to MOVCDS. which tallied for a 35.98 per cent change. As expected, the results of the t-test indicated a significant difference. Significant increase in respect of totalgross income is because the aromatic black rice growers used to sell their produce at Rs. 4500/q in the local market before registering to MOVCDS. The beneficiary aromatic black rice growers are selling the organic aromatic black rice to MOVCDS at a premium price of Rs.5800/q, hence there was a significant increase in the total gross income of aromatic black rice growers. Similar findings were reported by Jagadeesh *et al* (2020).

Table 1. Impact of MOVCDS on crop yield and income of aromatic black rice growers

Sl. No.	Particulars	Aromatic black rice growers		Percentage increase	't' value
		Before MOVCDS	After MOVCDS		
1	Productivity (yield/ha)				
a	Grain yield (q/acre)	27.25	28.75	5.50	0.99^{NS}
b	Straw (t/ha)	6.32	6.67	5.53	1.01^{NS}
2	Gross income (yield x price of produce) (Rs/ha)				
a	Grain (Rs/ha)	1,22,625	1,66,750	35.98	1.88*
b	Straw (Rs./ha)	11,070	11,680	5.51	1.03^{NS}
c	Total	1,33,695	1,78,430	33.46	2.85*
3	Net income (Gross income-cost of cultivation) (Rs/ha)				
Total		73,695	1,25,930	70.87	2.68**

Note: NS= non-significant; *= Significant at 5%; **= Significant at 1%; Cost of cultivation before and after MOVCDS is Rs. 60,000/ha and Rs. 52,500/ha, respectively; Price of aromatic black rice grain before and after MOVCDS is Rs. 4500/q and Rs.5800/q, respectively; Price of straw is 1750/t.

Impact of MOVCDSon net income of aromatic black rice growers

A perusal of data (Table 1) reveals that the aromatic black rice growers obtained a higher net income after registering for MOVCDS (Rs.1,25,930/ha) as compared to their net income before registering to MOVCDS (Rs. 73,695/ha) and the percentage increase in the net income works out to be 70.87. The student 't' test value revealed that there exists highly significant difference in the net income of the aromatic black rice growers before and after registering to MOVCDS.

It is evident from the results of the research study there is an increase in crop yield and income of the aromatic black rice growers could be attributed to the impact of MOVCDS.

Problems faced by aromatic black rice growers in Mission Organic Value Chain Development Scheme

In respect of production problems, scarcity of organic manure and inadequate financial assistance provided for off-farm inputs (biofertilizers, biopesticides and neem cake) were accorded first and second ranks by the aromatic black rice growers (Table 2). While, lack of credit facilities to invest on organic agriculture and allied activities, untimely disbursement of direct fund transfer after verification of on-farm input production units created by beneficiaries, scarcity of labour, erratic onset of monsoon rain, inadequate financial assistance provided for establishing on-farm input production units (liquid manure tanks, compost tanks, botanical extracts etc.), lack of knowledge on pests and disease control, and no reliable package of practices for organic farming were accorded III, IV, V, VI, VIII, VIII and IX ranks, respectively by the aromatic black rice growers.

With respect to the marketing problems, inaccessible to organic produce outlets was assigned first rank by the aromatic black rice growers, followed by lack of access to reliable market information, regulation and distribution channels (II rank), inadequate institutional support for marketing the produce (III rank) and irregular

Table 2. Problems faced by aromatic black rice growers in MOVCDS. (n=180)

Sr. No.	Problems	Aromatic black rice growers		
		No.	%	Rank
A.	Production problems			
1	Scarcity of organic manure	56	31.11	I
2	Inadequate financial assistance provided for off-farm inputs (biofertilizers, biopesticides and neem cake.	43	23.89	II
3	Lack of credit facilities to invest on organic agriculture and allied activities	42	23.33	III
4	Untimely disbursement of direct fund transfer after verification of on-farm input production units created by beneficiaries	37	20.56	IV
5	Scarcity of labour	34	18.88	V
6	Erratic onset of monsoon rain	36	20.00	VI
7	Inadequate financial assistance provided for establishing on-farm input production units (liquid manure tanks, compost tanks, botanical extracts etc.)	25	13.89	VII
8	Lack of knowledge on pests and disease control	23	12.78	VIII
9	No reliable package of practices for organic farming	13	7.22	IX
B.	Marketing problems			
1	Inaccessible to organic produce outlets	52	28.89	I
2	Lack of access to reliable market information, regulation and distribution channels	48	26.67	II
3	Inadequate institutional support for marketing the produce	44	24.44	III
4	Irregular collection of organic produces from farmgate	37	20.56	IV

collection of organic produces from farmgate (IV rank) were the other marketing problems faced by aromatic black rice growers in the order of importance. The authorities of MOVCDS should address the production and marketing problems faced by aromatic black rice growers for the effective implementation of MOVCDS.

Suggestions of aromatic black rice growers for the effective implementation of Mission Organic Value Chain Development Scheme

Accessibility to organic produce outlets (Rank I), access to reliable market information, regulation and distribution channels (Rank II), adequate institutional support needed for marketing the produce (Rank III) , and regular and timely collection of organic produces from farmgate (Rank IV) were the suggestions which were assigned the first four ranks by the aromatic black rice growers for the effective implementation of MOVCDS (Table 3) , while the suggestions namely, provision of adequate financial assistance provided for off-farm inputs (biofertilizers, biopesticides and neem cake (Rank V), provision of credit facilities to invest on organic agriculture and allied activities (Rank VI), timely disbursement of direct fund transfer after verification of on-farm input production units created by beneficiaries (Rank VII), inadequate financial assistance provided for establishing on-farm input production units (liquid manure tanks, compost tanks, botanical extracts etc.) (Rank VIII) and accessibility of extension workers for obtaining technical know-how on control of pests and disease control (Rank IX) were the suggestions which were assigned the last five ranks by the aromatic

Table 3: Suggestions of aromatic black rice growers for effective implementation of MOVCDS. (n=180)

Sr. No.	Suggestions	Aromatic black rice growers		
		No.	%	Rank
1	Accessibility to organic produce outlets	52	28.89	I
2	Access to reliable market information, regulation and distribution channels	48	26.67	II
3	Adequate institutional support needed for marketing the produce	44	24.44	III
4	Regular and timely collection of organic produces from farmgate	37	20.56	IV
5	Provision of adequate financial assistance provided for off-farm inputs (biofertilizers, biopesticides and neem cake.	43	23.89	V
6	Provision of credit facilities to invest on organic agriculture and allied activities	42	23.33	VI
7	Timely disbursement of direct fund transfer after verification of on-farm input production units created by beneficiaries	37	20.56	VII
8	Inadequate financial assistance provided for establishing on-farm input production units (liquid manure tanks, compost tanks, botanical extracts etc.)	25	13.89	VIII
9	Accessibility of extension workers for obtaining technical know-how on control of pests and disease control	23	12.78	IX

black rice growers for the effective implementation of MOVCDS.The suggestions put forth by the aromatic black rice growers needs to be considered by the policy makers and authorities of MOVCDS for the effective implementation of MOVCDS.

CONCLUSION

The study results has revealed that there is an increase in the grain and straw yield by five per cent and also there was a significant increase in the gross income (25.07%) and net income (41.47%) of aromatic black rice growers after joining the MOVCDS.Provision of adequate financial assistance provided for off-farm inputs and on farm input production units, adequate and timely availability of credit and timely disbursement of direct fund transfer by the authorities of MOVCDS will help the aromatic black rice growers to increase the adoption level of organic farming practices leading to enhanced crop yield. Accessibility to organic produce outlets, access to reliable market information, regulation and distribution channels, adequate institutional support needed for marketing the produce and regular and timely collection of organic produces from farmgate by the MOVCD authorities for getting good marketing facilities, besides receiving good price for the organic rice grain.

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Improved Management Practices of Garden pea (*Pisum sativum* L.) Produced Higher Yield in Karbi Anglong District of Assam

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ABSTRACT

Vegetables are very well grown in Karbi Anglong district due to its favourable climatic conditions. Out of all the major vegetables, garden pea is a popular crop out here. Due to the insufficient knowledge regarding the scientific management of the crop, farmers were not able to reap the maximum returns out of it. Under such circumstances, Krishi Vigyan Kendra, Karbi Anglong conducted demonstration programmes during the year 2019-20 and 2020-21 on scientific cultivation of Garden pea. Results revealed that the technology demonstrated had obtained higher plant height (51.94 cm), number of branches per plant (16.3 no) and days to flowering (41.58 d) than the farmers' practice which were 45.83 cm, 15.63 nos. and 52.17 days, respectively. In addition to that, the pod yield was higher in the demonstration plot (58.12 q/ha) than the farmers' practice which ended up its yield up to 46.84 q/ ha only. Moreover, the gross return in case of the scientific technology showed encouraging results (Rs. 205415/ha in 2019-20 and Rs. 201425/ ha in 2020-21) during both years. Whereas, the practice followed by the farmers obtained a return of Rs. 144960/ha in 2019-20 and Rs. 136110/ha in 2020-21.

Key Words: Arkel, Garden pea, Improved practice, Karbi Anglong, Vegetables.

INTRODUCTION

Garden pea (*Pisum sativum*) is one of the most important cool season vegetable crop grown almost throughout the country. It is one of the main crop in Karbi Anglong district. The plant foliage can be used as a fodder for cattle and green pods are highly nutritive and so are preferred for culinary purposes. Important constituents like digestible protein (7.2 g), carbohydrates (15.8 g), vitamin A (139 I.U.), vitamin C (9 mg), magnesium (34 mg) and phosphorus (139 mg) are present per 100 g of edible portion (Gopalkrishnan, 2007). Garden pea is a leguminous crop and therefore it fixes atmospheric nitrogen to soil and thus maintains the soil fertility. It is also been reported to fix residual nitrogen up to 50-60 kg/ha in soil (Negi *et al*, 2006). It can be grown in a wide range of soils with proper drainage facilities but, best pH ranges from 5.5 to 6.5.

Karbi Anglong is one of the three hill districts of Assam and is very suitable to a wide range of horticultural crops. Some vegetable growing pockets are present in the district *viz*., Barlangpher, Sariahjan, Bokolia, Rajapathar, Patradisha, Taralangso, Longnit *etc.* Under pea cultivation the district covers an area of 42 ha with an average production of 6015 kg/ha. Karbi Anglong receives an annual rainfall of 1121.50 mm with an average temperature range of 10°C to 30°C which makes it congenital for pea cultivation. Peas are rich source of protein and thus play an important role to maintain a healthy daily diet. As a result, the area under pea cultivation should be increased to meet the nutrition requirement for the increasing population. Under such circumstances, good agricultural practices like proper time of sowing, timely manuring and fertilization, proper irrigation facilities, weeding, appropriate plant protection measures, *etc.* has become an integral part in increasing the productivity. The crop is cultivated widely in the district but the farmers are not doing

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Table 1. Package of practices followed during the demonstration in both the plots.

Particular	Technology demonstration plot	Farmers' practice
Time of Sowing	Mid October	November to December
Seed rate	50 Kg/ha	No any specific rate followed usually use 90 kg/ha
Variety	Arkel (2019-20); AP3 (2020-21)	Non-descript seeds
Spacing	30 cm × 10 cm	Broadcasting, no line sowing is followed.
Fertilizer dose	N: P_2O_5 @ 20:45 Kg/ ha	Non judicious use of fertilizer, generally 60 kg Urea and 45 kg DAP/ha is followed
Irrigations	One irrigation at 40-50 DAS	No irrigation is done
Plant protection	Neem based insecticides	No use of chemicals or botanicals

it scientifically. Therefore, an effort has been made by the Krishi Vigyan Kendra, Karbi Anglong by conducting multiple demonstrations on garden pea under the North East Hill.

MATERIALS AND METHODS

Krishi Vigyan Kendra, Karbi Anglong conducted demonstrations under NEH programme to disseminate the technology of improved cultivation practices of garden pea using variety Arkel in 2019-20 and the variety AP 3 in 2020-21. The demonstrations were carried out covering an area of around 8.6 ha with 36 farmers. The villages selected for the demonstrations were Bhetagaon, Rongnihang, Sunpura, Manja, Bokolia, Sombudhon and Daujingphang. Under the technology demonstration plot, the land selected was with deeply worked soils and ploughed 2-3 times to obtain a good tilth. The package of practices followed in both the demonstration plots *i.e.,* the technology demonstration plot and the plot under farmers' practice are depicted in the Table 1. The data like plant height, pod length, number of pods per plant, number of seeds per pod, fresh pod yield, gross return, net return and B:C ratio were recorded. The technology gap, extension gap and technology index were calculated by using the following formula as given below (Samui *et al,* 2000).

Technology gap = Potential yield (q/ha) – Demonstration yield (q/ha)

RESULTS AND DISCUSSIONS

Growth parameters

The data (Table 2) revealed that the plant height in both the year was found higher in the improved practice (51.97 cm) than the farmers' practice (45.83 cm). This may be due to the favourable climatic conditions prevailing in this hill district. The result was in conformity with Sharma *et al* (2020). Similar results were also reported by Bozoglu *et al* (2007) and Shah *et al* (2016). In case of number of branches per plant, both the cultivation practices showed a slightly different behaviour. The higher number of branches was found in the demonstration (16.30) than the farmers' practice (14.99). This might be due to equal absorption of minerals and nutrients from soil by the cultivars of both the practices at the same time. The variations could be also due to the germplasm or climatic conditions (Wadan *et al*, 1993). Variation has been found in case of days to flowering in both the cultivation methods. The demonstration plot with improved practice had an early flowering (41.58) whereas, after around 11 days flowering has been seen in the farmers' practice (52.17). Similar results have also been reported by Khichi *et al* (2017). The cultivar which flowers early was found to have comparatively early maturity (Ozdemir, 2002). This might be the reason behind the lesser number of days to pod picking of the improved practice (59.33d) in comparison to the farmers' practice (65.45d). Similar results were also reported by Sharma *et al* (2020).

Table 2. Effect on growth parameters.

Cultivation practice	Plant height			No. of branches/plant			Days to flowering			Days to first pod picking		
	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean
Improved practice	53.27	50.67	51.97	16.48	16.12	16.3	40.54	42.62	41.58	58.36	60.31	59.33
Farmers' practice	45.36	46.31	45.83	14.36	15.63	14.99	53.31	51.04	52.17	66.25	64.66	65.45

A-2019 and B-2020

Yield and yield attributes

Various yield attributes were studied during the study (Table 3) like number of pods per plant, pod length, pod weight, number of seeds/pod and pod yield ha^{-1} which has been detailed as below.

In the study, it has clearly come out that the improved cultivation of garden pea has higher number of pods per plant (13.15) than the farmers' practice (10.70). From the earlier discussions it can be understood that maximum growth was found in the improved practice than the farmers practice during the crop establishment period and this might be the reason of higher number of pods in the former one (Muehlbauer and McPhee, 1997). These results are in line with the findings reported by Kumar *et al* (2018). The pod length in both the cases was not found to have a much difference (Table 3). Many workers in their earlier study reported that pea cultivars vary highly in pod length and number of seeds (Kakar *et al*, 2002). Pod weight in case of improve method was 3.85g whereas it was 3.42g by the method generally used by the farmers. This might be due to the reason that the cultivars possess certain inherent potential and their interaction with soil and climatic conditions (Khichi *et al*, 2017). Higher seed per pod (8.59) was evident in the demonstration plot on the other hand, the check plot was found to have a lesser number of seed per pod (6.74). It might be due to the varietal characteristics used in both the practices. Makasheva (1983) and Amjad *et al* (2002) stated similar statements in their findings. Moreover, Arshad *et al*(1998) also observed that numbers of seeds are correlated with pod length.

Huge difference has been observed in case of pod yield per hectare in case of both the cultivation practices. The higher yield was found in case of the demonstration plot (58.12 q/ha) and lower results have been shown by the check plot or farmers' practice (46.84 q/ha). This might have resulted due to a greater number of branches per plant with higher numbers of pods per plant, moreover,

Table 3. Effect demonstration on yield and yield attributes.

Cultivation practice	No. of pods/plant			Pod length			Pod weight			Number of seeds/pod			Pod yield/ha		
	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean
Improved practice	13.83	12.48	13.155	7.13	8.02	7.575	3.69	4.01	3.85	8.98	8.2	8.59	58.69	57.55	58.12
Farmers' practice	10.28	11.13	10.705	6.89	6.56	6.725	3.23	3.62	3.425	7.03	6.46	6.745	48.32	45.37	46.845

Table 4. Analysis of Technology gap, Extension gap and Technology index.

Year	Area (ha)	No. of farmers	Pod yield (q/ha)			Per cent increase	Tech. Gap (q/ha)	Extension gap (q/ha)	Tech. Index (%)
			Potential	Demo	Farmers' practice (Control)				
2019-20	4.93	19	60.0	58.69	48.32	21.46	1.31	10.37	2.18
2020-21	4.13	17	60.0	57.55	45.37	26.84	2.45	12.18	4.08

inherent characters of the varieties and prevailed favourable conditions of the location. Additionally, enhanced yielding ability might also be due to its genetic potential and better adaptability to the soil and climatic conditions (Khichi *et al,* 2016).

Yield gap

In the present study, the yield gap was analyzed in the form of technology gap and extension gap (Table 4). From the data, it can be inferred that the technology gap is much lesser in both the years (1.31 q/ha and 2.45 q/ha) which reflects the sincerity and seriousness of the farmers in conducting the demonstration. This gap might have resulted due to the varying soil fertility status and weather conditions. A huge extension gap has been seen (10.37 q/ha and 12.18 q/ha) in both the years. The majority farmers in this hill districts belongs to the tribal community and they are very reluctant to adopt any new technology. Thus, an extension gap has been created which depicts that more extension techniques should be applied for the effective adaptation of the technologies by the farmers. Technology gap exhibits the feasibility of the technology in the farmers' field conditions. From the Table 4, it has been found that the demonstration plot has a technology index of 2.18 per cent which was a lesser one and thus explains the feasibility of the technology because lower the value of technology index, more the feasibility of the technology (Jeengar *et al,* 2006).

Economics

Cost of cultivation and returns were calculated by the prices of the inputs required and the market value of the crop at the location where the study was conducted. In both the years it has been found that the improved practice has got a higher Benefit Cost ratio than the farmers' practice (Table 5). The total cost of cultivation in the year 2019-20 was Rs. 58977/- and in the year 2020-21 was Rs. 59177/- in the demonstration plot whereas, in case of the farmers' practice it was Rs. 62955/- and Rs. 65420/- in 2019-20 and 2020-21, respectively. Since, the demonstration plot has higher yield therefore, the gross return was Rs. 2,05,415/- in 2019-20 and Rs. 2,01,425/- in 2020-21 with a B:C ratio of 3.48 and 3.40, respectively. But, in case of the check/farmers' practice it could manage only up to 2.30 and 2.08 for the year 2019-20 and 2020-21, respectively.

CONCLUSION

From the study, it could be finally concluded that the improved cultivation practice of garden pea cultivation has a remarkable role in benefitting the farmers in getting higher returns than the existing

Table 5. Effect of the demonstration on Gross cost (Rs./ha), Gross return (Rs./ha), Net return (Rs./ha) and B:C ratio.

Method of practices	Gross cost (Rs.)		Gross return (Rs.)		Net return (Rs.)		B:C ratio	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Improved practice	58977	59177	205415	201425	146438	142248	3.48	3.40
Farmers' practice	62955	65420	144960	136110	82005	70690	2.30	2.08

practice followed by them. Since, the crop is very much favourable to the climatic conditions prevailed in the district; efforts should be done to spread the technology horizontally to cover more area under garden pea cultivation. Moreover, the extension workers and the farmers together must work hard to minimise the technology gap in fruitful adaptation of these technologies which will finally help in increase the crop productivity of the district.

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Innovative Technological Interventions Coupled with Proper Management is the Need of the Day for Producing Summer Green Gram in the Tribal District of Madhya Pradesh

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ABSTRACT

A total of 100 demonstrations on summer green gram variety IPM 2-3 were conducted by KVK, Jhabua during 2016-17 and 2017-18 across 10 tribal villages of Jhabua hills zone of Madhya Pradesh for exploring the production potential and economic benefits of improved practices. The results showed that farmers significantly increased the green gram productivity by switching over to improved variety (IPM 2-3) and adoption of improved production technology. The higher yield (823.5 kg/ha) of green gram was recorded under front line demonstration as compared to farmers' practice (568.5 kg/ha). The increase in the demonstration yield over farmers' practice was 45.23%. Simultaneously higher net returns (Rs. 29396/ha) and B:C ratio (2.59) were recorded in front line demonstrations as compared to farmers practices (net return of Rs. 16089 and B:C ratio of 1.95). The average extension gap, technology gap and technology index were 255 kg/ha, 376.5 kg/ha and 31.37%, respectively.

Key Words: Economics, Front line demonstrations, Technology gap, Summer green gram, Yield.

INTRODUCTION

India is the largest producer, consumer and importer of pulses. Pulses are a good and chief source of protein for a majority of the Indian population. Pulses contribute 11% of the total intake of proteins in India (Reddy, 2010). Pulses production in India has not kept up with growth in demand calling for import to the tune of 2.0 to 4.0 million tonnes (Kumawat *et al*, 2009a,b). Green gram is an excellent source of high quality protein (25%) having high digestibility. It being a leguminous crop has capacity to fix the atmospheric nitrogen (30-40 kg N/ha). It also helps in preventing soil erosion. Being a short duration crop, it fits well in many intensive crop rotations (Kumawat *et al*, 2009c and Kumawat *et al,* 2010). Green gram can be used as feed for cattle. In North India, it is cultivated in both *kharif* and summer seasons.

Jhabua is the tribal district of Madhya Pradesh and green gram is the most important summer pulse crop but due to low productivity and high infestation of yellow vein mosaic virus is not popular among tribal farmers. Low productivity might be due to unavailability of improved seed, poor crop management practices as well as unawareness and non adoption of recommended package of practices. Therefore, it was very necessary to demonstrate the high yielding varieties with recommended new production technologies. Keeping above points in view front line demonstrations were conducted on summer green gram by Krishi Vigyan Kendra, Jhabua to exhibit the performance of recommended package of practices for harvesting the potential yields and higher returns.

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MATERIALS AND METHODS

This study was conducted at farmers field where 100 demonstrations on green gram were conducted during summer 2016-17 and 2017-18. These demonstrations were conducted in five blocks of Jhabua district *viz*., Rama (03 village), Ranapur (03 village), Jhabua (02 village), Meghnagar (01 village) and Petlawad (01 village). Each demonstration was conducted in an area of 0.4 ha and adjacent to the farmer's fields in which the crop was cultivated with farmer's practice/ local variety. In 100 demonstrations full package of practices were provided to the beneficiaries. The package of practices included were improved variety of green gram (IPM 2-3), seed treatment with carbendazim + mencozeb, seed rate (20 kg/ ha), optimum sowing time (Ist fortnight of March), recommended fertilizers dose (NPK @ 20:50:20 kg/ha), weed management, irrigation management, plant protection measures etc. The sowing was done during first fortnight of March with the seed rate of 20 kg/ha by seed cum fertilizer drill. All the participating farmers were trained on scientific aspects of green gram production management before implementing the FLDs at their field.

The primary data were collected from the selected farmers with the help of interview schedule and interpreted and presented in terms of percentage increased yield. Thus, a total sample size comprised of 100 respondents from 10 villages across Jhabua district. To estimate the technology gap, extension gap and technology index following formulae used by Samui *et al* (2000).

Extension gap (kg/ha) = DY (Demonstration Yield) - FY (Farmers' yield)

Technology gap (kg/ha) = PY (Potential yield) - DY (Demonstration yield)

Technology index (%) = (Technology gap/ Potential yield) X 100

RESULTS AND DISCUSSION

The major differences were observed between demonstration package (were varieties, seed rate, seed treatment, time of sowing, nutrient management and plant protection measures) and farmer's practices. Under the demonstrations seed of green gram (IPM 2-3), fungicide for seed treatment, NPK (19:19:19) for foliar spray and insecticides for plant protection measures and rest package and practices were timely performed by the farmer itself. Under farmers' practice, sown their own seed being used since long time and variety was not identifiable. Farmers use higher seed rate without seed treatment

Table 1. Particulars showing the details of summer moong grown under Front Line Demonstrations and farmers practices.

Sr. No.	Particular	Technological intervention	Existing practices
1	Variety	Improved variety IPM 2-3	Their own seed mixture/ Old variety K 851
2	Seed rate	20 kg/ha	30-40 kg/ha
3	Seed treatment	Carbendazim + Mencozeb @ 3g/kg seed	No seed treatment
4	Use of Culture	Seed treatment with Rhizobium culture	No culture use
5	Time of sowing	Ist fortnight of March	Ist fortnight of April
6	Nutrient management	NPK @ 20:50:20 (Apply NPK 12:32:16 @ 150 kg/ha)	Apply DAP @ 50 kg/ha (NPK @ 09:23:0)
7	Plant protection	Indiscriminate use of Quinolfos or Trizophos	Need based plant protection measures

Table 2. Yield Performance and gap analysis of front line demonstrations on summer green gram.

Year	No. of Demonstration	Area (ha)	Average yield (kg/ha)		% increase	Extension gap (kg/ha)	Technology gap (kg/ha)	Technology index (%)
			FLD	Farmer practice				
2016-17	50	20	817	575	42.46	242	383	31.91
2017-18	50	20	830	562	48.01	268	370	30.83
Average			823.5	568.5	45.23	255	376.5	31.37

* Potential yield of IPM 2-3 is 12.0 q/ha

and there is no nutrient management and unaware about proper plant protection measures. It was also observed that under farmer situation, normally sowing of green gram was delayed due to lack of field preparation timely. Regarding fertilization, fertilizers were given on soil test value while in farmers' practice, used under and imbalance dose of fertilizer in pulses, thus leading to reduction in yield. Similar finding was also observed by Chandra (2010)

The results of demonstrations showed that farmers could increase the green gram productivity notably by switching over to improved variety and adoption of improved packages of practices. A comparison of yield performance between demonstrated practices and farmers' practices (Table 2). It was observed that higher grain yield (823.5 kg/ha) was recorded in demonstrated plot with improved variety IPM 2-3 and recommended packages of practices as compared to their local farm practices (568.5 kg/ha). The increase in the demonstration yield over farmer's practices was 45.23per cent. Farmer's practices were treated as control for comparison with recommended practices. During both the years, yield was recorded higher by 42.46 and 48.10 per cent over farmers' own practices, respectively (Table 2). It was evident from the results that the yield of demonstrations was better due to adoption of improved variety, seed treatment, nutrient management and proper plant protection measures. Farmers were motivated by results of demonstrated technologies applied in the FLDs and is anticipated that they would adopt these technologies in future. Singh *et al* (2016a) reported that the innovative intervention in front line demonstrations may have significant enhancement in productivity of soybean. These findings were in the conformity of the results carried out by Morya *et al* (2016), Singh *et al* (2016b) , Verma *et al* (2016) and Meena and Dudi (2018). Similar results were also observed by Bezbaruah and Deka (2020) and Khedkar *et al* (2017).

An extension gap between demonstrated technology and farmers' practices ranged from 242 to 268 kg/ha during 2016-17 and 2017-18, respectively and on average basis the extension gap was 255 kg/ha (Table 2). This gap might be attributed to adoption of improved technology in

Table 3. Economic analysis of demonstrated plots and farmer practices.

Year	**Average seed yield (kg/ha)**		**Gross Return (Rs./ha)**		**Net Return (Rs./ha)**		**B: C ratio**	
	FLD	**Farmer practice**	**FLD**	**Farmer practice**	**FLD**	**Farmer practice**	**FLD**	**Farmer practice**
2016-17	817	575	47394	33319	29144	16469	2.60	1.98
2017-18	830	562	48397	33009	29647	15709	2.58	1.91
Average	823.5	568.5	47896	33164	29396	16089	2.59	1.95

Table 4. Economic analysis for additional cost and incremental B:C ratio.

Year	Cost of cult		Additional cost in demonstration (Rs/ha)	MSP (Rs/q)	Average yield (kg/ha)		Gross Return (Rs)		Additional return in demo	Effective gain (Rs/h)	INC B:C ratio
	Demo	Farmer practice			FLD	Farmer practice	Demo	Cont			
2016-17	18250	16850	1400	5400	817	575	47394	33319	14075	12675	10.05
2017-18	18750	17300	1450	5575	830	562	48397	33009	15388	13938	10.61
Average	18500	17075	1425		823.5	568.5	47896	33164	14732	13307	10.33

* INC-Incremental benefit cost ratio

demonstrations which resulted in higher grain yield than the traditional farmers' practices.

The technology gap is the difference or gap between the demonstration yield and potential yield and it was average technology gap observed 376.5 kg/ha. The technology gap was observed 383 and 370 kg/ha in 2016-17 and 2017-18, respectively. The difference in technology gap in different years could be due to more feasibility of recommended technologies and also due to variation in the soil fertility and climatic conditions. Hence location specific recommendations are necessary to bridge the gap. These findings are similar to the findings of Patel *et al* (2013) and Kumari *et al* (2014).

Technology index shows the feasibility of the technology at the farmer's field. The lower the value of technology index more is the feasibility. Higher technology index reflected the inadequate proven technology for transferring to farmers and insufficient extension services for transfer of technology. Results revealed that the technology index value was 31.37. The results of demonstrations were in accordance with technology gap. The results of the present study were in recurrence with the findings of Kaur *et al* (2014).

The economics of green gram production under front line demonstrations have been presented in Table 3. The results revealed that the front line demonstrations recorded higher gross returns (Rs. 47896/ha), net return (Rs. 29,396/ha) and benefit cost ratio (2.59) were more than the farmer's practice. Further, additional cost of Rs.1425/ha in demonstration has increased additional net returns Rs.14732/ha with incremental benefit cost ratio of 10.33 (Table 4) suggesting its higher profitability and economic viability of the demonstration. The higher additional returns and effective gain obtained under demonstrations could be due to improved technology, timely operations of crop cultivation and scientific monitoring. The results confirm the findings of frontline demonstrations on oilseed and pulse crops by Yadav *et al* (2004) and Lathwal (2010).

CONCLUSION

Front line demonstration program was very effective in changing attitude of farmers towards cultivation of summer green gram. Cultivation of demonstrated plots of summer green gram with improved technologies has increased the skill and knowledge as well as net returns of the farmers. The findings of the study revealed that yield of summer green gram could be increased by 45.23 per cent by innovative technology interventions coupled with the proper management of demonstrations field. Further improved practices captured net returns of Rs. 29396/ha with B:C ratio of 2.59 as against Rs. 16089/ha and B:C ratio of 1.95 only in farmers practices. Under FLD improved practices create great awareness and motivated the other farmers to adopt improved production technologies for summer green gram. The selection of suitable variety, critical inputs and participatory approach in planning and conducting the demonstrations help in the transfer of technology to the farmers.

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Integrated Approach to Manage False Smut in Paddy (*Oryza sativa* L.)

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ABSTRACT

In most part of the Uttar Pradesh including Jaunpur district false smut caused by *Ustilaginoidea virens* is becoming a major disease of rice causing yield losses where rice is cultivated. Krishi Vigyan Kendra, Jaunpur conducted on farm trial on the integrated approach for management of false smut in paddy on 10 farmers' fields in two village viz. Alhadiya and Utreejpur of the district Jaunpur during *kharif* 2018 and 2019. Technological gap between improved management practices and farmers practices were studied based on survey and group discussion with farmers interactive group (FIG) of rice growers. The integrated approaches *i.e.,* seed and soil treatment with Trichoderma (6g/kg seed and 2.5 kg/ha), recommended dose of nitrogen (120kg/ha), weed management with Bispyribac-sodium10% EC @ 200ml/ha at 25 days after transplanting (DAT), removal of infected panicle carefully and spraying of fungicide Propiconazole 13.9 + Difenoconazole 13.9 % EC @ 500ml/ha at booting stage. On an average disease reduction was 75.41 per cent recorded with the use of integrated disease management approach. There was 34.29 per cent more yield in recommended practices plots than control and the highest net return and benefit to cost ratio was also obtained by application of recommended practices.

Key Words: Benefit Cost Ratio, False smut, Fungicide, Paddy, *Ustilaginoidea virens.*

INTRODUCTION

Rice (*Oryza sativa* L.) is the main staple food of around half of the world's population. It accounts for about 43 per cent of total food grain production and 46 per cent of total cereal production in India. It is also one of the most important food crop of Uttar Pradesh and mostly grown in Indo-Gangetic plains in rice-wheat cropping system.Uttar Pradesh achieved 14.64 million tons of rice from an area of 5.98 million hectares with productivity of 2447 kg/ha in 2013-14 (ASG, 2015).The area, production and productivity of rice in Jaunpur district of Uttar Pradesh are 157.28 (000'ha), 362.68 (000' t) and 2308kg/ha, respectively. False smut (*Ustilaginoidea virens*) is emerging as one of the potential threats to rice cultivationunder Indo-Gangetic plains in rice-wheat cropping system. The incidence of this disease is becoming a major constraint to adoption of modern rice cultivars in Jaunpur district which is situated in Indo-Gangatic plains regions. Earlier it was recorded as a minor disease, occurring sporadically in certain regions, but now epidemics of the disease are also being reported in different parts of the world including in India (Rush et al, 2000 and Anonymous, 2016). It is an important devastating disease causing yield losses from 1.01 to 10.91 per cent (Atia, 2004). Disease incidence of 10-20 per cent and 5-85 per cent respectively has been reported from Punjab and Tamil Nadu on different rice cultivars (Ladhalakshmi *et al*, 2012). In recent years, its outbreak is anticipated due to high input cultivation, increased use of hybrid varieties and climate change (Lu *et al*, 2009). The efficacy of several fungicides against false smut has also been reported by various workers from different parts of the world. Mohiddin et al, (2012) reported that prochloraz + carbendazim was effective against false smut. Pannu et al,

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Table 1: Technological gap between improved production technology and farmers' practices in paddy.

Sr. No	Practice	Recommended Practice	Farmer's practice	Gap
1.	Preparation of field	Summer ploughing with mould board plough and proper puddling	No summer ploughing and proper puddling	Ful gap
2.	Cultivars	HUBR-2-1, PRH 10, MTU 7029, BPT 5204, Pusa 1509, Arize 6444, Swarna	Moti, Damini, Sarju 52, Arize 6444. Swarna	Partial gap
3.	Time of transplanting	Third week of June to 2nd week of July in irrigated condition	Third week of June to 2nd week of July in irrigated condition	Nil
4.	Transplanting method (Line transplanting)	20 x 15 cm (R x P)	Improper transplanting 30 x 20 cm (R x P)	Partial gap
5.	Number of hill/m^2	32/m^2	20-22/m^2	Partial gap
6.	Seed/seedling treatment	Carbendazim 50% WP/Vitavax power 75% WP @ 2 g/kg seed or Carbendazim 50% WP + Thiram 75% WP @ 1:2 2g/kg seed Trichderma powder 1% WP @ 10g/ liter water for seedling treatment	No seed treatment	Full gap
7.	Fertilizer application	120:60:40:25 kg/ha	Use of imbalance fertilizer	Partial gap
8.	Weed management	Pretilachlor 50% EC @ 1500ml/ ha at 3-7 DAT and Bispyribac-sodium10% EC @ 200ml/ha at 25 DAT	Improper chemical weed management	Partial gap
9.	Plant protection	Propiconazole 25%EC or Azoxystrobin 18.2 % + Difenconazole 11.4 % SC @ 500ml/ha at booting stage	Injudicious use of fungicides	Partial gap

(2010) obtained reduction in false smut by spraying of fungicide copper oxychloride 50 WP (0.25%) at booting followed by propiconazole 25 EC (0.1%). The yield loss estimates ranged from 0.2 to 49 per cent in different regions with different rice varieties (Biswas, 2001). Keeping this in view, a study was conducted with farmers' participation by Krishi Vigyan Kendra Jaunpur, Uttar Pradesh regarding to assess the site specific integrated approach for management of false smut in paddy.

MATERIALS AND METHODS

Krishi Vigyan Kendra, Jaunpur conducted the on farm trials (OFTs) at 10 farmers' field in two village viz. Alhadiya and Utreejpur of the district. In selected villages of the district, technological gap between improved management practices and farmers practices were studied based on survey and group discussion with farmers' interactive group (FIG) of rice growers. Out of 100 farmers, 25 farmers were selected randomly and discussions were held

Table 2: Effect of integrated approach on yield and false smut disease in paddy during *kharif* 2018 and 2019.

Year	Av. infected panicle/hill		Av. infected panicle/m^2		Disease incidence (%)		Reduction in disease incidence (%)	Yield (q/ha)		Yield increase over FP (%)
	RP	FP	RP	FP	RP	FP		RP	FP	
2018	0.92	2.98	2.25	7.52	7.67	31.33	75.51	54.57	40.44	34.94
2019	1.02	3.27	2.85	8.27	8.50	34.45	75.32	55.25	41.34	33.64
Avg.	0.97	3.12	2.55	8.26	7.89	32.89	75.41	54.91	40.89	34.29

RP = Recommended Practice; FP= Farmer's Practice; Avg.= Average

on nine improved management package to study the technological gap. The gap between demonstration technologies and existing technologies was identified and categorized into three levels *viz.,* full (8-12), partial (4-7) and non-adoption (less than 3). The integrated approaches *i.e.,* seed and Soil treatment with Trichoderma (6g/kg seed and 2.5 kg/ha) recommended dose of nitrogen (120kg/ha), weed management with Bispyribac-sodium10% EC @ 200ml/ha at 25 days after transplanting (DAT), removal of infected panicle carefully and spraying of Propiconazole 13.9 + Difenoconazole 13.9 % EC @ 500ml/ha at booting stage were tested under on farm trial.The control plots were farmers' practices (use of hybrid varieties and most susceptible variety Moti, no seed treatment, improper transplanting methods, injudicious use of pesticides and poor crop management practices). Performance of yield and economics of rice crop was observed in terms of yield parameter, net returns and benefit cost ratio. Farmers reactions were observed with the help of personal interview and data on quantitative parameters were also recorded.

RESULTS AND DISCUSSION

The gap between improved technology and farmers' practices of rice cultivation is presented in table 1. Full gap was observed in case of field preparation and use of seed/seedling treatment. Partial gap were in use of varieties, method of transplanting, number of hill/m^2, use of fertilizers, weed management and plant protection measures, which definitely was the reason of not achieving potential yield. Farmers' are used most susceptible hybrid variety in their cultivation practices instead of high yielding resistant cultivars.

The farmers were much concerned about importance of time of transplanting. The results were similar with the findings of Mubarak and Shakoor (2019).

The minimum infected panicle/hill, infected panicle/m^2 and disease incidence were recorded in demonstrated technology as compare to farmers practice. Average incidence of false smut in paddy was recorded 7.89% in demonstrated plot while it was 32.89% in farmers' practice. The maximum disease incidence i.e. 34.45 per cent was noticed during kharif 2019 due to prevailing high humidity (>90%) with cloudy weather, medium temperature (25-30^{0}C) and high dose of nitrogenous fertilizer. On an average disease reduction was 75.41 per cent received with the use of integrated disease management approach. During both years, the average yield was recorded 54.91q/ha in recommended practices whereas in farmers' practice it was found to be 40.89 q/ha. There was 36.64 per cent more yield was recorded in recommended technology demonstrations plots than farmers practice. The loss of yield due to improper management of paddy crop like imbalance use of fertilizer, no seed treatment, improper spacing, injudicious use of fungicides and other pesticides resulting increased in cost of cultivation.

Table 3: Economic performance of paddy crop with recommended practices and farmers' practices.

Year	Gross cost (Rs/ha)		Gross return (Rs/ha)		Net returns (Rs/ha)		BCR	
	RP	FP	RP	FP	RP	FP	RP	FP
2018	36225.00	37125.00	98226.00	72792.00	62001.00	35667.00	2.71	1.96
2019	37150.00	38210.00	99450.00	74412.00	62300.00	36202.00	2.67	1.94
Av.	36687.50	37667.50	98838.00	73602.00	62150.50	35934.50	2.69	1.95

RP = Recommended Practice; FP= Farmer's Practice; BCR= Benefit Cost Ratio; Avg.= Average

The results are in conformity with the findings of Mubarak *et al* (2012).

The economic analysis reveals that the average net returns of demonstrated plots was Rs. 62150/ha in comparison to farmers practice Rs. 35934/ha. The higher net returns obtained under demonstrations could be due to improved technology, non-monetary factors, timely operations of crop cultivation and scientific monitoring. Benefit cost ratio range 1.94-2.71 and an average 2.69 were found under demonstrated technologies while it was 1.95 in farmer's practices. These results are in accordance with the findings of Balai *et al* (2013).

CONCLUSION

The results of present study led to conclusion that false smut is a major disease of paddy in irrigated and rain fed lowlands rice. The yield losses due to this disease can be managed by the application of improved technology. It was also concluded that the demonstrated technology is eco-friendly and safer to non-targeted organism. Based on farmer's feedback, it was noticed that the use of improved technology for false smut management in rice was highly acceptable, easily compatible in existing production and cropping systems.

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Impact Analysis of Trainings on Goat Production Technology

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ABSTRACT

Farmers of Alwar district are not following improved practices on goat farming *i.e.* breeding, feeding, health, management, production etc. which resulted in poor production performance of the goats. The present study underlines the importance of training programmes on goat farming to the rural youth which will help to recognize knowledge gaps in different areas of goat farming. The impact of the training programme on knowledge gained by rural youth was assessed through pre and post knowledge tests with the help of structured schedule. Majority (58.09%) of the trainees belonged to middle age and had higher secondary level education. They had 5-10 members in the family and land holding was less than 2 ha. Pre and post test score showed highly significant gain in knowledge in all 5 training programmes. This study suggested follow up of trainees is also required for better adoption of goat farming technologies.

Key words: Goat Farming, Impact analysis, Knowledge level, Trainings.

INTRODUCTION

Animal husbandry is essential for the rural livelihood, particularly farmers who have small size of land holdings. Livestock not only contribute to their earnings but provide best assurance against any natural calamity in farming. Goat plays a significant role in providing supplementary income and livelihood to millions of resource poor farmers and landless labours of rural area. India has the largest goat population in the world and majority of goats are reared by the marginal, small farmers and landless labourers under extensive management system (Dixit *et al,* 2014). The current goat population of Rajasthan is 218.40 lakh which in about 12 per cent of total population of goats in the country (20th Livestock census 2019). Mohan *et al* (2009) and Dixit *et al* (2014) mentioned that there is large gap between the improved and existing practices of goat rearing which result in poor production performance. Keeping this in view, the present study was undertaken to study impact of training programmes organised by Krishi Vigyan Kendra, Navgaon (Alwar-I) on knowledge gain of rural youth in Alwar district.

MATERIALS AND METHODS

The study was undertaken in Alwar district from Rajasthan. The district is situated in the north-east of Rajasthan between 27°34' and 28°4' north Latitudes and 76°7' and 77°13' east Longitudes. It is bounded on the north and north-east by Gurgaon (of Haryana) and Bharatpur district and on the north-west by Mahendragarh district of Haryana, on the south-west by Jaipur and on the south by Sawai- Madhopur and Jaipur districts. Krishi Vigyan Kendra, Navgaon (Alwar-I) organised 10-15 d training programme on goat farming for rural youth of Alwar District. Training programmes were designed according to rural youth training needs and focused on goat breeding, feeding, health, housing, reproduction, value addition, economics and marketing. The impact of the training programme on knowledge gain by rural youth was assessed through pre and post knowledge tests with the help of structured schedule. Knowledge test schedule consisted 50 questions related with different aspect of goat farming *i.e.* breeding, feeding, health, management, production, marketing, decision making in goat farming also asked about the

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Table 1. Socio-economic profile of trainees. n=105

Characteristic	Category	Frequency	Percentage
Age	Young age (up to 25 yr.)	36	34.28
	Middle age (26 to 35 yr.)	61	58.09
	Old age (above 35 yr.)	8	7.63
Education	Illiterate	2	01.90
	Primary Education	9	08.57
	Middle Education	34	32.38
	Higher Secondary	56	53.33
	Graduation	4	03.82
Family Size	Small (up to 5)	19	18.09
	Medium (6-10 members)	58	55.24
	Large (above 10 members)	28	26.67
Land Holding	Landless	21	20.00
	Less than 1 ha	52	49.52
	1 to 3 ha	27	25.72
	Above 3 ha	5	4.76
Experience in farming	1 to 4 yr.	31	29.52
	5 to 10 yr.	48	45.72
	More than 10 yr.	26	24.76
Annual income	Upto Rs. 1 lakh	26	24.76
	Rs. 1lakh to Rs.2 Lakh	71	67.62
	More than 2 lakh	8	7.62

constraints faced by rural youth in goat farming. A well-structured schedule was prepared and information was collected at the start of training and at the end of training course. Information was taken regarding age, education, family size, land holding, annual income and experience in farming. A set of 50 questions were used before and after training to understand the impact of training program on farmers. The data from 105 trainees of goat farming trainings conducted by Krishi Vigyan Kendra, Navgaon (Alwar-1) from year 2017 to March 2021were collected and analysed with the help of MS-Excel-2010.

RESULTS AND DISCUSSION

The socio-economic profile of trainees included age, education, family size, land holding, annual income and experience in farming. Majority of the trainees were from the middle-aged group (26 to 35 yr). Age of the trainees of goat farming training ranged between 18 to 43 yr. with an average age of 28.76 yr. Most of the trainees fall under middle aged group because of last two years trainings on goat farming conducted under the attracting and retaining rural youth in agriculture (ARYA) project in which 18-35 age group people were selected as participants of training. This finding was in line

Table 2. Impact on the knowledge level of the participants in training Programme.

Year	No. of participants	Average Knowledge Score		
		Before Training	After Training	t-Values
2017	16	10.53	42.77	12.19**
2018	18	12.98	39.11	13.17**
2019	21	9.14	43.86	11.83**
2020	20	14.38	40.78	13.86**
2021	30	16.96	45.67	16.27**
Total	**105**			

with the result of Shelly (2020) who reported that majority of goat farmers were middle aged in the study on effectiveness of training programme on the adoption behaviour of goat farmers in Punjab.

Education is one of the most significant socioeconomic variables which help to easy understand of technical knowledge related with goat farming. It is evident that formal education in terms of primary education, middle level education, higher secondary and graduation was 08.57, 32.38, 53.33 and 03.82, respectively (Table 1). The outcomes were in accordance with the findings of Sharma *et al* (2007) Tanwar *et al* (2008). In case of family size maximum trainees (55.24 %) had middle level family size (6 to 10 members). Maximum number (49.52%) of trainees possessed less than 1 ha land. 45.72 respondents had 5 to 10 years' experience in farming and majority (67.62 %) had less than 2 lakh annual income. Same findings were found by Dhaka *et al* (2017) and Hundal *et al* (2016).

In the year 2017 , average marks obtained 10.53 by trainees before trainings while after training average score was 42.77 and the t test score showed highly significant gain in knowledge (Table 2). The t- test score for all the trainings was highly significant which shows that trainee's knowledge level increased by attending training programmes. Most of the trainees were aware about the health management of goat but not aware about vaccination of goats. In case of breeding techniques , trainees score was minimum but after acquiring trainings they scored high in the breeding of goat section. This finding was in line with Dixit *et al* (2014) that average knowledge scores of pre and post training programms were increased significantly in all the training programmes.

CONCLUSION

The present study underlines the importance of training programmes on goat farming to the rural youth. A significant gain in the knowledge was observed in all 5 training programmes. Also found that socio –economic characteristics of trainees influenced gain of knowledge during training programme. These training programmes not only help to improve efficiency of goat farmers by educating them how they can use available resources in most efficient and balanced way but also provide a roadmap to the commercial goat farmers through introducing them with latest goat technologies.

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Impact of Management Practices on Field pea (*Pisum sativum* L.) Cultivation in Baksa district of Assam

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ABSTRACT

Field pea (*Pisum sativum* L.) is one of the highly cultivated crops in Assam due to its high profitability. Baksa district is situated at the Lower Brahmaputra valley zone of Assam, having cool and humid climatic condition and the average annual rainfall received is 2097.6 mm. The district has 115735 ha area of cultivated land where 10760 ha area is occupied under *rabi* pulses. Field Pea is one of the well grown crops in the rice fellow areas of the entire district. However, it is difficult to achieve maximum yields as the most of the farmers are not following scientific cultivation practices. Under such circumstances, Krishi Vigyan Kendra, Baksa has introduced a high yielding variety of field pea Aman through demonstration programmes during the year 2019-2020 and 2020-21at different locations in the district. The productivity and economic returns under improved technologies were calculated and compared with the prevailing farmers' practice. Results revealed that Aman variety under improved practices recorded higher yield of 37.80 and 33.92 per cent during 2019-20 and 2020-21 and the recommended practice gave higher net returns of Rs 26500 and 28300 per ha with B:C ratio of 1.81:1and 1.82:1, respectively as compared to farmers' practice.

Key Words: Lower Brahmaputra valley zone, Rabi pulse, Baksa, HYV, Aman

INTRODUCTION

Field Pea (*Pisum sativum* L.) is a very reach food for human as well as livestock because it contains approximately 23 to 35 percent protein. Moreover, some important minerals such as calcium, phosphorus and iron are present in abundant quantities which are lacking in cereals (Haque *et al,* 2015). Peas contain high levels of carbohydrates, are low in fiber and contain 86 to 87 percent total digestible nutrients, which makes them an excellent livestock feed. Legumes are critical in organic systems, as they fix and efficiently use their own N, and supply it back to the soil from biomass after harvest at a rate of 40 million tons per year (Udvardi and Poole, 2013). Field pea can be grownin a wide range of soil types with sandy loam to heavy clays but it could not tolerate in water logged soil conditions and required good drainage facilities with optimum soil pH is 5.5-6.5.

Baksa is one of the districts situated at the lower Brahmaputra valley zone of Assam. The district shares its boarder to hill steps of Bhutan and thereby, it receives ampoule of rainfall throughout the year. Thus, the entire district is highly suitable for cultivation of horticultural as well as field crops also. The field pea has been widely cultivated in the district covering the rice fellow areas and the crop covers an area of 850 ha with an average productivity of 855 kg/ha in Baksa district. The average annual rainfall of the district is 2097 mm with a temperature range of 10-35 °C.

Pulses are important and excellent crops for natural resource management, environment security, crop diversification and consequently for viable agriculture (Kumer *et al,* 2013). The scientific cultivation practices of pea crop like proper time of sowing, proper irrigation facilities, weeding, appropriate plant protection, manuring and fertilization *etc.* has become an integral part in increasing the productivity. The crop is cultivated

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Table 1: Package of practices followed during the demonstration in both the plots.

Particular	Technology Demonstration plot	Farmers' practice
Variety	Aman	Local variety (Farmer's own source)
Time of Sowing	Mid October-Mid November	Mid November- Mid December
Seed rate	70 Kg/ha	90 kg/ha
Method of sowing	Broadcasting	Broadcasting
Seed treatment	*Rhizobium* culture @ 50g/kg seed, Bavistin @ 2g/kg seed.	Not practiced
Fertilizer dose	20-46-0/ha (N-P_2O_5-K_2O)	Indiscriminate application
Irrigations	Need based irrigation provided	Rainfed
Plant protection	Integrated pest management	Indiscriminate use of pesticide

widely in the district without following the scientific cultivation practices and improved varieties. Therefore, Krishi Vigyan Kendra, Baksa conducted demonstrations on field Pea using the HYV Aman with an aim to increasing the production as well as productivity during the year 2019-2020 and 2020-21at different locations in the district.

MATERIALS AND METHODS

Krishi Vigyan Kendra, Baksa conducted demonstrations to spread the technology of scientific cultivation practices of field pea var. Aman to the farmers of Baksa district. The demonstrations were conducted in farmer's field as cluster mode during the period 2019-20 and 2020-21 covering an area of 8 ha and 10 ha involving 15 and 35 numbers of farmers, respectively. The villages selected for the demonstration were Bunbari, Khatpara, Barimakha, Nizdafeli, Dwarkuchi, Bhulukamuri and Santipur. The demonstrations were started in the month of mid October to mid November after harvesting of rice. Under the technology demonstration plot, the land selected was with deeply worked soils and ploughed 2-3 times to obtain a good tilth. The package of practices followed in the demonstration plots and the plot under farmers' practice are depicted in the Table 1. The parameters like plant height, pod length, number of pods per plant, number of seeds per pod, grain yield, gross return, net return and B:C ratio were duly recorded. The technology gap, extension gap and technology index were calculated by using the following formula as given below (Samui *et al,* 2000).

RESULTS AND DISCUSSION

After 125 days of sowing the crop was almost ready for harvesting. The data (Table 1) revealed that the plant height in both the year was found higher in the improved practice (116.5 cm) than the farmers' practice (95.5 cm). This may be due to the favorable climatic and soil status prevailing in this district. The result was in conformity with Dixit *et al* (2014). The result showed that the variety Aman produced the maximum number of pods/plant (14.20 pods) as compared to local check (11.55 pods). Singh *et al* (2018) also found the same result. Togay *et al* (2008) showed that the number of pods per plant had the highest moderate indirect positive effects on seed yield. The branches per plant were also higher in case of Aman variety (13.3) as compared to farmer's practice (11.8). The increasing number of branches in case of technology may be due to the adequate utilization of nutrients. The variation has been found in case of pod length. Aman has found higher length (8.0 cm) as compared to local check (6.47 cm). The demonstrated variety was ready for harvest after 125 days of sowing but the local variety was taken more than 135 days to mature the grain. These results were in conformity with findings of Singha *et al* (2020) that the average grain yield of field pea (var. Aman) under technology was 12.07q/ha as

Table 2. Yield and yield contributing factors under improved and farmers' practice in Pea.

Sr. No.	Parameter	Improved practice	Farmer's practice
A.	**Plant height (cm)**		
	2019-20	152	135
	2020-21	158	140
	Mean	155	137
B.	**Number of pods/plant**		
	2019-20	13.2	11.4
	2020-21	15.1	11.7
	Mean	14.2	11.5
C.	**Pod length (cm)**		
	2019-20	7.9	6.4
	2020-21	8.0	6.5
	Mean	8.0	6.4
D.	**Pod weight (g)**		
	2019-20	3.6	3.0
	2020-21	3.8	3.1
	Mean	3.7	3.0
E.	**Number of seeds/pod**		
	2019-20	7.3	6.0
	2020-21	7.5	6.2
	Mean	7.4	6.1
F.	**Grain yield (q/ha)**		
	2019-20	11.9	8.6
	2020-21	12.2	8.9
	Mean	12.0	8.8

compared to 8.81 q/ha under farmers' practice. The Aman variety was comparatively resistance against powdery mildew as compared to local check. This was in agreement with results reported by Dixit *et al* (2014).

Yield parameters

It was evident that the scientific cultivation practices had higher number of pods per plant (14.2) in comparison to the farmers' practice (11.5). From the earlier discussions it can be understood that maximum growth was found in the scientific cultivation practices than the farmers practice during the crop establishment period and this might be the reason of higher number of pods in the former one (Muehlbauer and McPhee, 1997). Pertaining to the pod length, it has been observed that there was not much difference between the two cultivation methods. However, the pod length was slightly found higher in case of improved practice (8.0) than the practice followed by the farmers (6.4). A similar observation was also reported by Wasseem *et al* (2008), who stated that the application of balance nutrients promotes vigorous growth of the plant which ultimately increases the size of pod as well as seed. Khichi *et al* (2017) reported that, this

Table 3: Economics of field pea variety Aman under scientific cultivation practices and Farmer's practices.

Treatment	Gross cost (Rs.)		Gross return (Rs.)		Net return (Rs.)		B:C ratio		B : C ratio
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	Mean
Improved practice	32400	34100	58900	62400	26500	28300	1.81	1.82	1.82
Farmers' practice	28500	29500	41200	43500	12700	14000	1.44	1.47	1.46

might be due to the reason that the cultivars possess certain inherent potential and their interaction with soil and climatic conditions. Similarly, seed per pod was also found to follow the same trend in both the cultivation practices with higher in demonstration or improved practice (7.4) and lesser in check plot (6.1). It might be due to the varietal characteristics used in both the practices. Cousin (1997) stated that number of seeds per pod depends partially on the cultivar and on the environmental conditions but has also been documented to be affected by plant density. After harvesting of the crop, there is a huge difference observed in case of grain yield per hectare in both the cultivation practices. The higher yield was found in case of the demonstration plot (12.0 q/ha) as compared to the farmers' practice (8.0 q/ha). The results were in conformity with the results reported by Singha *et al* (2020). It might be because of better uptake and assimilation of available nutrients by the plants during the entire growth period therefore, meeting the demand of the crop for development and yield of field pea crop (Kumar *et al,* 2009 ;Valenciano *et al* 2010). Further, this might have resulted due to the greater number of branches per plant with higher numbers of pods per plant and inherent characters of the varieties which is prevailed favorable conditions of the locality. Additionally, enhanced yielding ability might also be due to its genetic potential and better adaptability to the soil and climatic conditions (Khichi *et al,* 2016).

The higher gross return was achieved under the scientific cultivation practices than the farmers' plot (Table 3). In addition to this, net return was also following the same with an average B: C ratio of 1.82 and 1.46 respectively under improved and farmer's practice.

Gap analysis

The perusal of the data (Table 4) revealed that the technology gap was lesser in both the years (10.08 q/ha and 9.78 q/ha) which reflects the devotion and hard work of the farmers of the locality in carrying out this demonstration. Probably, this gap might have occurred due to the varying soil fertility along with soil nutrient status and weather conditions. Extension gap was found to be similar in both the years (3.27 q/ha and 3.26 q/ha). An extension gap of 3.27 q/ha and 3.26 q/ha has been created which depicts that more extension methodologies need to be adopted for obtaining encouraging results of the technologies by the farmers. Technology gap exhibits the feasibility of the technology in the farmers' field conditions. It has been found that the demonstration plot has a technology index of 45.81 per cent in 2019-20 and 44.45 per cent in 2020-21 which thus explains the easy acceptability of the technology because lower the value of technology index, more the feasibility of the technology (Jeengar *et al,* 2006). Likewise, this emphasized the need of KVKs to educate the farmers more particularly those non-beneficiaries through various extension means for the adoption of scientific practices in cultivation of all the pulse crops (Singha *et al,* 2020).

Table 4. Technology gap, extension gap and technology index.

Year	Area (ha)	No. of farmers	% Increase over FP	Tech. Gap (q/ha)	Ext. gap (q/ha)	Tech. Index (%)	Pod yield (q/ha)	
							Demon.	Farmers' practice
2019-20	08	30	37.80	10.08	3.27	45.81	11.92	8.65
2020-21	10	35	33.92	9.78	3.26	44.45	12.22	8.96

CONCLUSION

The productivity gain under demonstration programme over existing practices of field pea cultivation created greater awareness and motivated the other farmers to adopt suitable production technology of field pea in the district. This variety of field pea (*Aman*) gained a momentum in upscaling the field pea productivity, which created a positive impact on farming community.

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Level of Potassium Affects Concentration and Uptake of Nutrients in Bt. cotton.

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ABSTRACT

The present study was carried out at the farm of Krishi Vigyan Kendra, Sirsa in a sandy loam soil, low in organic carbon and nitrogen, medium in phosphorus with medium to high potash levels. *Bt.* cotton (var. Bioseed-6588) seed was sown in two soils with varying potassium (K) levels. The treatments comprised of T_1 - $N_{175}P_{60}$, T_2 - $N_{175}P_{60}$ + Water Spray, T_3 - $N_{175}P_{60}$+ 1% foliar spray of KNO_3, T_4 - $N_{175}P_{60}$+ K_{30}, T_5 - $N_{175}P_{60}$+ K_{30}+1% foliar spray of KNO_3, T_6 - $N_{175}P_{60}$+K_{60} and T_7 - $N_{175}P_{60}$+K_{60}+ 1% foliar spray of KNO_3. The two foliar sprays were done at the time of early and peak boll development stages. Application of K increased the N content in the plant parts. P content in different plant parts decreased in all the treatments over treatment where only recommended dose of N and P applied. The relative K concentration in plant parts followed the order: leaves > bur > seed > stems. The mean N uptake in various plant parts in medium K fertility soil was lower as compared to the same in high K fertility soils. The mean P uptake was slightly higher in high K fertility soils as compared to the medium K fertility soils. The uptake showed a decreasing rate as the level of K increased.

Key Words: K levels, KNo3 foliar spray, NPK concentration, NPK uptake.

INTRODUCTION

Cotton is the most important cash crop in India which has a major share in the raw material for the textile industries. Thus, cotton plays a dominant role in the industrial and agricultural economy of the country. Introduction of transgenic cotton in Indian agriculture has resulted in an immense increase in seed cotton yield. This economically viable technology (Mehta *et al*, 2009) of *Bt.* cotton has helped significantly in increasing the net income of farmers. The maximum yield potential of *Bt.* cotton hybrid can only be achieved with suitable agronomic practices like plant geometry and optimum fertilization over the years (Devraj *et al*, 2011).

Cotton is a heavy feeder and removes a large quantity of nutrients from the soil thus crop nutrition forms a crucial components of cotton production (Kaur *et al*, 2007). To cater the uptake needs of these crops, soil reserves alone are not sufficient, hence needs to supply them through chemical fertilizers. However, the fertilizers applied are either insufficient or imbalanced and not based on soil supply capacity after suitably taking into consideration the fertilizer contribution and crop requirements that is leading to un-sustainability of the production systems. Nitrogenous and phosphoric fertilizers are more emphatically used by the farmers leading to an imbalanced nutrient supply ratio.

MATERIALS AND METHODS

The present study was carried out at the farm of Krishi Vigyan Kendra, Sirsa. The experimental soil was sandy loam in texture, slightly alkaline in reactions, low in organic carbon and nitrogen, medium in phosphorus with medium to high potash levels. The *Bt.* cotton (var. Bioseed-6588) seed was sown in two soils with varying K fertility with three replications and seven treatments and the design was RBD. In the experiment *Bt.* cotton (var. Bioseed-6588) was sown. The treatments were

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Table 1. N concentration (%) and uptake (kg/ha) in various plant parts.

Treatment	N seed			N Stem			N Leaves			N burr		
	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean
T_1 ($N_{175}P_{60}$)	2.20 (34.37)	2.30 (48.53)	2.25 (41.45)	0.60 (12.45)	0.63 (14.36)	0.62 (13.41)	1.70 (5.39)	1.90 (6.21)	1.80 (5.80)	0.67 (2.87)	0.69 (3.31)	0.68 (3.09)
T_2 ($N_{175}P_{60}$ + Water Spray)	2.22 (35.88)	2.35 (50.82)	2.29 (43.35)	0.61 (13.33)	0.63 (15.82)	0.62 (14.57)	1.87 (6.81)	2.00 (7.42)	1.94 (7.11)	0.69 (3.63)	0.71 (4.21)	0.70 (3.92)
T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	2.30 (44.28)	2.41 (54.21)	2.36 (49.24)	0.62 (14.23)	0.66 (17.46)	0.64 (15.84)	1.90 (7.01)	2.05 (7.87)	1.98 (7.44)	0.73 (4.45)	0.73 (5.07)	0.73 (4.76)
T_4 ($N_{175}P_{60}$ + K_{30})	2.39 (50.54)	2.48 (54.98)	2.44 (52.76)	0.62 (15.50)	0.66 (17.87)	0.64 (16.68)	1.89 (7.33)	2.04 (7.77)	1.97 (7.55)	0.73 (5.20)	0.74 (5.60)	0.74 (5.17)
T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3)	2.45 (54.72)	2.49 (57.70)	2.47 (56.21)	0.63 (16.58)	0.68 (19.23)	0.66 (17.91)	1.95 (8.03)	2.15 (8.98)	2.05 (8.51)	0.76 (5.58)	0.78 (6.31)	0.77 (5.76)
T_6 ($N_{175}P_{60}$ + K_{60})	2.52 (58.71)	2.42 (56.88)	2.47 (57.79)	0.64 (17.05)	0.67 (19.09)	0.66 (18.07)	1.96 (8.36)	2.05 (9.85)	2.01 (9.10)	0.75 (6.26)	0.76 (6.26)	0.76 (5.92)
T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3)	2.59 (63.86)	2.44 (57.75)	2.52 (60.80)	0.65 (18.05)	0.69 (19.76)	0.67 (18.90)	1.99 (9.61)	2.14 (11.13)	2.07 (10.37)	0.77 (4.68)	0.77 (6.52)	0.77 (6.39)
Mean	2.38 (48.91)	2.41 (54.41)		0.62 (15.31)	0.66 (17.65)		1.89 (7.08)	2.05 (8.46)		0.73 (0.22)	0.74 (5.33)	
C.D.(p= 0.05) Soil fertility	N.S. (2.34)			0.01 (0.50)			0.03 (0.29)			0.01 (0.41)		
Treatments	0.19 (4.38)			0.03 (0.93)			0.05 (0.54)			0.02 (N.S.)		
Interaction	N.S. (6.20)			N.S. (N.S.)			N.S. (0.76)			N.S. ()		

(Parenthesis represents uptake)

comprised of T_1 - $N_{175}P_{60}$, T_2 - $N_{175}P_{60}$ + Water Spray, T_3 - $N_{175}P_{60}$+ 1% foliar spray of KNO_3, T_4 - $N_{175}P_{60}$+ K_{30}, T_5 - $N_{175}P_{60}$+ K_{30}+1% foliar spray of KNO_3, T_6 - $N_{175}P_{60}$+K_{60} and T_7 - $N_{175}P_{60}$+K_{60}+ 1% foliar spray of KNO_3. The two foliar sprays were done at the time of early and peak boll development stages. Yield attributes like plant population, number of bolls per plant, boll weight, seed cotton yield per plant and per hectare was determined. The data were analyzed statistically by applying the analysis of variance Technique as suggested by Cochran and Cox (1950).

Pre and post harvest surface (0-15cm) soil samples were collected from each treatment and analysed for available N by alkaline permanganate method (Subbiah and Asija, 1956), P was extracted by the method of Olsen *et al* (1954). With 0.5 N NaHCO3 (pH 8.5), and K was determined by using flame photometer as described by USDA Hand Book No. 60 (Richards, 1954). International Pipette method (Piper, 1950) was used for mechanical analysis. Soil EC and pH was determined in 1:2: soil: water suspension by using EC meter and pH meter, respectively.

Particular	Medium K Fertility	High K Fertility
Sand (%)	57.4	57.2
Silt (%)	29.3	29.4
Clay (%)	13.3	13.4
pH (1:2)	8.2	8.2
EC	0.17	0.2
Organic Carbon	0.25	0.30
Available N(kg/ha)	224	227
Available P205(kg/ha)	12	12
Available K20(kg/ha)	260	390

In plant samples, Leaf, stem, khokri (Bur) , and seed samples were digested separately in a diacid mixture using sulphuric and perchloric acid in 4:1 ratio and N, P and K were analysed in the digested plant material by the following methods. The critical differences were obtained at 5% level of significance as described by Panse and Sukhatme (1961)

RESULTS AND DISCUSSION

Nutrient concentration and uptake (kg/ha)

Nitrogen

The mean N content in the leaves, stems, bur and seed in the high K fertility soil was significantly increased over that in medium K fertility soil. Within the K levels, there was no significant

Table 2. P concentration (%) and uptake (kg/ha) in various plant parts.

Treatment	P Seed			P Stem			P leaves			P Burr		
	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean
$T_1 (N_{175}P_{60})$	0.81 (12.64)	0.81 (17.07)	0.81 (14.86)	0.080 (1.66)	0.080 (1.82)	0.080 (1.74)	0.19 (0.59)	0.18 (0.60)	0.19 (0.60)	0.10 (0.45)	0.08 (0.40)	0.09 (0.42)
$T_2 (N_{175}P_{60}$ + Water Spray)	0.80 (12.90)	0.79 (17.04)	0.79 (14.97)	0.080 (1.76)	0.080 (2.00)	0.080 (1.88)	0.20 (0.73)	0.19 (0.69)	0.19 (0.71)	0.12 (0.65)	0.09 (0.51)	0.11 (0.58)
$T_3 (N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	0.79 (15.15)	0.78 (17.59)	0.79 (16.37)	0.079 (1.80)	0.079 (2.10)	0.079 (1.95)	0.20 (074)	0.18 (0.70)	0.19 (0.72)	0.10 (0.59)	0.10 (0.72)	0.10 (0.65)
$T_4 (N_{175}P_{60} + K_{30})$	0.78 (16.47)	0.78 (17.22)	0.78 (16.84)	0.078 (1.96)	0.078 (2.10)	0.078 (2.03)	0.19 (0.74)	0.17 (0.65)	0.18 (0.69)	0.09 (0.57)	0.10 (0.73)	0.09 (0.65)
$T_5 (N_{175}P_{60} + K_{30}$ + Foliar spray of 1% KNO_3)	0.78 (17.33)	0.77 (17.86)	0.77 (17.60)	0.078 (2.05)	0.078 (2.19)	0.078 (2.12)	0.18 (0.74)	0.18 (0.74)	0.18 (0.74)	0.09 (0.64)	0.09 (0.70)	0.09 (0.67)
$T_6 (N_{175}P_{60} + K_{60})$	0.77 (17.95)	0.76 (17.86)	0.77 (17.91)	0.079 (2.10)	0.077 (2.18)	0.078 (2.14)	0.20 (0.75)	0.18 (0.85)	0.19 (0.70)	0.08 (0.60)	0.07 (0.57)	0.08 (0.59)
$T_7(N_{175}P_{60}+K_{60}$+Foliar-spray of 1% KNO_3)	0.79 (19.44)	0.77 (18.15)	0.78 (18.79)	0.078 (2.17)	0.077 (2.20)	0.078 (2.19)	0.21 (1.01)	0.17 (0.88)	0.19 (0.95)	0.07 (0.54)	0.07 (0.62)	0.07 (0.58)
Mean	0.79 (15.98)	0.78 (17.54)		0.079 (1.93)	0.078 (2.09)		0.20 (0.73)	0.18 (0.73)		0.09 (0.58)	0.09 (0.61)	
C.D.(p= 0.05) Soil fertility	N.S. (0.34)			N.S. (0.05)			0.01 (N.S.)			N.S. (N.S.)		
Treatments	0.02 (0.64)			N.S. (0.10)			N.S. (0.10)			N.S. (0.07)		
Interaction	N.S. (0.90)			N.S. (N.S.)			N.S. ()			N.S. (N.S.)		

(Parenthesis represents uptake)

difference in N concentration in the respective treatment. The nitrogen content of stems and seed significantly increased in the treatments T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3) to T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3) over treatment where only recommended dose of N and P applied. In all the treatments, the N status in plant parts was significantly higher over treatment where only recommended dose of N and P applied. The higher N content in plant parts due to increased K levels may be attributed to the synergetic effects of K-fertilizer on absorption of N by various plant parts. These results were in line with those obtained by Makhdum *et al* (2007) who reported increased N concentration of 33.3, 33.3, 30.1, 6.6 and 4.4 per cent in burs, lint, seed, stems and leaves, respectively with application of 250 kg K/ha compared to K unfertilized treatment. The N uptake in various plant parts was in the order: khokri< leaves< stems <seed. Figure 7 indicates that the mean N uptake in various plant parts in medium K fertility soil (4.68, 7.08, 15.31 and 48.91 in bur, leaves, stems and seed respectively) was lower as compared to the same in high K fertility soils viz: 5.33, 8.46, 17.65 and 54.41 kg/ha. The contribution of various plant parts towards the N uptake was 6.15, 9.31, 20.15 and 64.37 per cent of the total N uptake in the medium K fertility soil. In the high K fertility soil the contribution was to the tune of 6.20, 9.85, 20.55 and 63.37 percent of the total nitrogen uptake in Khokri, leaves, stems and seed respectively.

Phosphorus

The mean P content in the different plant parts in high K fertility soil was more than that in medium K fertility soils. However, as compared to treatment where only recommended dose of N and P applied, the K content numerically decreased with increase in K levels. These results were in line with those observed by Makdhum *et al* (2007) who found a negative correlation coefficient between K and P concentration maintain by various plant the reason being an antagonistic interaction between the two elements. Figure 8 indicates that the mean P uptake was slightly higher in high K fertility soil as compared to the medium K fertility soils. The P uptake in various plant parts was in the order: bur < leaves < stems < seed. The uptake showed a decreasing rate as the level of K increased. In the medium K fertility soil, P uptake by bur, leaves, stems and seed was 0.58, 0.73, 1.93 and 15.98 kg/ha, respectively, which was 3.01, 3.79, 10.04 and 83.14 percent of the total P uptake. In high K fertility soils, P uptake by khokri, leaves, stems and seed was 0.61, 0.73, 2.09 and 17.54 kg/ha, respectively, which contributed 2.90, 3.48, 9.96 and 83.64 percent of the total P uptake. The slight decrease in medium K soil over high K as attributed to more dry matter in these treatments otherwise the P content in plant parts was adversely affected by increased K application.

Potassium

The K content of leaves, stems, bur and seed in the higher K fertility soil was higher over medium K fertility soil in the respective treatments. The mean K content in various plant parts in high K fertility soil was significantly increased over medium K fertility soil. The relative K concentration in plant parts were followed the order: leaves > bur > seed > stems. The mean K concentration in various plant parts increased linearly with an increase in level of K fertilizer. These results are in line with those obtained by Makhdum *et al.*, (2007) who found that the application of 250 kg K/ha increased K concentration of 73.7, 43.8, 43.2, 39.1 and 24.2 percent in burs, seed, stems, lint and leaves, respectively as compared to K- unfertilized treatments. These results are in line with Aladakatti *et al* (2011) also recorded higher concentration of K in leaf, stem, but and seed with application of K as compared to the treatments without application of potassium.

The mean K uptake was highest in T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3) treatment which measured 10.72, 15.03, 21.16 and 30.07 kg/ha in leaves, bur, stems and seed respectively. Soil and foliar applied potassium significantly increased the

Table 3. K concentration (%)and uptake in various plant parts (kg/ha).

Treatment	K seed			K Stem			K Leaves			K burr		
	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean
T_1 ($N_{175}P_{60}$)	1.15 (17.96)	1.17 (24.66)	1.16 (21.31)	0.62 (12.87)	0.65 (14.82)	0.64 (13.85)	1.67 (5.29)	2.01 (6.57)	1.84 (5.93)	1.45 (6.25)	1.51 (7.21)	1.48 (6.73)
T_2 ($N_{175}P_{60}$ + Water Spray)	1.16 (18.77)	1.19 (25.75)	1.18 (22.26)	0.63 (13.77)	0.67 (16.73)	0.65 (15.25)	1.70 (6.18)	2.06 (7.64)	1.88 (6.91)	1.48 (7.76)	1.52 (8.97)	1.50 (8.36)
T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	1.17 (22.53)	1.20 (26.98)	1.19 (24.75)	0.65 (14.91)	0.68 (17.99)	0.67 (16.45)	1.74 (6.41)	2.11 (8.10)	1.92 (7.26)	1.54 (9.43)	1.57 (10.86)	1.56 (10.15)
T_4 ($N_{175}P_{60}$ + K_{30})	1.19 (25.13)	1.22 (27.04)	1.21 (26.09)	0.68 (17.00)	0.71 (19.13)	0.69 (18.07)	1.86 (7.21)	2.15 (8.19)	2.01 (7.70)	1.59 (10.38)	1.64 (12.36)	1.62 (11.37)
T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3)	1.20 (26.75)	1.23 (28.52)	1.22 (27.64)	0.69 (18.16)	0.72 (20.26)	0.71 (19.21)	1.91 (7.87)	2.21 (9.23)	2.06 (8.55)	1.61 (11.01)	1.66 (13.36)	1.64 (12.19)
T_6 ($N_{175}P_{60}$ + K_{60})	1.22 (28.43)	1.25 (29.38)	1.24 (28.90)	0.72 (19.18)	0.75 (21.37)	0.74 (20.27)	1.96 (8.36)	2.24 (10.75)	2.10 (8.06)	1.74 (13.00)	1.80 (14.77)	1.77 (13.88)
T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3)	1.23 (30.31)	1.26 (29.82)	1.25 (30.07)	0.74 (20.55)	0.76 (21.76)	0.75 (21.16)	1.98 (9.58)	2.28 (11.86)	2.13 (10.72)	1.77 (14.46)	1.85 (15.61)	1.81 (15.03)
Mean	1.19 (24.27)	1.22 (27.45)		0.68 (16.63)	0.71 (18.87)		1.83 (6.84)	2.15 (8.91)		1.60 (10.33)	1.65 (11.88)	
C.D.(p= 0.05) Soil fertility	0.03 (0.67)			0.01 (0.51)			0.03 (0.28)			0.03 (0.48)		
Treatments	0.05 (1.26)			0.03 (0.95)			0.05 (0.53)			0.05 (0.89)		
Interaction	N.S. (1.78)			N.S. (N.S.)			N.S. (0.75)			N.S. (N.S.)		

(Parenthesis represents uptake)

K uptake. In the high K fertility soil, the K uptake by the leaves, bur, stems and seed was 8.91, 11.88, 18.87 and 27.45 kg/ha, respectively, which was about 13.27, 17.70, 28.11 and 27.45 percent of the total K uptake by the *Bt*. cotton crop. In the medium K fertility soil, the K uptake by the leaves, bur, stems and seed was measured 6.84, 10.33, 16.63 and 24.27 kg/ha, respectively, which contributed about 11.77, 17.78, 28.63 and 24.27 percent of the total K uptake by the *Bt*. cotton crop. Figure 9 indicates that the K uptake by different plant parts in the high K fertility soil was more than that in the medium K fertility soil. The nitrogen uptake in various plant parts was in the order: leaves < bur < stems < seed.

CONCLUSION

The mean N content in the leaves, stems, bur and seed in the high K fertility soil was significantly higher over that in medium K fertility soil. Application of K increased the N content in the plant parts. P content in different plant parts decreased in all the treatments over treatment where only recommended dose of N and P applied. The K content in leaves, stems, bur and seed in the higher K fertility soil was higher over medium K fertility soil in the respective treatments. The K application significantly affected the K content. The relative K concentration in plant parts followed the order: leaves > bur > seed > stems. The mean P uptake was slightly higher in high K fertility soils as compared to the medium K fertility soils. The mean K uptake was highest in T_7 ($N_{175}P_{60} + K_{60}$ + Foliar spray of 1% KNO_3) treatment.

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Management of Root Mealybug in Black Pepper (*Piper nigrum*)

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ABSTRACT

Effective management of root mealybug in black pepper was evaluated with Entomopathogenic Fungi (EPF) and chemicals separately in pot experiment. Among the EPF, *Lecanicillium lecanii* and among the chemicals, Imidacloprid 17.8 SL and Chlorpyriphos 20 EC were found to be the most effective. These treatments alone and in combinations of chemical and EPF, along with farmers' practice were tested in pot experiment, where the Imidacloprid was found superior in managing the root mealybug causing 65 per cent mortality. This effective treatment was evaluated at field level and found to be effective in reducing the mealybug population at two weeks after the first application itself.

Key Words: Entomopathogenic fungi (EPF), Chemicals, Root mealybug, Black pepper.

INTRODUCTION

The black pepper productivity of Kerala is adversely affected by biotic and abiotic stresses prevailing in the state. Among the biotic stresses, the infestation of sucking pests is more serious in recent years, in which the root mealy bugs are a serious threat affecting the growth and production of black pepper. The infestation of root mealybugs on black pepper were reported to be severe in some districts of Kerala, especially in higher altitude districts like Idukki and Wayanad. Five species of mealybugs *viz., Planococcus* sp., *P. citri, P. lilacinus* Cockerell*, Dysmicoccus brevipes* (Cockerell) and *Ferrisia virgata* (Devasahayam *et al,* 2010) and three other species viz., *Formicococcus polysperes* Williams, *Dysmicoccus. brevipes* (Cockerell) and *Pseudococcus* sp. (Najitha *et al,* 2018) were reported to infest the roots and basal region of stem under the soil resulting in yellowing, defoliation and mortality of vines.

Though the infestation of root mealybug species in black pepper is documented, the studies on their management at field level is lacking and therefore, an experiment was carried out to find the effective management measure to check the root mealybug population in black pepper.

MATERIALS AND METHODS

The available management options of mealybug, *viz.,* entomopathogenic fungi and chemical pesticides were evaluated separately in pot experiment to obtain the best results from each category so that the effective biocontrol agent, chemical and their combination can be assessed to obtain the best result for field evaluation. The root mealybug species *F.polysperes* was used for the artificial release in pot experiment, as it was found to be the dominant species in black pepper ecosystem (Najitha *et al*, 2018).

Entomopathogenic fungi

Efficacy of four entomopathogenic fungi *viz., Beauveria bassiana* (Balsamo) Vuillemin*, Lecanicillium lecanii* (Zimm.) Zare & W.Gams, *Metarhizium anisopliae* (Metschnikoff) Sorokin and *Paecilomyces lilacinus* (Thom) Samson, at three different doses of 2 x10^6, 2 x10^7 and2 x 10^8 spores/ml were evaluated against root mealybug, *F. polysperes*. The control treatment was maintained with teepol (0.1%).The required concentrations of fungi were made from the stock culture by serial dilution technique (Waksmen and Fred, 1922).

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Chemicals

Eight chemical insecticides were assessed against the root mealybug in a separate pot experiment. An untreated control was also maintained. The insecticides and their doses are given in Table 1.

Table 1. Insecticides used to test against root mealybugs.

Treatment	Insecticide	Dose (a.i/ha)
T_1	Bifenthrin 10 EC	60 g
T_2	Fipronil 5 EC	25 g
T_3	Imidacloprid 17.8 SL	25 g
T_4	Thiacloprid 21.7 SC	30 g
T_5	Thiamethoxam 25 WG	25 g
T_6	Emamectin benzoate 5 SG	6 g
T_7	Cartap hydrochloride 50 SP	500 g
T_8	Chlorpyriphos 20 EC	300 g
T_9	Control	

Pot experiment

One month old pepper seedlings of Panniyur-2 variety were used for the experiment. Pepper seedlings were planted in grow bags (20 x 15 cm) filled with potting mixture. These grow bags were kept under shade. The experiment was laid out in Completely Randomized Design (CRD) separately for entomopathogenic fungi and chemicals. Three replications were maintained for each treatment and six grow bags were maintained per replication.

Twenty five third instar mealybug nymphs were released at collar region of pepper seedlings using a camel hair brush. Treatments were applied as drenching and the volume required for drenching each grow bag was estimated prior to application. Spore suspension of entomopathogenic fungi and drenching solution with chemicals were prepared for the estimated volume. Treatments were applied after one week of insect release and were given two times at one week interval. Observations on mortality were taken at one week after each application by destructive sampling. Three plants were sampled for each observation.

Combination of entomopathogenic fungi and chemical in Pot experiment

The best treatments from the screening tests of entomopathogenic fungi (EPF) and chemical insecticides were evaluated alone and in combination of EPF and insecticides along with the common practice adopted by farmers against the root mealybug. An untreated control was also maintained. The experiment was laid out as pot experiment by planting pepper seedlings in grows bags as given in section (c). The treatment details are as follows.

T_1 – entomopathogenic fungi

T_2 – chemical insecticide (I)

T_3 – chemical insecticide (II)

T_4 – chemical insecticide (I) + entomopathogenic fungi

T_5 – chemical insecticide (II) + entomopathogenic fungi

T_6 – neem cake (20g/ bag) + Azadiractin 1%

T_7 – untreated control

Three replications were maintained for each treatment. Treatment applications were given twice at weekly interval from one week after insect release. Observations on mortality of root mealybugs were recorded after a week of each application.

Statistical analysis

Mortality per cent was calculated and analysed statistically by ANOVA. Treatment means were compared by Duncan's Multiple Range Test (DMRT).

Field evaluation of effective treatment

The effective treatment from the pot culture experiment was evaluated in the root mealybug infested field. Its efficacy was compared with that of chlorpyriphos as it was commonly used insecticide against mealybugs. Farmer's field at Kaniyambetta panchayat of Wayanad district was selected for

Table 2. Mortality of root mealybugs caused by entomopathogenic fungi in pot experiment.

Treatment	*Average per cent mortality	
	One week after first drenching	One week after second drenching
T_1: *Beauveria bassiana* at 2x10^6 spores/ml	11.11[e] (3.41)	16.11[cde] (4.07)
T_2: *B. bassiana* at 2x10^7 spores/ml	16.11[bcd] (4.05)	16.67[cd] (4.14)
T_3: *B. bassiana* at2x10^8 spores/ml	17.78[abc] (4.27)	19.44[bc] (4.46)
T_4: *Lecanicillium lecanii* at2x10^6 spores/ml	17.22[abc] (4.21)	17.78[cd] (4.27)
T_5: *L. lecanii* at 2x10^7 spores/ml	18.89[ab] (4.39)	22.78[b] (4.82)
T_6: *L. lecanii* at 2x10^8 spores/ml	21.11[a] (4.64)	28.33[a] (5.37)
T_7: *Metarhizium anisopliae* at 2x10^6 spores/ml	12.22[de] (3.56)	12.22[ef] (3.55)
T_8: *M. anisopliae* at 2x10^7 spores/ml	11.67[e] (3.47)	12.22[ef] (3.55)
T_9: *M. anisopliae* at 2x10^8 spores/ml	13.89[cde] (3.79)	13.89[def] (3.79)
T_{10}: *Paecilomyces lilacinus* at 2x10^6 spores/ml	10.56[e] (3.29)	11.67[f] (3.48)
T_{11}: *P. lilacinus* at 2x10^7 spores/ml	10.56[e] (3.29)	11.11[f] (3.39)
T_{12}: *P. lilacinus* at 2x10^8 spores/ml	16.67[abc] (4.14)	16.67[cd] (4.14)
T_{13}: Control	2.78[f] (1.79)	7.78[g] (2.81)
CD (0.05)	3.93	4.007

*Average of three replications

Figures represented by the same alphabets did not differ significantly

Figures in parentheses are square root transformed values

the field evaluation. The experiment was laid out in Exploded Block Design (EBD) in which two insecticide treatments were compared with the control. The whole pepper garden was divided into three blocks and each block was allotted for each treatment. Twenty one plants were selected in each treatment. Vines infested with root mealybugs were tagged and the number of root mealybugs on root

Table 3. Mortality of root mealybugs caused by chemical insecticides in pot experiment.

Treatment	*Average per cent mortality	
	One week after first drenching	One week after second drenching
T1: Bifenthrin 10 EC at 60 g a.i/ha	48.33[ab] (6.98)	55.56[ab] (7.46)
T2: Fipronil 5 EC at 25 g a.i/ha	42.22[bc] (6.53)	46.67[b] (6.86)
T3: Imidacloprid 17.8 SL at 25g a.i/ha	59.44[a] (7.74)	63.89[a] (8.02)
T4: Thiacloprid 21.7 SC at 30 g a.i/ha	51.11[ab] (7.18)	58.33[ab] (7.66)
T5: Thiamethoxam 25 WG at 25 g a.i/ha	50.56[ab] (7.14)	52.78[ab] (7.28)
T6: Emamectin benzoate 5 SG at 6 g a.i/ha	33.89[c] (5.86)	45.00[b] (6.73)
T7: Cartap hydrochloride 50 SP at 500 g a.i/ha	36.67[c] (6.08)	52.22[ab] (7.25)
T8: Chlorpyriphos 20 EC at 300 g a.i/ha	55.56[a] (7.46)	62.78 [a] (7.94)
T9: Control	6.11[d] (2.44)	7.78[c] (2.75)
CD (0.05)	9.20	13.03

*Average of three replications

Figures represented by the same alphabets did not differ significantly

Figures in parentheses are square root transformed values

up to 15 cm length was recorded. The treatments were applied as drenching at the rate of five liters for each vine. All the vines in each block were drenched with respective treatments. The vines in control block were drenched with five liters of water. The drenching was given two times at weekly interval. Observations on mealybug population were taken after a week of each application and pre-treatment count was taken before each treatment application. The efficiency of treatments was expressed in terms of per cent reduction in mealybug population.

Statistical analysis

The treatment means were subjected to independent 't' test and was compared with corresponding 't' value.

RESULTS AND DISCUSSION

Evaluation of entomopathogenic fungi in pot experiment against root mealybug

Application of all the fungal bioagents caused significant mortality of root mealybugs when compared to the mortality in control (2.78 % after 1st

Table 4. Mortality of root mealybugs caused by enotmopathogenic fungus, chemicals and their combinations in pot experiment.

Treatment	*Per cent mortality	
	One week after first drenching	One week after second drenching
T1: .*L. lecanii* 2x10^{8}spores/ml	23.88^c (4.92)	36.67^d (6.09)
T2: Imidacloprid 17.8 SL at 25 g a.i/ha	56.67^a (7.56)	65.00^a (8.09)
T3: Chlorpyriphos 20 EC at 300 g a.i/ha	53.89^a (7.36)	60.00^{ab} (7.77)
T4: Imidacloprid 17.8 SL at 25 g a.i/ha + *L. lecanii* at 2x10^8 spores/ml	53.89^a (7.36)	58.89^{ab} (7.69)
T5: Chlorpyriphos 20 EC at 300 g a.i/ha + *L. lecanii* at 2x10^8 spores/ml	46.11^{ab} (6.82)	51.11^{bc} (7.17)
T6: Neem cake + Azadiractin 1% (Farmer's practice)	37.78^{ab} (6.18)	46.67^c (6.87)
T7: Control	6.11^d (2.43)	7.22^e (2.65)
CD (0.05)	9.36	9.03

*Average of three replications

Figures represented by the same alphabets did not differ significantly

Figures in parentheses are square root transformed values

drenching and 7.78 % after 2nd drenching). Among the three entomopathogenic fungi, drenching with *L. lecanii* at 2x10^8 spores/ml caused highest mortality of 21.11 per cent after one week of first drenching and 28.33 per cent after second drenching. The results obtained are presented in Table 2.

Smitha and Mathew (2010) also found *Cephalosporium lecanii* (*L. lecanii*) as the best bio control agent among the three fungi screened, *viz.*, *B. bassiana*, *Hirsutella sp*. and *C. lecanii*. They recorded 1.95 mealybug colonies per sample in *C. lecanii* treated banana plants at five months after planting. The low per cent mortality obtained during the present study may be due to the unfavourable environmental conditions prevailed for the development of *L. lecanii* during the experiment period. Walstad *et al* (1970) cited by Tehri *et al* (2015) reported that the entomopathogenic fungi require relative humidity above 92.5 per cent and temperature between 15 to 35^o C for spore germination, mycelial growth and sporulation. The weather data reveal that maximum and minimum temperature observed during the present study period were 31.5and 23.7^o C, respectively with relative humidity of 83.2 per cent in morning and 65.6 per cent in evening which were not very conducive for the growth and development of EPF.

Evaluation of chemical insecticides in pot experiment against root mealybug

All the insecticides caused significantly higher per cent mortality than that of control. Imidacloprid

Table 5. Efficacy of imidacloprid and chlorpyriphos against root mealybugs on black pepper in field condition.

Treatment	Per cent reduction in root mealybug population			
	First drenching		Second drenching	
	7 DAT	14 DAT	7 DAT	14 DAT
T_1: Imidacloprid 17.8 SL at 25 g a.i/ha	97.98	100.00	-	-
T_2: Chlorpyriphos 20 EC at 300 g a.i/ha	79.89	86.06	94.54	100
$T_{3:}$ Control	-34.07	-34.07	-15.74	-15.74
T_1 vs T_2	2.97 *	2.96*	NS	NS
T_1 vsT_3	7.88*	8.02*	8.21*	8.21*
T_2 vsT_3	6.43*	6.92*	7.21*	7.21*

NS = Non significant

*Statistically significant at 5% level

Negative sign (-) in control: Per cent increase in population

17.8 SL at 25 g a.i/ha and chlorpyriphos 20 EC at 300 g a.i/ha caused highest mortality of 59.44 and 55.56 per cent, respectively at one week after first drenching and were statistically at par (Table 3). At one week after second drenching also, imidacloprid 17.8 SL at 25 g a.i/ha caused highest mortality of 63.89 per cent, followed by chlorpyriphos 20 EC at 300 g a.i/ha (62.78). The mortality recorded in the control was 7.78 per cent.

De Souza *et al* (2007) reported that imidacloprid 700 WG caused 100 per cent mortality of coffee root mealybug, *Dysmicoccus taxensis* in a single application. The efficacy of chlorpyriphos against root mealybug was reported by Smitha and Mathew (2010) also. According to them, drenching of chlorpyriphos (0.05%) at monthly intervals @ 2.5 ml/l effectively reduced the root mealybug population in banana.

Management of root mealybug with entomopathogenic fungi, chemicals and their combinations in pot experiment

Perusal of the data (Table 4) reveal that, the highest mortality of 56.67 per cent was recorded in imidacloprid 17.8 SL at 25 g a.i/ha and was statistically at par with the treatments, chlorpyriphos 20 EC at 300 g a.i/ha and imidacloprid 17.8 SL at 25 g a.i/ha + *L. lecanii* at 2x 10^8spores/ml, both of which caused 53.89 per cent mortality each. A similar trend was shown by the treatments at one week after second drenching also. Highest per cent of mortality was caused by imidacloprid 17.8 SL at 25 g a.i/ha (65.00) followed by chlorpyriphos 20 EC at at 300 g a.i/ha (60.00) and imidacloprid 17.8 SL at 25 g a.i/ha + *L. lecanii* at 2x 10^8spores/ml (58.89) which were statistically at par with each other.

Field evaluation of EPF and chemicals against root mealybug in black pepper

The effective treatments from the pot experiment, namely, imidacloprid 17.8 SL and chlorpyriphos 20 EC were evaluated in the root mealybug infested field at Kaniyambetta panchayat of Wayanad district. The results obtained on the field evaluation of effective treatments against root mealybugs are presented in Table 5, along with the 't' values.

Imidacloprid 17.8 SL at 25 g a.i/ha caused 97.98 per cent reduction in the root mealybug population at one week after first drenching, while chlorpyriphos 20 EC at 300 g a.i/ha caused 79.89 per cent reduction in the root mealybug population. At two weeks after first drenching, imidacloprid 17.8 SL caused 100 per cent reduction and thereafter, no mealybug population was recorded. After two weeks of second drenching, the treatment with chlorpyriphos 20 EC at 300 g a.i/ha also could achieve complete freedom from root mealybug infestation.

CONCLUSION

The present study was conducted to obtain the most suitable management measure for the root mealy bugs in black pepper. It could be concluded that the new generation chemical Imidacloprid 17.8 SL is most effective for the management of root mealybug as compared to chlorpyriphos, which is commonly used for the sucking pests. Also, as biocontrol measure, the entomopathogenic fungi, *L. lecanii* can be adopted, but with more frequent application and under congenial environmental conditions.

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Management of Yellowing and Spike shedding in Black Pepper at Kodagu District of Karnataka

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ABSTRACT

Yellowing and spike shedding is one of the major limiting factors in production and productivity of Black Pepper in Kodagu District. A Technology assessment was carried out to evaluate the various technological options for management of yellowing and spike shedding in Devarapura village of Virajpet Taluk, Kodagu district in Karnataka. Four different technologies were assessed for a period of 3 yr from 2018-19 to 2020-21, in a randomized block design replicated five times, comprising of four treatments. The results revealed that, spraying of Black Pepper special (5g/l) during May and September + Spraying of Carbendazim (2g/l) of water during May + Drenching of Arka Microbial Consortium (20 g/l) at the rate of 5 litre per plant during June and September + Soil application of Farm Yard Manure enriched with *Pachonia chlamydosporia* (1kg mixed with 100 kg FYM) during May and September was found to be better with less pooled spike drop (3.09%), reduced pooled yellowing (5.54%) and also resulted in early initiation of spikes as compared to other treatments. Hence, the above mentioned technological package has proved highly effective for getting pooled higher dry yield (8.56 q/ha) from Black Pepper.

Key Words: Black pepper, yellowing, spike shedding, Arka Microbial Consortium.

INTRODUCTION

Black Pepper (*Piper nigrum L.*) the king of spices is one of the important spice commodities of commerce and trade in India since pre-historic period. It originated in the tropical evergreen forests of the Western Ghats of India. Pepper is used in food and drinks for imparting agreeable flavor and aroma and also used as a preservative (Veerendra *et al*, 2018). It is also used in the production of essential oil for the pharmaceutical and perfumery industries (Parthasarathy and Zachariah, 2008). Pepper is rich in aroma and pungency, which are attributed to the presence of an alkaloid called piperine (Damanhouri and Ahmad, 2014). India is the largest producer of black pepper, growing in about 1.34 lakh hectares with annual production of 48,000 MT and productivity of 761 kg/ha.

Black pepper is cultivated to a large extent in the states of Karnataka and Kerala. Karnataka and Kerala account for 92 per cent of production of black pepper in the country (Anonymous, 2019). Low productivity in pepper is attributed to use of local varieties, lack of appropriate agronomic practices, unavailability of superior planting materials and losses due to incidences of biotic and abiotic stress (Hussain *et al*, 2017). The major problems in Black Pepper cultivation is nutrient imbalance between the soil and plant, which often predispose the pepper plants to diseases including spike shedding and yellowing of leaves (Srinivasan *et al*, 2012). In India, spike shedding of pepper is not limited to either flower drop or berry drop but also take account of berries being failed to develop into normal size. Spike shedding occurs at various stages of flower and fruit development, leading to yield loss of 40 % or even more (Kandiannan *et al,* 1994). Factors leading to shedding of berries include lack of pollination, prolonged drought, heavy rains and sudden change in weather across seasons. Nutrition imbalance between the soil and

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plant predisposes the pepper plants to diseases such as fusarium wilt and slow wilt (Srinivasan *et al,* 2012). Varying degrees of foliar yellowing, defoliation and damages on feeder roots caused by nematodes tend to be misinterpreted as symptoms of nutrient deficiency. Fungi species such as *Fusarium* and *Phytophthora* have been reported to cause yield losses varying from 30 – 64 percent in India (Ravindra *et al,* 2014). Apart from nutrition imbalances, pathological attacks of fungi and nematodes either singly or in their combinations have been associated with yellowing and spike shedding (Thomas *et al*, 2017). Keeping this in view, ICAR-Krishi Vigyan Kendra, Gonikoppal, Kodagu conducted a technology assessment on management of yellowing and spike shedding in black Pepper in Kodagu District of Karnataka.

MATERIALS AND METHODS

On farm Technology assessment for management of yellowing and spike shedding in Black Pepper was carried out at Devarapura village of Virajpet Taluk, Kodagu with 5 farmers and 4 technological options. The four different technologies assessed were T1: spraying of 1% Bordeaux mixture during June and September; T2: Spraying of Carbendazim (2g/l) during May + Drenching of Carbosulfan (2ml/l) + drenching of Copper oxychloride (3 g/l) during June and September; T3: Spraying of Black Pepper special (5 g/l) during May and September + Spraying of Carbendazim (2g/l) during May + Drenching of Arka Microbial Consortium (20 g/l) and applied at the rate of 5 l/ plant, during June and September + Soil application of Farm Yard Manure enriched with *Pachonia chlamydosporia* (1kg mixed with 100 kg FYM) during May and September; T4: Soil application of AYAR (containing calcium, magnesium, sulphur, zinc and boron) 100g/ plant during June and September month + drenching of Arka Microbial Consortium 20g/l (applied at the rate of 5 l per plant) during June and September + Spraying of Carbendazim (2 g/ l) during May. The assessment was laid in randomized block design with 5 replications and 4 treatments. The assessment was carried out for three years (2018-19 to 2020-21). For each treatment, 10 Black pepper vines were taken in five farmers' field. The observations on per cent yellowing, per cent spike shedding and yield (q/ ha) were recorded. The per cent yellowing and spike shedding was calculated at three levels of plant canopy of 0.5 m^2 area, randomly selected, preferably each at lower , middle and upper level of the canopy. The per cent yellowing and spike shedding was computed using the formula given below:

$$\text{Per cent Yellowing} = \frac{\text{No. of leaves showing yellowing symptoms in } 0.5\ \text{m}^2 \text{ area}}{\text{Total no. of leaves present in a } 0.5\ \text{m}^2 \text{ area}} \times 100$$

$$\text{Per cent Spike shedding} = \frac{\text{No. of spikes dropped in } 0.5\ \text{m}^2 \text{ area}}{\text{Total no. of spikes present in } 0.5\ \text{m}^2 \text{ area}} \times 100$$

RESULTS AND DISCUSSION

Different technologies assessed had a considerable influence on yellowing per cent of black pepper (Table 1). During all the 3 yr, yellowing per cent was significantly lower under T3, which was followed by T4, T2 and T1 in order. However, T1 resulted in higher yellowing per cent as compared to all other treatments. The pooled data showed the following trend for yellowing per cent T3<T4<T2<T1 (5.44<8.66<25.78<29.89 %), respectively. Spike shedding per cent in black pepper showed a decreasing trend (T1>T2>T4>T3) in the following order, respectively during all the years (Table 1). However, pooled data of spike shedding per cent followed the same trend as mentioned above. The lowest pooled spike

Table 1. Management of yellowing and spike shedding in black pepper.

Treatment	Yellowing (%)				Spike shedding (%)				Dry pepper yield (q ha^{-1})			
	Year				Year				Year			
	2018-19	2019-20	2020-21	Pooled	2018-19	2019-20	2020-21	Pooled	2018-19	2019-20	2020-21	Pooled
T1	31.64	29.96	28.08	29.89	20.76	19.76	18.5	19.67	3.92	3.94	4.16	4.01
T2	28.91	24.36	24.07	25.78	16.96	16.58	14.39	15.97	4.76	5.82	5.99	5.52
T3	6.98	5.30	4.35	5.54	3.58	3.10	2.60	3.09	7.38	8.95	9.35	8.56
T4	9.78	8.42	7.78	8.66	4.8	3.88	3.06	3.91	6.88	8.19	8.02	7.70
SEm±	0.23	0.23	0.14	0.10	0.16	0.11	0.17	0.08	0.14	0.16	0.17	0.08
CD (*P*=0.05)	0.72	0.72	0.44	0.29	0.50	0.34	0.52	0.24	0.44	0.48	0.51	0.24

shedding per cent was 3.09 per cent which was obtained by Spraying of Black Pepper special 5 g/l during May and September + Spraying of Carbendazim 2g/l during May + Drenching of Arka Microbial Consortium (20 g/l) and applied at the rate of 5 l per plant during June and September + Soil application of Farm Yard Manure enriched with *Pachonia chlamydosporia* (1kg mixed with 100 kg FYM) during May and September, which was significantly lower as compared to all other treatments. Significantly highest dry pepper yield of 7.38, 8.95 and 9.35 q/ha was recorded by Spraying of Black Pepper special 5 (g/l) during May and September + Spraying of Carbendazim (2g/l) during May + Drenching of Arka Microbial Consortium (20 g/l) and applied at the rate of 5 litre/ plant during June and September + Soil application of Farm Yard Manure enriched with *Pachonia chlamydosporia* (1kg mixed with 100 kg FYM) during May and September, respectively during 2018-19, 2019-20 and 2020-21. The significantly highest and lowest pooled dry pepper yield of 9.35 and 4.16 q/ ha was recorded under T3 and T1, respectively. Soil application of Arka Microbial Consortium will help in fixation of atmospheric nitrogen, solubaliztion of native phosphorous and reduction of *phytophthora* disease incidence (Veerendra *et al*, 2018). *Pochonia chlamydosporia* is a fungal egg parasite which induce plant defense mechanisms by formation of fungal-plant interaction and reduce nematode population in the rhizosphere of Black pepper vines, thereby reducing yellowing per cent (Rosa *et al,* 2013). This may result in early initiation of spike, reduced yellowing and spike shedding and ultimately result in higher yield of Black pepper

CONCLUSION

It was found that Spraying of Black Pepper special (5 g/l) during May and September month + Spraying of Carbendazim 2 (g/l) o during May month + Drenching of Arka Microbial Consortium (20 g/l) at the rate of 5 litre/ plant during June and September month + Soil application of Farm Yard Manure enriched with *Pachonia chlamydosporia* (1kg mixed with 100 kg FYM) during May and September performed better in terms of reduction in yellowing per cent, Spike shedding and also resulted in higher yield. While adopting this technology mortality of the vines was also considerably less. The health of the vines were found to better with less spike drop, reduced yellowing per cent and also resulted in early initiation of spikes. Hence, T3 technological option has proven highly effective for harnessing higher yield of pepper vines in Kodagu district of Karnataka.

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Management of Yellow Vein Mosaic Disease of Okra Using Suitable Resistant Varieties

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ABSTRACT

Okra (*Abelmoschus esculentus* L.) crop is badly affected by yellow vein mosaic disease (YVMD) which is the most important biotic stress leading to poor production. The disease was found devastating the crop raised by farmers of Kollam district. Hence, a farmer participatory on farm evaluation was conducted for identifying the best suitable resistant hybrid variety of okra for Kollam district in Kerala during 2017-18. The hybrids evaluated were Manjima (KAU), Arka Anamika (IIHR) and CO4 (TNAU) against local variety(check) in fields of 10 farmers during the first crop season. Manjima was significantly superior in recording higher seed germination percentage (98), yield (16.44 t/ha) and benefit cost ratio (2.55). Yellow vein mosaic was absent in all plots where Manjima was cultivated , other two hybrids were on par and recorded 1.43% incidence of disease and the local variety recorded 28.4% disease incidence. Hence, Manjima was recommended as suitable yellow vein mosaic resistant, high yielding hybrid for wide spread adoption in Kollam district.

Key words: Okra, yellow vein mosaic, Manjima, on farm trial

INTRODUCTION

Okra (*Abelmoschus esculentum* L (Moench.) is an important vegetable crop mainly grown for its immature fruits throughout the world. Various biotic and abiotic stresses affect the growth, performance and yield of the crops in field. Major production constraint in case of this crop is a viral disease caused by yellow vein mosaic virus . This virus is not seed borne but transmitted by the whitefly *Bemisia tabaci.* Disease becomes severe during summer season and if the crop is in its early stages, entire crop would be lost. About 94 per cent loss is expected if the crop is affected after 25 days (Peethambaran *et al*, 2008).This viral disease was first reported from Bombay in India. Symptoms are vein clearing followed by yellowing, reduction in size of leaves and fruits, thereby causing significant reduction in yield (Dhaliwal and Sharma, 2016).

The disease became widespread during 2016-17 in Kollam district with the farmers cultivating varieties purchased from various seed shops in expectation of huge returns without knowing the suitability of them in the area. During the monthly technology advisory meetings with the extension functionaries held at the Kendra, though remedial measures were advised, it was not sufficient to save the crop in areas where the disease had already progressed. In this scenario, Krishi Vigyan Kendra Kollam conducted an on farm trial to evaluate the suitability of yellow vein mosaic resistant varieties in Kollam district.

MATERIALS AND METHODS

The study was undertaken in the farmers' fields of Kollam district as on farm testing programme by KrishiVigyan Kendra Kollam during the year 2017-18.

Selection of farmer partners: With the help of Department of Agriculture Kollam, Kendra has arranged a meeting with the farmers whose crops were badly affected by the YVMD during the previous season on May 2017. They were made

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Table 1. Performance of okra hybrids

Observation	T1	T2	T3	T4	CD(0.05)	CV	SEM
Per cent seed germination	98 (82.506) a	80 (63.529)b	75 (60.084)c	58 (49.623)d	3.021	5.149	1.0836
Per cent YVMD incidence	0 (0.331)a	1.43 (6.123)b	1.43 (5.775)b	28.4 (32.044)c	2.244	22.093	0.5980
Yield (t/ha)	16.206 a	14.909b	13.508c	8.690d	0.327	2.677	0.0127
BCR	2.550 a	2.370 ab	2.128 b	1.430 c	0.324	16.662	0.0125

Values in parentheses are after arc sine transformation

aware on the importance of crop health management viz. disease management practices including alternate host control by regular weed management, vector control measures and the general package of practices of KAU for okra. From this group,10 farmer partners were selected for the on-farm evaluation of mosaic resistant varieties. In addition to the training, they were given details on laying out of experiment, practices to be followed and how to take observations as a printed instruction sheet.

Design of experiment: Experimental design followed was randomized block design with 4 treatments and 10 replications. One farmer was assigned as a replication. Individual plot size was 1 cent (40m^2).

Treatments: Three high yielding mosaic resistant hybrids were evaluated in field condition against the local variety. Treatments were Manjima (released from Kerala Agrl. University), Arka Anamika (from Indian Institute of Horticultural Research), CO4 (from Tamil Nadu Agricultural University) and the local variety as check.

Other practices followed: Farmers were advised to follow a spacing of 60 x45cm. Lime application at 20g per pit was done; application of 250g crushed leaves and tender twigs of *Chromolaena odorata* and 1kg of *Trichoderma* enriched organic manure were applied as a preventive measure against plant parasitic nematodes, pathogens and as a general protectant to plant that enhance plant health 1-1.5 wk before sowing. Before sowing, seeds were soaked in 2% *Pseudomonas fluoresens* solution for 1-2 hr and a pinch of Arbescular Mycorrhizal Fungi(AMF), approximately 2-3 g was applied on the pit , seed was sown over that and covered using soil. Along with chemical fertilizers as per recommendations of KAU, top dressing with supernatant of groundnut cake @1kg/10l was applied at fortnightly intervals till flowering. Need based sprays of 1% neem oil soap was recommended against insect and mite pests and 2% *Pseudomonas fluoresens* spray was done at fortnightly intervals. These measures were followed in all the plots to ensure that the produce is safe to eat. Critical inputs for all necessary practices were provided along with seed by the Kendra. Regular field visits were conducted to the plots by the scientists of Kendra.

Observations: Germination of seeds, incidence of mosaic disease, yield, BC ratio, average fruit weight, taste and marketability.

Analysis: The data collected were analysed using 'web agri stat package 2.0'

RESULTS AND DISCUSSION

Okra hybrids performed well as indicated (Table.1). Three hybrids were good yielders but Manjima was significantly superior over others in recording yield followed by Arka Anamika and CO4. The highest BCR was also recorded by the hybrid Manjima and was significantly superior to others. Yellow vein mosaic disease was totally absent in all plots where Manjima was cultivated, mosaic disease appeared in both the other hybrids but it was only 1.43 per cent compared to the local check which recorded 28.4 per cent disease incidence. As per Shetty *et al* (2013), resistance to YVM virus is not stable and frequent break down of resistance have been observed in developed varieties. Chaitanya *et al* (2018) also reported 2.6-5.1 per cent occurrence of this disease in the variety Arka Anamika under two different packages of practices. Other pests and diseases were comparatively low in all the plots than the previous season. This might be due to the plant protection and crop health measures strictly adopted from the beginning of the crop. Species of *Trichoderma* were found to be managing diseases, abiotic stresses and enhancing crop health (Singh *et al,* 2020). Okon in 2014 also reported that inoculation with the AMF (*Glomus mosseae*) increased plant growth, fruit yield and nutrient uptake in okra. Apart from controlling various diseases causing pathogens, *Pseudomonas fluorescens* significantly improves growth and biomass production of crop plants (KAU, 2016).

Manjima recorded 98 per cent seed germination which was significantly superior over other and Arka Anamika (80%) , CO4 (75%) and local variety (58%). Though all the hybrids were good yielder, average per plant yield and fruit weight of Manjima was 438g and 37.68g, had higher fruit weight and number with good taste and marketability. Arka Anamika individual fruit weighed 30.22g on an average, though it had good taste and marketability, number of fruits per plant were found to be less, per plant yield was 403g. Fruits of CO4 were the tastiest and the individual fruits weighed 27.06g on an average but the fruits matured very fast affecting marketability, per plant yield was 365g. Since the crop was cultivated in a safe to eat manner, the farmers got very good price and marketing had thus became easier. Present findings were in confirmation to that of Rajput *et al* (2016) who also emphasized the importance of cultivating high yielding variety of okra with recommended package of practices for increased yield and income. According to Nicaise (2014), viral diseases of crop plants pose serious threat to global food security and the use of crop genetic resistance is a powerful tool to be applied in agriculture.

CONCLUSION

For the management of any biotic or abiotic stress, inclusion of a suitable resistant or tolerant variety would be beneficial to the farmers as well as the ecosystem, since it helps to avoid frequent application of agrochemicals and improve the yield and income of farmers. The okra hybrid Manjima was selected for popularizing through front line demonstration and also through the schemes of Department of Agriculture in Kollam district.

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Nutri Garden: A Road Map for Enhancing the Health Status of Girl Children

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ABSTRACT

The nutrition is a burning issue in India which leads to malnourished problem in girl children and paramount anemic patients can be seen in the rural area. There are several reasons like lack of knowledge, economic problem and lack of education with regard to balanced diet. The study was undertaken by the KVK, Ujjain in collaboration with the ICDS and allied departments. A total of six villages were selected from 6 blocks of Ujjain District. Only severe malnourished girl children were identified from these villages and thus 16 families could be identified. Vegetable seed kits were provided to these families along with the scientific layout of nutri-garden. The physical parameter age, height and weight were also calculated for enhancing the health status of the girl child in rural area. The impact of the KVK activities was assessed in terms of before and after intervention followed by the per cent change in malnutrition by calculating BMI.

Keyword

INTRODUCTION

Health and nutrition are the most important contributory factor for human resource development in the country. Nutrients which obtained through food have vital effects on physical growth and development, maintenance of normal body function, physical activity and health (Krishnaswamy, 2011). Human needs a wide range of nutrients to perform various functions in the body and to lead a healthy life. The nutrient includes protein, fat, carbohydrates, vitamins and minerals but still the vegetable cultivation was not in habit of the farm families. Limbu (2019) observed that imparting nutritional education had a positive effect on knowledge level of the farm women. Utilizing methods like frontline demonstration, field day, method demonstration along with lectures for imparting trainings could have resulted in significant improvement of knowledge. Nath *et al* (2020) also revealed that Government should take necessary steps to reduce the problems faced by farmwomen to boost the production and productivity in vegetable farming. It was also evident that because of unawareness of nutrients and consumption of vegetables in daily diet of rural people specially girl children, face the malnutrition problem. Hence, a study was conducted by KVK, Ujjain for minimizing the malnutrition problem and to assess the physical parameters of girl child to overcome the nutrient deficiency problem and enhance the health status. A new concept of Nutri Garden was given in villages along with the detail technology of cultivation of vegetables at household level.

MATERIALS AND METHODS

A special targeted survey was conducted in collaboration with staff working under Integrated Child Development Scheme (ICDS) and allied departments. All six block were visited and identified one village from each block. The selected villages were Kalyanpura, Ratnakhedi Kalesar Kanchankhedi Pitlwadiya and Kalapiapl from block Ujjain, Tarana, Ghattiya, Khachrod, Badnagar and Mahidpur, respectively to collect the mal nutrition data.

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Table 1. Detail of selected group for the study as per the Malnutrition category.

Block	Village	Malnourished Girl Children	Percentage	Remark
Ujjain	Kalyanpura	04	25.00	Yellow Category
Tarana	Ratnakhedi	01	06.25	Red Category
Ghattiya	Kalesar	03	18.75	Red Category
Khachrod	Kanchankhedi	03	18.75	Red Category
Badnagar	Pitlwadiya	03	18.75	Red Category
Mahidpu	Kalapiapl	02	12.50	Red Category

Three categories were made for identification of the health status of children *viz.,* red, yellow and green colour. Red colour indicated sever problem of malnutrition, yellow colour for moderate health status and green colour pointed out the good health of the children. Targeted total 16 girl children were identified and selected as per sever and moderate category for the further study who were less than 5 yr.

Physical Parameter

Physical parameters were calculated in terms of age (yr), weight (kg), height (cm). Body Mass Index (BMI) was calculated by using height and weight of the respondent. Vegetable seed kits containing leafy vegetables, climbers, roots and tubers, beans and fruits type vegetables viz. brinjal, chilly and tomato etc were provided to the participants. A systematic layout of the nutri garden with a total area of 100 m^2 with a bed size of 1.5m X 5 m was laid out.

The impact in terms of minimizing the malnutrition problem was assessed before and after consumption of the vegetables in daily diet by calculating the BMI (Body Mass Index) by using following formula

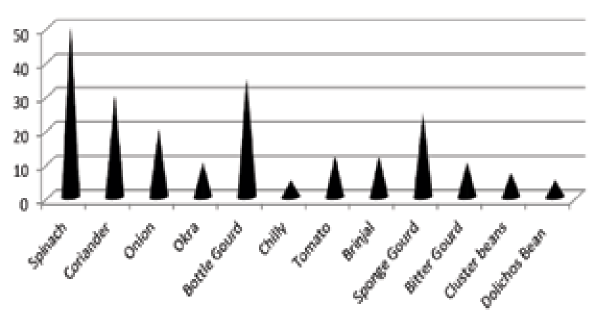
$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2 \text{(cm)}}$$

RESULTS AND DISCUSSION

Total six villages were selected namely Kalyanpura, Ratnakhedi, Kalesar, Kanchankhedi, Pitlawdiya and Kalapipal from each block of Ujjain District covering 16 sample size for the study. The selected girl children fell under two category of malnutrition (Table 1).

In the normal daily consumption practice of meal in rural families was pulses, Bengal gram flour, pickle and negligible amount of vegetable. It was evident that production of spinach, bottle gourd, coriander and sponge gourd was abundant while okra, chilly and bean were cultivated minimally.

Figure 1. Yield in Nutri Garden for minimizing the Malnutrition problem Yield (kg)/season (Approximate)



Emphasis was given on vitamins because at rural area the diseases and symptoms were very common related to deficiency of vitamins. The vegetables were good source of almost vitamins like carotene, thiamin riboflavin and niacin. The ascorbic acid (Vit. C) was completely absent in farmers routine daily diet whereas ascorbic acid is essential vitamin for protein digestion and helps in formation of hemoglobin. Spinach and Corinder were reach source of Carotene chilly, spinach and bitter gourd were the richest source of ascorbic acid (Longvah *et al, 2017*).

Table 2. Nutrient contents in vegetables /100g.

Vegetable	Nutrients / 100 g. β carotene				
	Vit A (µg)	Vit C (mg)	Vit. B1 (mg)	Vit. B2 (mg)	Vit. B3 (mg)
	Carotene	Ascorbic acid	Thiamine	Riboflavin	Niacin
Spinach	2605 ± 521	30.28 ± 4.71	0.16 ± 0.016	0.10 ± 0.009	0.33 ± 0.03
Coriander	3808 ± 891	23.87 ± 11.67	0.09 ± 0.005	0.05 ± 0.004	0.73 ± 0.03
Onion	1.10 ± 0.06	10.96 ± 2.00	0.07 ± 0.012	0.02 ± 0.004	0.21 ± 0.01
Okra	69.10 ± 10.41	22.51 ± 1.60	0.04 ± 0.005	0.07 ± 0.009	0.61 ± 0.01
Bottle Gourd.	44.05 ± 11.68	04.33 ± 1.55	0.03 ± 0.003	0.01± 0.001	0.14 ± 0.01
Chilly	125 ±122	94.07 ± 11.67	0.09 ± 0.033	0.1 ± 0.038	0.89 ± 0.15
Tomato	905 ±58.4	00.03 ± 0.004	0.03 ± 0.004	0.52 ± 0.01	27.47 ± 1.77
Brinjal	146 ± 24.0	02.09 ± 0.85	0.06 ± 0.016	0.11 ± 0.011	0.53 ±0.08
Sponge Gourd	130 ± 00	3.80 ± 00	0.03 ± 00	0.01 ± 00	0.04 ± 00
Bitter Gourd	126 ± 7.10	50.87 ± 3.03	0.06 ± 0.008	0.04 ± 0.005	0.29 ± 0.03
Cluster Bean	241 ± 32.8	17.96 ±5.83	0.05 ± 0.006	0.03 ± 0.005	0.71 ± 0.05
Walore	35.52 ± 6.0	5.99 ± 00	0.07 ±00	0.07 ± 00	0.32 ±00
FP (Farmers' Practice)					
Red Gram Pulse	127 ± 26.3	00	0.45 ±0.046	0.11 ± 0.006	2.09 ±0.14
Bengal Gram flour	165 ± 22.8	00	0.35± 0.029	0.15 ±0.003	1.87 ± 0.06

The results revealed that there was a slight positive growth in height and weight after consumption of vegetable in daily diet. BMI totally depends on height and weight , as these two parameters increase, BMI also increases. Before consumption of vegetables BMI was 12.23 ±1.86 whereas after one year it was 13.07 ± 0.89.

CONCLUSION

The study showed that daily consumption of vegetables in daily diet enhanced the health status and help in minimizing the malnutrition problem to maximum extend. Nutri Garden which contents all types of vegetables can play a vital role especially in rural area where consumption of vegetable is not in practice, hence for habituating them for incorporating vegetables in their daily diet, Nutri Garden is excellent weapon. It could be a cheapest source for rural people specially girl children for overcome the malnutrition problem.

Table 3. Physical Parameters of Selected respondents with respect to age, height and weight.

Parameter	Before			After		
	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum
Age (yr)	4.37 ± 0.44	3.8	5.0	05.37 ± 0.44	4.8	6.0
Height (cm)	98.21 ± 6.82	88	107	103.07 ± 6.68	91	112
Weight (kg)	11.44 ±1.55	9.5	14.2	13.88 ± 1.52	10.8	15.5
BMI	12.23 +1.86	10.85	17.16	13.07 + 0.89	11.55	14.80

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Nutrient Management in Bengal Aromatic Rice of Terai-Teesta Alluvial Zone in West Bengal

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ABSTRACT

A field experiment was conducted during *kharif* season of 2018-19 and 2019-20 at Jalpaiguri district of West Bengal to study the effect of combination of organic and inorganic sources of nutrients in aromatic rice variety Kalonunia production. The experiment consisted of three treatments comprising of farmers' practice *i.e.,* imbalanced use of fertilizers (30 kg N/ ha + 20 kg P_2O_5 /ha + 20 Kg K_2O /ha), T1; 80% RDN (RDF- 50:25:25 Kg/ ha) through inorganic source + 20% N through organic Sources (FYM and mustard cake), T2: 60% RDN (RDF- 50:25:25 Kg/ha) through inorganic source + 40% N through organic sources (FYM and mustard cake).The results indicated that, application of 60% RDN through inorganic source + 40% N through organic sources gave maximum grain yield (2.48 t/ha) and straw yield (6.62 t/ha). and recorded significantly higher growth parameters and yield attributes whereas lowest observation was with famers' practice.

Key Words: Economics, Nutrient, Farm Yard Manure, Mustard cake, Grain yield.

INTRODUCTION

The domestication and adaptation of different rice cultivars mainly by the Asian and African peasant farmers over thousands of year's results in selection of cultivars suited to needs, local cultural practices and agro-ecological conditions. Aromatic rice is categorized in two types: (i) Basmati and (ii) non-Basmati, with specific distinctions in terms of grains quality features and geographical areas of cultivation. Basmati, the long-grains ones, are traditionally cultivated at the foothills of Himalayans in north states while short and medium-grain non-Basmati scented rice are grown in small pockets of the native areas in different parts of the country (Nene, 1998). The state of West Bengal has precious wealth of genetic diversity in different indigenous aromatic rice. It is estimated that about 3.0 to 3.5lakh tonnes of such premium rice is produced every year in the state (Bhattacharya, 2003). These non-Basmati scented rice includes Gobindabhog, Tulaipanji, Kalonunia, Radhunipagal, Badshabhog, Kataribhog, etc.; which have different end-uses like cooked table rice, pulse-mixed rice (bhog), dessert (payesh), polao, biriyani etc.

Farmers in north Bengal areas specially Jalpaiguri district produce Kalonunia rice mostly for sale of their produce to the rice mills for earning money at a time, and sometimes a small portion for their family use. They cultivated the variety usually with low inputs and traditional practices intermixed with a few modern technologies in recent times during *kharif* season. The nutrition of indigenous tall *indica* rice, traditionally by organic manures may be refined or upgraded for better yield and quality. Therefore, a suitable combination of organic and inorganic source of nutrients is necessary for sustainable indigenous rice production that can ensure food production with high quality. Keeping in view, a study was undertaken to assess the appropriate use of organic manure in combination with chemical fertilizers for improvement of grain yield and quality of Kalonunia rice.

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Table 1. Effect of nutrient management on growth attributes of Kalonunia rice (Pooled over two years).

Treatment	Plant Height (cm)		Number of Tillers/m^2		Dry matter accumulation (g/m^2)	
	28 DAT	84 DAT	28 DAT	84 DAT	28 DAT	84 DAT
Farmers' practice	66.85	131.54	236.58	287.52	181.78	502.41
T1	67.45	128.82	239.70	292.87	184.40	524.17
T2	67.54	125.93	243.44	298.36	189.15	533.40
SEm(±)	0.030	0.205	0.252	0.397	0.873	1.157
CD at 5 %	0.10	0.64	0.79	1.24	1.85	4.61

MATERIALS AND METHODS

An On Farm trial (OFT) was conducted during *kharif* season of 2018-19 and 2019-20 for assessing the effect of integrated nutrient management in terms of yield and economy of Bengal aromatic rice Var. Kalonunia. Experiment was conducted at seven different locations of Jalpaiguri district on 0.42 ha of area comprising 0.06 ha each with treatments namely farmers' practice *i.e.,* imbalanced use of fertilizers (30 kg N/ ha + 20 kg P_2O_5 /ha + 20 Kg K_2O /ha), T1; 80% RDN (RDF- 50:25:25 Kg/ha) through inorganic source + 20% N through organic Sources (FYM and mustard cake), T2: 60% RDN (RDF- 50:25:25 Kg/ha) through inorganic source + 40% N through organic sources (FYM and mustard cake) in randomised block design with seven replications.

The experiment was conducted on a medium low land, which belonged to the class of sandy loam with low fertility and acidic in reaction. The average initial physico-chemical properties of the experimental soil were bulk density (1.57g/cm^3), pH (5.25), EC (0.23 dS/m), organic carbon (0.54 %), available N (232.74 kg/ha), available P (28.28 kg/ha), available K (239.54 kg/ha) and available S (6.31 kg/ha). Three weeks old seedlings @ 2-3/ hill were transplanted manually at the spacing of 20 cm × 15 cm in the main field. Recommended dose of fertilizers for Kalonunia was 50:25:25 kg of NPK/ ha. Nitrogen was supplied through urea, phosphorus through single super phosphate and potassium through muriate of potash. Farmers usually applied 20:20:20 kg/ ha of N: P_2O_5: K_2O at basal + 10 kg N/ ha at 4 wk after transplanting. Treatment T1, FYM was applied @ 2 t and 25:10 kg of P_2O_5:K_2O/ ha at basal, 25 Kg nitrogen was applied at 3 wk after transplanting and 15:15 kg/ ha of N: K_2O at 6 wk after transplanting. Treatment T2, FYM was applied @ 2t/ ha and 25:10 kg P_2O_5:K_2O/ ha at basal, 15 Kg N and 0.2 t mustard cake/ ha at 3 wk after transplanting and 15:15 Kg/ ha of N:K_2O at 6 wk after transplanting. The crop was harvested by sickles at ground level, when 80% of the panicles with 80% grains in each panicle were matured. After proper cleaning and drying, the grains and straws of each plot were weighed separately and the yields were calculated in terms of t/ ha. The data collected as described earlier were subjected to statistical analysis by the analysis of variance method suitable for randomised block design (Gomez and Gomez, 1984) using OPSTAT on-line software. The significance of different sources of variation was testes by Fisher's F test for appropriate degrees of freedom. Fisher and Yates table (1963) was consulted to test 'F' statistics as well as for computation of critical difference (C.D.) at 5% level of significance.

Table 2. Effect of nutrient management on yield attributes and yield of Kalonunia rice (Pooled over two years).

Treatment	Yield Components				Grain yield (t/ha)	Straw yield (t/ha)
	Panicle length (cm)	No. of Panicle/ m^2	No. of filled grain/ Panicle	1000 grain weight (g)		
Farmers' practice	24.0	259.0	95.0	13.3	2.07	6.40
T1	25.9	274.5	103.0	13.2	2.36	6.57
T2	27.1	281.0	107.5	13.3	2.48	6.62
SEm(±)	0.114	0.825	0.461	0.002	0.015	0.008
CD at 5 %	0.35	2.57	1.44	NS	0.11	0.03

RESULTS AND DISCUSSION

The growth parameters *i.e.,* plant height and number of ttillers/m^2 and dry matter accumulation (g/m^2) of Kalaonunia rice, varied significantly due to application of different sources of nutrients. The data (Table 1) indicated that highest plant height found (67.54 cm and 125.93 cm) at 28 and 84 DAT in T2 compared to other treatments. Among the different treatments, 60% RDN through Inorganic source + 40% through Organic Sources (FYM and mustard cake) recorded higher number of tillers/m^2 (243.44 and 298.36) and dry matter accumulation (189.15 and 533.40 g/ m^2) compared to other treatment. This might be due to higher availability of essential nutrients and application of organic source which helped in improving the physical condition of the soil for better root proliferation leading to higher absorption of water and nutrients and ultimately resulting in higher growth attributes. Similar results have also been reported by Rathiya *et al* (2017) and Mahapatra *et al* (2004).

There was a steady increasing trend in accumulation of aerial dry matter in Kalonunia rice with the advancement of crop growth. Combination of Inorganic and organic offers more balanced nutrition to the plants which positively affect number of tillers.

Maximum grain yield (2.48 t/ha) and straw yield (6.62 t/ha) were obtained with the application of 60% RDN through inorganic source and 40% N through organic Sources which was followed by application of 80% RDN through inorganic source and 20% N through organic Sources. Similar was the trend in case of yield attributes also except test weight. The minimum grain yield (2.07 t/ha) and straw yield (6.40 t/ha) were recorded in farmer's practices during both year of investigation. Combination of FYM, mustard cake and inorganic fertilizers enhanced the yield attributes and production than the farmer's practices. Generally, chemical fertilizer enhances the yield but in aromatic landraces more application of inorganic causes lodging and

Table 3. Effect of nutrient management on Economics of rice (Mean data of two years).

Technology option	Cost of cultivation (Rs./ha)	Gross return (Rs./ ha)	Net return (Rs./ ha)	BC ratio
Farmers' practice	35,580	72,390	36,810	2.03
T1	38,225	81,655	43,430	2.13
T2	36,235	85645	49,410	2.36

reduces the aroma. So, appropriate combination of inorganic and organic fertilizers may help achieving the higher yield and quality of indigenous aromatic rice. Adhikary and Majumdar (2002) also suggested combined application of chemical fertilizers and organic manures for attaining higher grain yields. Higher yields under combined use of RFD and FYM could be attributed to well decomposition of FYM, which favoured better nutrient availability coupled with higher assimilation of nutrients.

Among different treatments cost of cultivation was found highest in T1(Rs. 38,225/ha-) whereas lowest cost of cultivation was recorded in farmers' practices Rs. 35,580/-ha due to more cost regarding inorganic as well as organic fertilizer and management of resources.

CONCLUSION

The combination of inorganic and organic fertilizer showed positive response in terms of growth parameter as well as yield attributes that enhances the yield and quality of Kalonuina rice. Application of 60% RDN through inorganic source and 40% N through oganic sources (T2) showed significant responses than other treatments in terms of all characters. Among the three treatments, T2 resulted in highest B:C ratio and net returns. On the basis of present investigation, it can be concluded that the application of 60% RDN through inorganic source and 40% N through organic sources found most effective in increasing the growth, yield and quality of rice and also helped in maintaining soil health for sustainable aromatic rice production.

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Nutritional Food Security of Households Through Establishment of Kitchen Garden in Mayurbhanj District of Odisha

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ABSTRACT

Mayurbhanj is a tribal population dominated district of Odisha constituting 58.7per cent of the tribal people and was declared as the fully scheduled district of the state. In villages of Mayurbhanj district, the major problems are poor health status, malnutrition causing growth retardation, reduced work output, social and retarded mental development and high morbidity and mortality rate among the population. In order to improve food and nutritional security of family members, KVK, Mayurbhanj-1 demonstrated FLD on Kitchen gardening during 2018-19, 2019-20 and 2020-21. It was found that the production of vegetables of respondents increased by 586.2 per cent resulting increase in consumption of vegetable by 48.81 per cent and subsequently vegetable purchasing decreased by 32.1%. It was also seen that apart from economic saving on vegetable consumption, kitchen gardening also provided them a livelihood support enterprise for fighting against malnutrition and poverty by providing them an additional income and empowerment to women. Likewise, intake of energy, protein and iron increased significantly after introduction of kitchen garden ($p \leq 0.05$).

Key Words: Nutrition, Health status, Malnutrition, Kitchen gardening.

INTRODUCTION

Mayurbhanj is a tribal population dominated district of Odisha. The tribal population is more concentrated in five blocks such as Udala, Khunta, Bijatola, Jamda and Baripada blocks where the population differs from 70-80 percent of the total population of the respective blocks. Along with this hill Khariar, Birhor (Mankirdia) and Lodha are the three types of particularly vulnerable tribal groups seen in this district required special attention from social, financial and nutritional point of view. In villages of Mayurbhanj district, the major problems are poor health status, malnutrition causing growth retardation, reduced work output, social and retarded mental development and high morbidity and mortality rate among the population. Majority of the tribal families are small and marginal and rice is the main food group in their daily diet which serving as important source of energy to their body. Large populations of children and women in Mayurbhanj district suffering from micronutrient deficiency diseases *viz*., anaemia, night blindness, keratomalacia, spongy bleeding gums, cheilosis, sore throat, angular stomatitis and scurvy etc.

Vegetables play an important role in human diet and rural mass should get the awareness about the importance of vegetable in the daily diet (Jain, 2017). Kitchen garden provides fresh fruits and vegetables round the year at our hand along and fulfils the micronutrients requirements of the body. Establishment of Kitchen Garden in rural areas is easy due to availability of space and farm families are already engaged in agriculture practices (Arya *et al*, 2018). There are many social benefits that have emerged from kitchen gardening practices; better health and nutrition, increased income, employment, food security within the household,

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Table 1. Socio economic status of the respondents.

Variable	Category	Number	Percent (%)
Type of family	Joint Nuclear	8 22	26.7 73.3
Size of family	Small (1-4) Medium (5-7) Large (>7)	12 12 6	40 40 20
Annual Income (Rs.)	50000 50,000 – 1,00,000 >1,00,000	13 7 10	40.3 20.3 30.4
Education	Illiterate Primary Middle Graduation	9 6 12 3	30 20 40 10
Land holding	Small (< 2ha) Medium (2-5ha) Large (5ha)	12 14 4	40 46.7 13.3

and enhance in community social life (Awasthi *et al*, 2016). Hence, kitchen garden would be a nice and easy way to improve household food security, health and nutritional status of a family (Rani *et al*, 2015 and Thakor *et al*, 2020). Krishi Vigyan Kendra, Mayurbhanj-1 conducted FLDs during 2018-19, 2019-20 and 2020-21 in different villages in Mayurbhanj district to enhance the nutritional and household food security of the incumbents.

MATERIALS AND METHODS

The present study was conducted in 11 villages i.e., Kadalibadia, Badakhaladi, Machhia, Kansapal, Sirisabani, Dhanpur, Ambdubi, Karanjia, Gargaria, Bholagadia and Jualirama to improve the nutritional security of the family members through development of kitchen garden near to their houses. A total of 30 numbers of families were selected constituting 30 farm women. Different capacity building activities including training, exposure visit and farmer-scientists interaction on different aspects including modern ways of vegetable production, homestead vegetable production, planning and layout of nutritional gardening were planned and carried out. The farm women were guided and advised about proper planning and lay out of a kitchen garden in scientific and organic way, so that all the seasonal vegetables could be grown fresh and thus available to farm families at any time to their hand. Use of high yielding varieties of different vegetable crops such as Leafy vegetables, Radish, Carrot, Tomato, Brinjal, Cabbage, Cauliflower, Capsicum, Chilli, Okra, Cucumber, pumpkin etc in kitchen garden. The unit size of the garden was 200 m^2. The nutritional education was also given while planning the kitchen garden. The methodology for this study included both qualitative and quantitative components based on house hold surveys and focus group meeting. Base line survey was conducted to obtain basic information such as socio-economic status, dietary food habits and practices and nutritional deficiency diseases. In order to assess the impact of nutritional garden an end line survey was conducted in the study sites. End line survey was structured on the line of base line for comparison purpose. Total amounts of vegetables produced per family were recorded average were calculated and recorded. The collected data were analysed using Microsoft Excel data analysis. Statistical procedures included paired t test (Snedecor and Cockran, 1989).

Table 2. Changes occurred by intervention of kitchen garden.

Parameter	Production (Kg)	Purchase (Kg)	Distribution/Sale	Consumption (Kg)
Before intervention	55	321	00	379
After intervention	398	218	52	564
Change	340	-103	52	185
Percent Change	586.2	32.1	--	48.81
T value	-35.1596	12.894	-22.6934	-11.5054
P value	0.000*	0.000*	0.000*	0.000*

*significant at $P \leq 0.05$

RESULTS AND DISCUSSION

The present study revealed the socio-economic status of the selected village of the Mayurbhanj district (Table 1). It was observed that 73.3 per cent of the respondents come under nuclear family followed by 27.7 per cent under joint family. Equal percentage of family (40%) belongs to small and medium family whereas 20 per cent of the family comes under large category. In the study about 40.3 per cent of the family belonged to the income group of less than 50,000/- followed by 30.4 and 20.3 per cent under more than income of Rs. 100,000/- and income in-between 50,000 and 100, 000/- respectively. As far as education is concerned, the study revealed that 30 per cent of the respondents were illiterate while 40 per cent of the respondents studied upper primary and high school (middle) followed by 20 per cent under primary education and 10 per cent were graduate. Majority of them comes under medium (46.7%) and small (40%)

Table 3. Average vegetable production and income from nutritional garden.

Name of vegetable	Vegetable Production (kg)	Vegetable Production (kg)	Vegetable Production (kg)	Average Production	Average price / kg(Rs.)	Average Total Income (Rs.)
	2018-19	2019-20	2020-21			
Leafy vegetables (Spinach)	8.15	7.25	8.35	7.92	25.00	162.00
Radish	38.5	39.25	37.85	38.53	10.00	340.00
Carrot	21.25	19.45	19.85	20.18	15.00	280.00
Tomato	59.63	58.45	59.65	59.24	10.00	564.00
Brinjal	64.45	65.65	64.58	64.89	10.00	625.00
Cabbage	48.34	47.45	47.93	47.91	20.00	930.00
Cauliflower	35.6	34.7	37.5	35.93	15.00	510.00
Capsicum	9.35	10.45	12.43	10.74	25.00	248.00
Chilli	12.3	11.4	11.8	11.83	30.00	324.00
Okra	12.5	13.4	11.8	12.57	8.00	80.00
Cucumber	21.1	19.3	18.3	19.57	10.00	178.00
Pumpkin	18.3	19.3	19.6	19.06	7.00	113.00
TOTAL	345.47	339.05	343.64	342.72		4354.00

Table 4. Per capita availability of nutrients before and after intervention.

Nutrients	Per capita availability of nutrients/day		% Recommended Dietary Allowance		Difference (%)	T	p
	Before	After	Before	After			
Energy (Kcal)	124	278	6.52	14.63	+ 8.11	-45.7031	0.000*
Protein (g)	3.13	5.89	5.69	10.70	+ 5.01	-38.3728	0.000*
Beta carotene (mg)	2108	4014	43.9	83.6	+ 39.7	-51.2529	0.000*
Folic acid (mcg)	16.5	43.43	8.25	21.7	+13.45	-70.9089	0.000*
Calcium (mg)	118.9	308.5	19.8	51.4	+ 31.6	-48.9633	0.000*
Iron (mg)	2.12	7.32	10.09	34.8	+ 24.71	-53.448	0.000*
Vitamin C (mg)	42.34	48.52	105.85	121.3	+ 15.45	-14.225	0.000*

*significant at $P \leq 0.05$

land holding category. Only 13.3 per cent of the respondents have more than 5 ha of land i.e. large farmers.

The change in production and consumption of vegetables of respondents are depicted in Table 2. In traditional practices they cultivated 2-3 different vegetables such as brinjal, okra and tomato during whole the year. For fulfilling their daily requirement of vegetables, they mainly depended on the market. After intervention, they had grown 10-12 types of seasonal vegetables such as leafy vegetables, radish, carrot, tomato, brinjal, cabbage, tomato, cauliflower, chilli, capsicum, cucumber and pumpkin during both in *Kharif* and *Rabi* seasons. The study revealed that there was an increase in production, consumption, distribution / sale of surplus vegetables to near friends and relatives after intervention of nutritional garden by KVK. Comparison of data on before and after intervention showed a significant improvement in production, distribution and consumption of vegetables ($P \leq 0.05$). Purchase of vegetables also reduced significantly ($P \leq 0.05$). It was very clear from table 2 that the production of vegetables of respondents increased by 586.2 per cent which led to enhanced consumption of vegetable by 48.81 per cent and subsequently vegetable purchasing decreased by 32.1 per cent. The present finding showed similarity with findings of Nandal and Vaishisth (2009), Chayal *et al* (2013) and Verma *et al* (2019).

The average vegetable production during the year 2018-19, 2019-20 and 2020-21 is given in Table 3. The total average production of eleven villages was 342.72 kg during both the seasons. By considering the local available market price, the average income of Rs 4354/- was recorded as the economic benefit to the individual family which was in conformity with the findings found by Verma *et al* (2019). It was concluded that apart from economic saving on vegetable consumption by adopting kitchen garden, it also provided them a livelihood support enterprise for fighting against malnutrition and poverty by providing them an extra income and empowerment to women.

The data presented in table 4 revealed that after introduction of nutritional garden, the per capita availability of the nutrients per day increased which contributed towards the good health. Nutritional values of different vegetables were calculated as per the procedures of Gebhardt and Robin (2002). The data (Table 4) indicated that there was significant increase in consumption of beta carotene, folic acid, calcium and vitamin C ($p \leq 0.05$). These findings were supported by the findings of Yusuf *et al* (2008) and Chayal *et al* (2013). It was also found that intake of energy, protein and iron increased significantly after introduction of kitchen garden ($p \leq 0.05$). Similar resulted were obtained by Singh *et al* (2018) and Nandal and Vaishisth (2009).

CONCLUSION

Promotion of kitchen garden had played a major role in combating the malnutrition and related problems in unreachable and interior areas of Mayurbhanj a tribal dominated district of Odisha. The intervention on kitchen garden was very much adoptable and successful model for empowerment of women and not only women but also a farm family for fighting against malnutrition and poverty among tribal people of inaccessible areas. Over a short period of three years significant increase in the quantity and consumption of vegetables suggests a positive trend as well as acceptance of the technology in the selected villages. It may be concluded that establishment of kitchen garden had immense role in tackling the problem of malnutrition and micronutrient deficiencies in rural areas. Hence it is recommended that concept of kitchen garden should be reached to every women and farm families whether through government or non-government agencies.

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Perception of Women Dairy Farmers about Dairy Enterprise in Ramanagara District of Karnataka

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ABSTRACT

Dairying has become an important source of income for millions of rural families and assumed most important role in providing employment and income generating opportunities particularly for marginal and women farmers. Perception to dairy enterprise is operationally defined as psychological awareness of women dairy farmers on the advantages and disadvantages of being dairy entrepreneurs. The study was conducted in Ramanagara district of Karnataka. Magadi taluk and Ramanagara taluk were purposely selected based on the highest and the lowest number of women Dairy Cooperative Societies (WDCS) functioning, respectively. Women dairy co-operative societies were exclusively selected. Six women dairy co-operative societies were randomly selected from each taluk. Fifteen women members including office bearer's *i.e.,* president, vice president and secretary were selected from each WDCS, constituting a sample size of 180 for the study. It could be inferred that regarding communication characteristics a great majority (82.22%) had low organisational participation, belonged to medium (61.66%) level of extension participation and medium (52.22%) level of cosmopoliteness. Further, less than half (45.56%) of the members had a good overall perception about dairy enterprise. With respect to dimensions of perception, the majority of the women dairy farmers had a good (53.34%) economic perception, poor (40.56%) technological perception and good (53.33%) general perception.

Key Words: Dairy, Enterprise, Farmers, Perception, Performance, Women.

INTRODUCTION

Women have entered in different fields of business, contributing to the growth of the economy. The activities like *papad* making, *agarbatti* making, tailoring, pickle making, pottery, petty shops etc., are the major entrepreneurial activities being undertaken by women in rural areas to ensure economic security, besides engaging themselves in agriculture and allied activities including dairy enterprise. India ranks first among the world's milk producing Nations since 1998 and has the largest bovine population in the World. Milk production has been increasing steadily over the year from 55.6 Mt in 1991-92 to 176.3 Mt in 2017-18. The average annual growth rate of milk production is 4.5% as of 2018. The per capita availability of milk in India during 2017-18 was 375 g/day and by 2023-24, it is estimated to increase to 592 g/day. This represents sustained growth in the availability of milk and milk products for our growing population.

Dairying has become an important secondary source of income for millions of rural families and has assumed the most important role in providing employment and income generating opportunities particularly for marginal and women farmers. Most of the milk is produced by animals reared by small, marginal farmers and landless labourers. Karnataka Cooperative Milk Producers' Federation Limited (KMF) is the second largest dairy co-operative amongst the dairy cooperatives in the country. In South India it stands first in terms of procurement as well as sales. The dairy enterprise ensures not only provide economic support but also ensures nutritional security for the children and other family members. Majority of activities in dairying are taken up by women folk. In some cases, all-most

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Table 1. Communication characteristics of women dairy farmers. (n=180)

Sr. No.	Characteristic	Category	Magadi Taluk (n_1-90)		Ramanagara Taluk (n_2-90)		Total (n-180)	
			No.	%	No.	%	No.	%
1	Organizational Participation	Low (<1.14)	75	83.34	73	81.11	148	82.22
		Medium (1.14-1.69)	4	4.44	6	6.67	10	5.56
	Mean = 1.42± 0.55	High (>1.69)	11	12.22	11	12.22	22	12.22
2	Extension Participation	Low (<14.51)	18	20.00	14	15.56	32	17.78
		Medium (14.51 -15.49)	58	64.44	53	58.88	111	61.66
	Mean = 15±1.94	High (>15.49)	14	15.56	23	25.56	37	20.56
3	Cosmopoliteness	Low (<5.52)	15	16.66	14	15.56	29	16.11
		Medium (5.52-7.09)	50	55.56	44	48.88	94	52.22
	Mean = 6.3±1.57	High (>7.09)	25	27.78	32	35.56	57	31.67

all activities are carried out by women. Increasing demand for milk and milk products in recent years made the dairy farming as a profitable enterprise for women. Further, in the recent past women dairy co-operative societies (WDCS) are gaining importance and are being established in big numbers. Perception of women dairy farmers about the dairy enterprise is very much important in making the WDCS a successful unit. Thus, it was found worthwhile to conduct a study with the objective to measure the communication characteristics and perception of women dairy farmers about dairy enterprise.

MATERIALS AND METHODS

The study was conducted in Ramanagara district of Karnataka. Magadi taluk and Ramanagara taluk were purposively selected based on the highest and the lowest number of WDCSs functioning in the respective taluks. Six women dairy co-operative societies were randomly selected from each taluk. Fifteen women members including office bearers *i.e.,* president, vice president and secretary are selected from each WDCS, constituting a sample size of 180 for the study. The dependent variables like performance and four socio-economic variables namely occupation, land holding, annual income and milch animal possession were considered for the study looking into the objectives of the study. Perception scale developed by Preethi (2015) was slightly modified and used to measure perception of women dairy farmers about dairy enterprise. Independent variables selected for the study were quantified by using structured schedule with suitable scales. Data were gathered through personal interview method with the help of structured, pre-tested interview schedule. The collected data were quantified and analyzed using frequency, percentage, mean and standard deviation.

RESULTS AND DISCUSSION

Organizational participation

A majority of the women dairy farmers (>80 %) belonged to low organizational category in Magadi taluk and Ramanagara taluk whereas about 12 per cent of them belonged to high organizational category in both Magadi and Ramanagara taluka (Table 1). Same trend was observed in the pooled data. The possible reasons for this might be due to

Table 2. Overall perception of women dairy farmers. (n=180)

Sr. No.	Category	Magadi Taluk (n_1=90)		Ramanagara Taluk (n_2=90)		Total (n=180)	
		No.	%	No.	%	No.	%
1	Poor (<46.79)	16	17.78	34	37.78	50	27.78
2	Good (46.79-48.55)	42	**46.66**	40	**44.44**	82	**45.56**
3	Better (>48.55)	32	35.56	16	17.78	48	26.66

Dimension wise perception of women dairy farmers

the fact that, normally women hesitate to participate, due to their pre-engagements in house hold works along with their inhibitions and the presence of male counterparts in the meetings. The present findings were in accordance with the findings of Chaudhari (2006).

Extension participation

The data (Table 1) revealed that a majority (64.44%) of women dairy farmers belonged to medium level of extension participation, whereas only 20.0 per cent belonged to low level of extension participation followed by high (15.56%) level of participation in Magadi taluk. However, in Ramanagara taluk, majority (58.88%) of them belonged to medium level while, nearly one fourth (25.56%) of them belonged to high level followed by low level (15.56%) of extension participation. In pooled situation, majority (61.66%) of the women dairy farmers belonged to medium level of extension participation, whereas only 20.56 per cent of them belonged to high level followed by low level (17.78%) of extension participation. The above findings are in line with the findings of Hadagali (2013). The reason for medium extension participation observed in the study may be due to busy schedule of work and that the male members in the family would have not permitted them to attend, instead the male members only might have participated in the extension activities.

Cosmopoliteness

Results (Table 1) reveal that a majority (55.56%) of women dairy farmers had medium level of cosmopoliteness whereas nearly one fourth (27.78%) of them had high level followed by low (16.66%) level in Magadi taluk. In Ramanagara taluk 48.88 per cent women dairy farmers had medium level of cosmopoliteness, whereas 35.56 per cent of them had high level followed by low level (15.56%). In pooled situation, majority (52.22%) of the respondents belonged to medium cosmopoliteness, while, 31.67 per cent belonged to high followed by low (16.11%) level. The above findings were in line with the findings of Mamathalakshmi (2013), Preethi (2015) and Kowsalya (2017). The reason for the results obtained might be due to the work related to women dairy co-operative society and also weekly once sandy day in the nearest town. They need to purchase domestic and personnel daily needs at sandy day.

Overall perception of women dairy farmers

The data (Table 2) revealed that 46.66 , 35.56 and 17.78 per cent of women dairy farmers in Magadi taluk has good, better and poor overall perception about dairy enterprise, respectively. In Ramanagara taluk 44.44, 37.78 and 17.78 per cent of respondents has good, poor and better perception about dairy enterprise, respectively. In pooled situation, 45.56, 27.78 and 26.66 per cent of the women dairy farmers had good, poor and better perception about dairy enterprise respectively. The above findings were in line with the findings of Mahesh (2014) and Preethi (2015). The possible reason for the good overall perception of women dairy farmers about dairy enterprise might be due

Table 3. Dimension wise perception of women dairy farmers. (n=180)

Sr. No.	Dimension	Category	Magadi Taluk (n_1=90)		Ramanagara Taluk (n_2=90)		Total (n=180)	
			No.	%	No.	%	No.	%
1	Economic	Poor (<17.91)	7	7.78	8	8.89	15	8.33
	Mean = 18.35±0.87	Good (17.91-18.79)	40	44.44	56	62.22	96	53.34
		Better (>18.79)	43	47.78	26	28.89	69	38.33
2	Technological	Poor (<15.41)	25	27.78	48	53.33	73	40.56
	Mean = 15.87±0.92	Good (15.41-16.33)	36	40.00	28	31.11	64	35.56
		Better (>16.33)	29	32.22	14	15.56	43	23.89
3	General	Poor (<13.07)	3	3.33	7	7.78	10	5.56
	Mean = 13.44±0.76	Good (13.07-13.82)	48	53.34	48	53.33	96	53.33
		Better (>13.82)	39	43.33	35	38.89	74	41.11

to their education level, income expected from dairy, experience in dairy management and taking up dairy as a major occupation along with farming.

Economic dimension

It could be inferred (Table 3) that 47.78 and 44.44 per cent of women dairy farmers from Magadi taluk had better and good economic perception, respectively followed by poor (7.78%) perception, whereas, in Ramanagara taluk 62.22 and 28.89 per cent of respondents had good and better economic perception, respectively. In pooled data, 53.34 and 38.33 per cent of respondents had good and better economic perception, respectively. The above findings were in line with the findings of Preethi (2015). The reason for majority of the respondents to possess good to better economic perception about dairy enterprise might be attributed to their assured income from dairy activities that would have helped in the upliftment of their livelihood.

Technological dimension

The data (Table 3) revealed that about 40.00, 32.22 and 27.78 per cent of the women dairy farmers in Magadi taluk had good, better and poor technological perception respectively. Whereas in Ramanagara taluk 53.33, 31.11 and 15.56 per cent of the respondents have poor, good and better technological perception respectively. In pooled data 40.56, 35.56 and 23.89 per cent of the respondents have poor, good and better technological perception, respectively. The above findings werein contrast with the findings of Preethi (2015). The possible reasons for poor to good technological perception about dairy enterprise may be due to their medium education level and low level of scientific orientation. The women dairy farmers are mostly traditional in nature, so they feel difficulty in accepting the scientific and technical aspects easily.

General dimension

It could be inferred (Table 3) that 53.34 and 43.33 per cent of the women dairy farmers from Magadi taluk had good and better general perception respectively followed by poor (3.33%) perception. In Ramanagara taluk, 53.33 and 38.89 per cent of respondents had good and better general perception respectively, followed by poor (7.78%)

perception.In pooled data 53.33 and 41.11 per cent of respondents had good and better general perception respectively, followed by poor (5.56%) perception. The above findings were in line with the findings of Preethi (2015). The reason for majority of the respondents having good to better general perception about dairy enterprise may be due to their medium level of experience in dairy farming and better annual income. In general, they have a good perception about dairy enterprise.

CONCLUSION

Regarding communication characteristics, it can be concluded that a great majority of women members of WDCS had a low organizational participation, medium level of extension participation and a medium level of cosmopoliteness. Further, less than half of them had a good overall perception about dairy enterprise. With respect to dimensions of perception, the majority of women dairy farmers had a good economic perception, a poor technological perception and a good general perception to dairy enterprise.

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Peptone Supplementation of Potato Dextrose Agar Medium Proved Better for Mushroom Mycelial Development

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ABSTRACT

An experiment was conducted to assess the suitability of different media on mycelial development of five different mushrooms in College of Agriculture, Vellayani, Kerala. The medium used was potato dextrose agar (PDA), carrot dextrose agar (CDA), yeast malt agar (YMA), malt extract agar (MEA) and potato dextrose peptone agar (PDPA) and study was conducted using *Pleurotus florida, Hypsizygous ulmerius, Calocybe indica, Agaricus bitorquis, Volvariella volvaceae*. Amongst various media used PDPA was found best in enhancing the mycelial coverage of *P. florida* (9 cm on 6th day) followed by *H. ulmerius* (8.96 cm on 6th day) and *V. volvaceae* (8.93 cm on 6th day) in 9 cm petri plates. Peptone supplementation of the PDA media have a pronounced influence on accelerating the mycelia spread of these mushrooms. PDPA was found least effective in mycelial development of *C. indica* which showed its inhibitory effect. At par with PDPA, MEA was also found effective in development of mycelia of *V. volvaceae* (8.76 cm on 6th day). MEA turned out to be the best media for the growth of *A. bitorquis* (8.83 cm on 6th day). PDA media was most effective media for development of *C. indica* (8.63 cm on 6th day).

Key Words: Culture media, Mycelial growth, Mushrooms, Peptone supplemented media, Peptone.

INTRODUCTION

Mushroom bodies are much valued food items from time unmemorable and also gained importance as nutraceutical and pharmaceutical agent due to the ability of producing high protein content with essential amino acids, vitamins, minerals and exopolysaccharides and also numerous useful secondary metabolites, (Adebayo-Tayo *et al*, 2011; Zikriyani *et al*, 2018). Mushrooms are rich sources of nutrients, especially proteins, minerals and also vitamins B, C and D (Panjikkaran and Mathew, 2013; Bellettini *et al,* 2019). Mushrooms naturally grow on any semi-synthetic compost and absorb nutrients for their development and survival. The maintenance and revival of pure culture mycelium with magnificent quality is the first critical stage towards the success of spawn preparation (Sharma *et al*, 2019; Kumar *et al*, 2018). Like all other microbes, mushrooms also require a set of conditions under which they can grow and sporulate best in artificial conditions and culture medium is the crucial factor influencing fungal mycelial growth (Dhingra and Sinclair, 2014). Mycelial growth of mushrooms varies pronouncedly with each culture media. A small variation in the composition of the culture media will positively or negatively influence the mycelial development of mushrooms (Abon *et al*, 2020).

Curvetto *et al* (2002) and Mukhopadhyay *et al* (2002) reported that for the growth of any fungus including mushrooms, both quality and quantity aspects *viz.,* biological productivity and efficiency are much linked to the nutrient type and growth conditions. The mycelium branches

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Table 1. Effect of different media on mycelial development of *P.florida*

Media	Growth on 3rd day	Growth on 5th day	Growth on 6th day	Nature of Mycelia
PDA	4.233	7.900	8.733	++++
CDA	3.666	7.000	7.733	++++
YMA	3.000	6.700	7.033	++++
MEA	2.200	6.000	6.633	+++
PDPA	**4.433**	**8.066**	**9.000**	+++
CD Value	0.252	0.278	0.223	

Table 2. Effect of different media on mycelial development of *H. ulmerius*

Media	Growth on 3rd day	Growth on 5th day	Growth on 6th day	Nature of Mycelia
PDA	4.166	7.900	8.766	++++
CDA	3.933	7.600	8.500	++++
YMA	3.233	7.100	7.900	+++
MEA	2.566	6.666	7.166	++++
PDPA	**4.333**	**8.233**	**8.966**	**++++**
CD Value	0.157	0.196	0.149	

and produces enzymes that digest complex carbohydrates, lipids and protein, which in-turn will be easily absorbed by the developing hyphae (Yadav and Chandra, 2014). Mycelium growth may be considered as the best tool in identification of necessary nutrients for the production of fruiting bodies of many mushrooms as mycelium growth requires much short time in comparison with fruiting bodies development (Kalmis and Kalyoncu, 2006). Many researchers have been driven the use of different agar media as an effective culture platform that supports the mycelial growth of different mushroom species (Cañal *et al*, 2020). Potato Dextrose Agar medium is reported to be effective for the mycelial growth of many species of Oyster mushrooms (*Pleurotus* sp.) , Milky mushroom and Paddy straw mushroom (Dey *et al*, 2007; Neelam *et al*, 2013; Pant *et al*, 2020). Malt extract and peptone agar medium was reported as one of the preferable culture medium for *Agaricus bitorquis* (Ali *et al*, 2015). Peptones and extracts are excellent natural sources of amino acids, peptides and proteins in growth media (Davami *et al*, 2015). Keeping in view the importance of cultural media in the cultivation process of any edible mushroom, the present investigations were conducted with an objective to study the influence and suitability of different media on mycelial development of five different mushrooms.

MATERIALS AND METHODS

Mushroom cultures used

The pure culture of 5 edible mushrooms *viz., Pleurotus florida, Hypsizygous ulmerius, Calocybe indica, Agaricus bitorquis* and *Volvariella volvaceae* from the Department of Plant Pathology, College of Agriculture, Vellayani, Kerala was utilized for this study.

Media preparation

Potato Dextrose Agar (PDA) media: The medium was prepared by using 200 g peeled potato, 20g dextrose and 20g agar in a liter of water, *Carrot Dextrose Agar (CDA) media*: The medium was prepared by using 200g peeled and sliced carrot, 20g dextrose and 20g agar in a

Table 3. Effect of different media on mycelial development of *C. indica*

Media	Growth on 3rd day	Growth on 5th day	Growth on 6th day	Nature of Mycelia
PDA	**3.833**	**7.233**	**8.633**	**+++**
CDA	2.933	6.800	7.900	+++
YMA	2.800	6.533	7.466	+++
MEA	2.900	6.466	7.733	++++
PDPA	1.033	1.200	1.333	+
CD Value	0.149	0.192	0.238	

Table 4. Effect of different media on mycelial development of *A. bitorquis*

Media	Growth on 3rd day	Growth on 5th day	Growth on 6th day	Nature of Mycelia
PDA	0.533	0.533	0.533	+
CDA	0.633	0.633	0.633	+
YMA	1.166	2.833	3.000	++
MEA	**3.866**	**7.100**	**8.833**	**++++**
PDPA	1.933	3.666	4.100	++
CD Value	0.177	0.207	0.192	

liter of water, *Malt Extract Agar (MEA) media*: The medium was prepared by dissolving 20g malt extract and 20g agar in a litre of water, *Yeast Malt Agar (YMA) media*: The medium was prepared by dissolving 10g dextrose, 5g peptone, 3g malt extract, 3g yeast extract and 20g agar in a liter of water, *Potato Dextrose Peptone Agar (PDPA) media*: The normal PDA medium was modified by adding peptone. *i.e.,* the medium was prepared by using 200g peeled potato, 20g dextrose, 5g peptone and 20g agar in a liter of water.

Sterilization of medium

The above five media prepared were sterilized in an autoclave at 1.05 kg/cm^2 for 20 min and then poured into 90 mm petri dishes inside the laminar airflow chamber. Media were cooled and solidified to room temperature at 30$\pm$2^o C.

The petri dishes were inoculated with 5 mm mycelial bit of actively growing pure cultures (10d old) of *P. florida, H. ulmerius, C. indica, A. bitorquis* and *V. volvaceae* taken using sterile cork-borer. The plates were incubated at 30$\pm$2^o

Table 5. Effect of different media on mycelial development of *V. volvaceae*

Media	Growth on 3rd day	Growth on 5th day	Growth on 6th day	Nature of Mycelia
PDA	3.800	7.500	8.066	+++
CDA	2.166	6.466	7.033	+
YMA	3.800	7.800	8.166	+++
MEA	**3.966**	**7.866**	**8.766**	**+++**
PDPA	**3.966**	**8.033**	**8.933**	**++++**
CD Value	0.212	0.192	0.259	

Fig. 1. Growth on 6th day of P. florida on different media

Graph 1. Effect of different media on mycelial development of P. florida

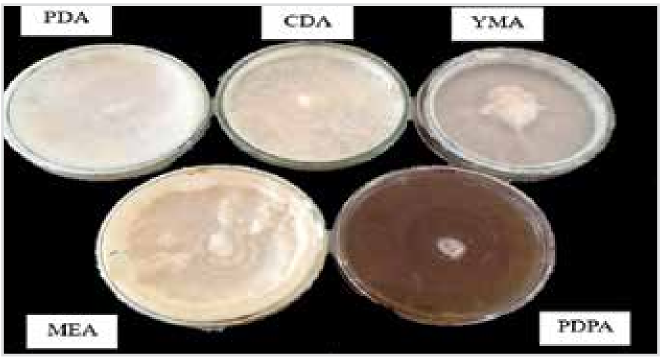


Fig. 2. Growth on 6th day of H. ulmerius on different media

Graph 2. Effect of different media on mycelial development of H. ulmerius

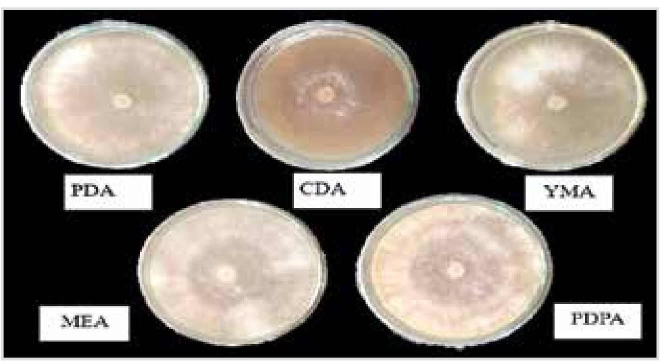
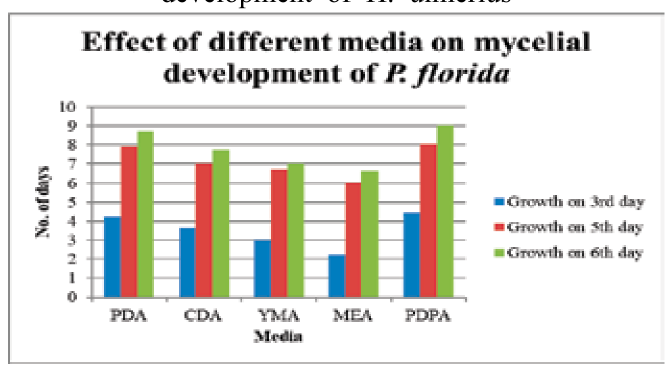


Fig. 3. Growth on 6th day of C. indica on different media



Graph 3. Effect of different media on mycelial development of C. indica

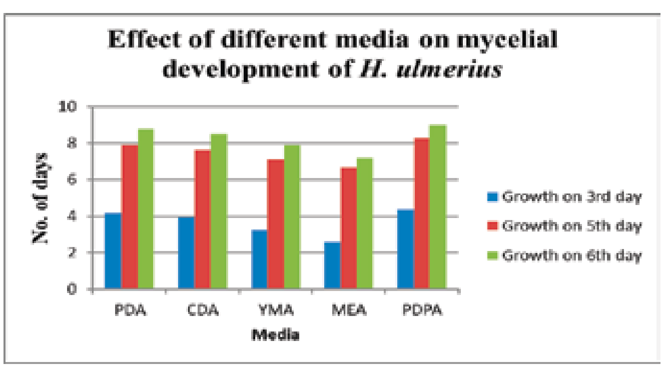
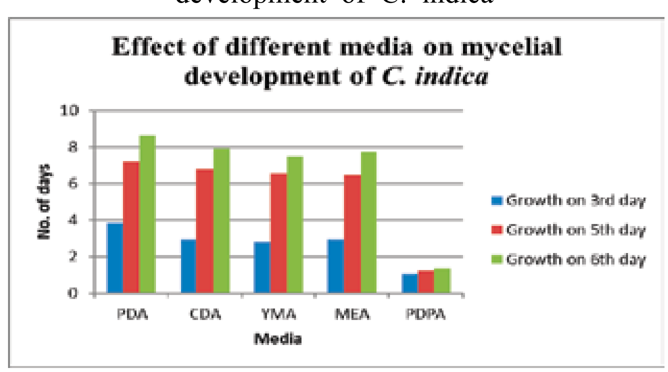


Fig. 4. Growth on 6th day of A. bitorquis on different media



Graph 4. Effect of different media on mycelial development of A. bitorquis

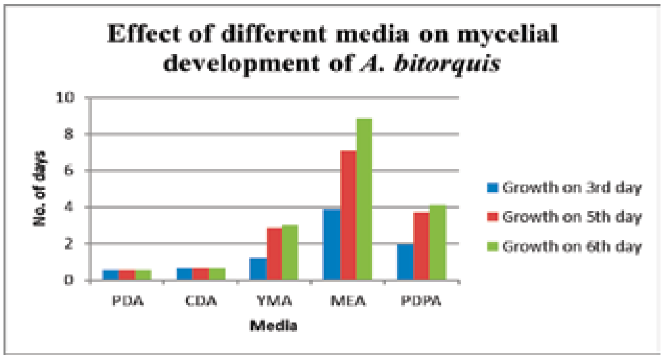
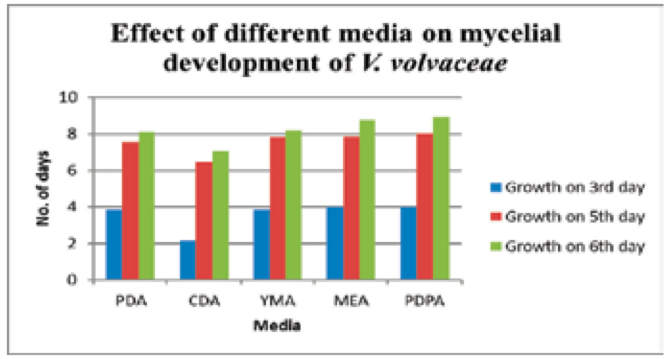


Fig. 5. Growth on 6th day of V. volvaceae on different media



Graph 5. Effect of different media on mycelial development of V. volvaceae

C. The radial mycelial growth and mycelial density were observed and recorded continuously.

Daily mycelial growth was measured using a ruler placed across the petri dish horizontally. The mycelial density was rated as follows (Kadiri, 1998):

+ = Very Scanty mycelial density

++ = Scanty mycelial density

+++ = Moderate mycelial density

++++ = Abundant mycelial density

+++++ = Very abundant mycelial density.

The experiment was conducted in a completely randomized design (CRD) with three replications for each treatment under in vitro conditions and the data were analyzed by using statistical package of program WASP2.0. Critical difference was calculated at 5 per cent probability.

RESULTS AND DISCUSSION

It was found that PDPA media was best in fastening the mycelial coverage of *P. florida* (9 cm on 6th day) followed by *H. ulmerius* (8.96 cm on 6th day) and *V. volvaceae* (8.93 cm on 6th day) in the petri plates. But the mycelial density of *P. florida* was moderate in PDPA medium while it was abundant in PDA, CDA and YMA media. *H. ulmerius* showed abundant mycelial density in PDA, CDA, MEA and PDPA while it showed only moderate mycelial density in YMA. Thus, animal nitrogen source peptone have a profound influence in the mycelial development of these mushrooms which is evident from the vigorous mycelial growth as well as from the abundantly developed mycelial density.

Among the five solid media used, PDPA was found as least effective in the mycelial development of *C. indica.* The mycelial density of *C. indica* on PDPA media was also scanty which showed its inhibitory effect. PDA media was the most effective media for development of *C. indica* (8.63 cm on 6th day) with moderate mycelial density. *C. indica* showed abundant mycelial density in MEA the mycelial development was not appreciable in MEA. On par with PDPA, MEA also founded effective in the development of mycelia of *V. volvaceae* (8.76 cm on 6th day). However, the mycelial density of *V. volvaceae* was found to be abundant in PDPA medium and only moderate in MEA medium. *V. volvaceae* also showed moderate mycelial density in PDA and YMA but showed very scanty mycelial density in CDA.

MEA turned out to be the best medium for the growth of *A. bitorquis* (8.83 cm on 6th day) with abundant mycelial density followed by PDPA. The mycological peptone present in the malt agar could have rapid influence on the development of luxuriant growth of the mycelia of *A. bitorquis.* The mycelial density of *A. bitorquis* was scanty in PDA and CDA and was scanty in YMA and PDPA.

CONCLUSION

The peptone supplemented potato dextrose agar (PDPA) medium was found more effective in mushroom mycelial development in the present study. Peptone supplementation of the PDA media had shown a pronounced influence on accelerating the mycelial spread as well as the mycelial density of *P. florida*, *H. ulmerius* and *V. volvaceae.* In the case of *C. indica,* PDPA was not preferable as it has an inhibitory effect. MEA turned out to be the best media for the mycelial growth of *A. bitorquis* and *V. volvaceae.* Since mushrooms are good source of various bioactive compounds of industrial and therapeutic importance also, the in-vitro developed mycelia may be used for the large scale production of the compounds as most mushrooms are seasonal. The present study may be useful in order to make the bioactive production technology from the mycelia and to obtain high cost effectivity.

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Performance of Drought Tolerant Groundnut Variety in Chittoor District of Andhra Pradesh

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ABSTRACT

The western mandals of Chittoor district in Andhra Pradesh are prone to frequent drought marked by deficit and late onset of rainfall and also prolonged dry spells impacting productivity of groundnut (*Arachis hypogaea L.*). To build resilience into the system and to mitigate impact of drought on productivity, 40 demonstrations were conducted using drought tolerant groundnut variety Dharani under National Innovations on Climate Resilient Agriculture (NICRA) by RASS - KVK, Chittoor during 2015-18. The results revealed that about 16per cent higher pod yield was recorded with Dharani variety (1796 kg/ha) compared to the Kadiri-6 (1551kg/ha). Dharani recorded higher number of pods per plant (17.5) and uniform maturity of pods than Kadiri-6 (14.8). The average net returns (Rs.34890/-ha) and BC ratio (1.76) were also higher in case of Dharani when compared to Kadiri-6 (Rs.25226/-ha and 1.57). Efforts are on by the KVK to scale out this success story to other blocks of the district with similar climatic vulnerability through participatory seed production by farmers and trying to forge converge with the seed chain of the district.

Key Words: Dharani, Demonstrations, Groundnut, Net Returns, NICRA, Yield.

INTRODUCTION

Groundnut (*Arachis hypogaea L)* is grown in an area of 4.56mha with an average yield of 1486kg/ha (Anonymous, 2016). Eighty percent of the groundnut area and 84% of the production in India is confined to the states of Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. In Andhra Pradesh groundnut is grown in area of 9.3lakh ha during *Kharif* with a production of 3.91 lakh tonnes and a productivity of 419kg/ha. In Chittoor district it is grown in an area of 1.33lakh ha with a production of 0.72lakh tonnes and with an average yield of 540kg/ha (Anonymous, 2017). Climate change and increasing climatic vulnerabilities on agriculture could result in problems with food and nutritional security and may threaten the livelihood activities upon which much of the population depends, especially small and marginal farmers. The impacts of climate change are global, but countries like India are more vulnerable in view of the high population depending on agriculture. Promoting suitable and appropriate adaptation strategies will enable farmer to cope with climatic risks, efficient use of natural resources to bring sustainable crop production.

Groundnut productivity in India is low due to moisture stress, poor soil fertility, pests and diseases, and cultivation of the crop on marginal and sub marginal lands. Nearly 80% of the groundnut area in India is under rainfed and relies entirely on monsoon rainfall. The rainfall in most of the groundnut-growing regions is low and erratic. There is a high variability in the onset of monsoons, annual rainfall and distribution of rainfall over the growing season. Moreover, such high variability in precipitation is generally associated with a high probability of an early season drought. The western

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Table 1. Yield particulars of Dharani groundnut variety.

Year	Plant Height (cm)		No of pods/plant		Pod Yield (Kg/ha)		Haulm Yield (Kg/ha)	
	K-6	Dharani	K-6	Dharani	K-6	Dharani	K-6	Dharani
2015	44.3	41.2	14.2	15.1	1396	1630	3675	2650
2016	42.8	39.6	15.3	17.4	1665	1850	4382	3007
2017	46.5	42.3	16.1	18.5	1715	1930	4513	3137
2018	47.2	44.3	13.8	19.2	1428	1774	4150	3300
Average	45.2	41.8	14.8	17.5	1551	1796	4180	3024

mandals of Chittoor district in Andhra Pradesh are prone to frequent drought marked by deficit and late onset of rainfall and also prolonged dry spells impacting productivity of groundnut. In addition to above, lack of improved and high yielding varieties in sufficient quantity is the problem faced by the farmers in the district. Farmers generally grow Kadiri-6 variety which is of low yielding and susceptible to drought and bud necrosis. Hence the present study was undertaken to evaluate drought tolerant Dharani groundnut variety in vulnerable cluster villages of Chittoor district, Andhra Pradesh.

MATERIALS AND METHODS

To build resilience into the system and to mitigate impact of drought on productivity, 40 demonstrations were conducted using drought tolerant groundnut variety Dharani by Rashtriya Seva Samithi (RASS) - Krishi Vigyan Kendra (KVK), Chittoor during Kharif 2015-18 in villages, Chittecherla and Deendarlapalli of Chinnagottigallu mandal, Chittoor district, Andhra Pradesh. The farming situation is rainfed, soils are red sandy in texture, neutral in reaction (pH 7.3), Electrical Conductivity (EC) is normal (0.38 milli mhos per cm), low in organic carbon (0.38%) and available nitrogen (160kg per ha), medium in available P2O5 (57kg per ha) and low in available Potassium (240 kg per ha). The package of practices *viz.,* seed treatment, nutrient management, weed management, pest and disease management were followed in the demonstration as per ANGRAU recommendations. The data on plant height, number of pods per plant, pod yield, haulm yield, cost of cultivation, gross returns, net returns and BC ratio were recorded from all the demonstrations at the time of harvest. The variety used in the demonstration was Dharani released in 2013, 100-105 days duration, moderate stature, pod yield is 1600-2600kg/ha in kharif, 100 seed weight is 40.43g, drought tolerant withstands up to 35 days dry spell, uniform maturity, and in the farmers practice it was Kadiri-6 (K-6). It is semi spreading type, 105-110 days duration and yield potential is 2000-2200kg/ha during *kharif.* The results of the study were analyzed statistically using independent t-test and Repeated Measures mixed ANOVA.

RESULTS AND DISCUSSION

The results (Table 1) revealed that the average plant height was found to be 41.8cm in Dharani and it was 45.2cm in the case of Kadiri-6. The average number pods per plant were more with 'Dharani' (17.5) when compared to Kadiri-6 (14.8). It might be due to better translocation of photosynthates from source to sink which resulted in more number of pods. Similar results reported by Umadevi *et al* (2018) and Bhagavata Priya (2014). The average yield of Dharani variety (1796kg/ha) was more when compared to Kadiri-6 variety (1551kg/ha). About 15.8% increase in yield was observed in Dharani variety when compared to Kadiri-6 variety. This might be due to more number of pods due to better translocation of photosynthates from source to sink. Bhagavatha Priya *et al* (2016) also reported that highest pod yield was recorded by Dharani variety followed by TAG-24, Kadiri-6 and

Table 2. Economics of Dharani groundnut variety.

Year	Cost of Cultivation (Rs/ha)		Gross Returns (Rs/ha)		Net Returns (Rs/ha)		BC Ratio	
	K-6	Dharani	K-6	Dharani	K-6	Dharani	K-6	Dharani
2015	38225	39947	56367	65828	18142	25881	1.47	1.65
2016	43020	44370	86580	96200	43560	51830	2.01	2.17
2017	48135	49575	73745	82990	25610	33415	1.53	1.67
2018	50668	51395	64260	79830	13592	28435	1.27	1.55
Average	45012	46322	70238	81212	25226	34890	1.57	1.76

Table 3. Comparison between the varieties during each year (Independent t-test).

Particulars	Year	Treatments	Mean	SD	t-value	p-value
No of pods/plant	2015	K-6	14.22	0.44	5.467**	0.000
		Dharani	15.11	0.25		
	2016	K-6	15.26	0.42	10.380**	0.000
		Dharani	17.35	0.47		
	2017	K-6	16.14	0.37	12.438**	0.000
		Dharani	18.49	0.46		
	2018	K-6	13.77	0.44	28.719**	0.000
		Dharani	19.24	0.40		
Pod Yield (kg/ha)	2015	K-6	1396	26.95	9.797**	0.000
		Dharani	1630	70.55		
	2016	K-6	1665	35.39	10.535**	0.000
		Dharani	1850	42.75		
	2017	K-6	1715	28.48	9.072**	0.000
		Dharani	1930	69.32		
	2018	K-6	1428	43.98	19.722**	0.000
		Dharani	1774	33.81		

** Significant 1% level

Greeshma during early kharif season in Sothern agro climatic zone of Andhra Pradesh.

The average haulm yield was more in Kadiri-6 when compared to Dharani variety. It might be due to increase in plant height results in more vegetative growth. This finding was in agreement with that of Bhutadiya *et al* (2019).

The average cost of cultivation of Dharani variety was higher than Kadiri-6 by Rs.1310/- ha but, Dharani variety recorded higher average gross returns (Rs.81212/-ha) and net returns (Rs.34890/-ha). The average B.C Ratio of Dharani (1.76) was more than the Kadiri-6 (1.57). Bhagavatha Priya *et al* (2016) also reported that highest net returns was recorded by Dharani variety followed by TAG-24, Kadiri-6 and Greeshma during early kharif season in Southern agro climatic zone of Andhra Pradesh.

Independent "t' test was used to compare number of pods per plant and pod yield between Dharani and K-6 varieties in each year. From the data (Table 3), it can be understood that there was a significant difference between Dharani and K-6 varieties with regard to number of pods/plant and pod yield. No

Table 4. Pooled analysis for the variables using Repeated Measures (RM) mixed ANOVA

Variables	**Pods per plant**		**Pod Yield (Kg/ha)**	
Source	F-value	p-value	F-value	p-value
Years	135.94	0.000	183.14	0.000
Years*treatments	105.01	0.000	11.26	0.000
Treatments	970.38	0.000	556.50	0.000

of pods and pod yield of Dharani was significantly higher than Kadiri-6 during every year.

Mixed ANOVA is carried out for pooled analysis of four years data due to repeated measures. The data (Table 4) identified a significant difference between the varieties during all the years with respect to number of pods per plant and pod yield in both Kadiri-6 and Dharani varieties. Further, treatments differed significantly in all the years in which Dharani performed well with respect to number of pods and pod yield than farmers practice, Kadiri-6. Hence it can be concluded that no of pods and pod yield of Dharani variety is significantly higher than Kadiri -6 during all the years.

CONCLUSION

It can be concluded from the study that the yield, gross returns, net returns and BC Ratio were more with 'Dharani' groundnut variety than Kadiri-6 in vulnerable village clusters of Chittoor district, Andhra Pradesh.

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Performance of Groundnut Varieties for Better Yield in Nagapattinam District of Tamil Nadu

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ABSTRACT

The present study was conducted during *kharif* 2017 in three villages of Nagapattinam district to assess the suitable variety of Groundnut. Five farmers' field were randomly selected and sown three high yielding improved varieties of groundnut namely Kadiri 9, CO 6 and ICGV 91114 with five replications with one check variety already grown by the farmers. The study revealed that Kadiri 9 recorded higher pod yield (19.87 q/ha), higher number of pods/plant (21.12), lesser root rot incidence (4.30 %) and optimum plant population (33.02 plants / M^2) as compared to CO 6 and ICGV 91114. Kadiri 9, CO 6, and ICGV 91114 recorded 35.15, 27.10 and 18.89 per cent higher yield than the check variety TMV 7, respectively. A reduction in root rot incidence, leaf minor, leaf spot, Spodoptera damage and optimum plant population was observed in all the three varieties as compared to check variety. Gross and net returns were Rs.1,19,220/- and Rs.73,990/-ha, respectively by cultivating Kadiri 9 as against Rs.77,280/- and Rs.37,824/-ha in the check variety. Hence, it was inferred that Kadiri 9 variety of ground nut proved better followed by CO 6 and ICGV 91114.

Key Words: Extension gap, Groundnut, Technology, Varieties, Yield.

INTRODUCTION

Groundnut or peanut (Arachis hypogaea L.) is an important food and cash crop for resource poor farmers in Asia and Africa. Due to its high monosaturated content, it is considered healthier than saturated oils and is resistant to rancidity. Groundnut is particularly valued for its protein content (26%). In addition to protein and oil, groundnut is a good source of Ca, P, Fe,B and Zn. Hence, groundnut played an important role in nutritional security to the resource poor farmers. In addition, the haulms provided excellent fodder for livestock, cake obtained after oil extraction was used in animal feed and overall the crop acted as good source of biological nitrogen fixation (Nautiyal *et al*, 2011). It is 6th most important oilseed crop in the world. It is habituated in the tropical, subtropical and warm temperate regions with average yield of 1520 kg/ha. Groundnut crop can be cultivated in region were rainfall received from 500 to 1250 mm of rainfall. It cannot withstand severe drought, water logging and frost. The major groundnut production states are Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra. These five states contribute 86 percent of groundnut production in India. Tamil Nadu occupies 338300 ha with a production of 783200 t as per Arul Prasad *et al* (2019).

Groundnut growing areas in Nagapattinam district on 1737 ha was mostly under rainfed and irrigated condition. Important limitation other than irrigation is varietal preferences. As farmers were growing different local varieties during *kharif* season and save their own seeds over years for next sowing. Hence, the study was planned with the objectives to evaluate the improved groundnut varieties with high yield under *kharif* season. Method of sowing was by broadcast the seeds. The participatory rural appraisal study in the block reveals that the non availability of released variety suited to kharif season, farmers were cultivating

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Table 1. Details of practices in Nagapattinam district under.

Sr. No	Cultural practice	Improved practice	Existing practice
1.	Variety	Kadiri 9 , CO 6 and ICGV 91114	TMV 7
2.	Land preparation	Ploughing and Levelling	Ploughing and Levelling
3.	Pre emergent herbicide	Pendimethalin @ 1L/ha	No herbicide
4.	Seed rate	120 kg/ha	175 kg/ha
5.	Seed treatment	Biofertilizers & Pseudomonas	Non adoption of seed treatment
6.	Fertilizer dose	INM	Indiscriminate application
7.	Foliar application of nutrient	2 sprays of TNAU groundnut rich @ 5.0 kg/ha at 35 DAS and 45 DAS	Non adoption of foliar spray
8.	Plant protection	IPM	Indiscriminate application

the local variety of ground nut (TMV 7) which is low yielding, susceptible to root rot, leaf minor, leaf spot and Spodoptera . For control of these pests and diseases farmers were using pesticides indiscriminately which has led to increased cost of cultivation. Several biotic, abiotic and socio-economic constraints inhibit exploitation of the yield potential of groundnut and these are needed to bead dressed. Crop growth and yield are limited through poor plant nutrition and uncertain water availability during the growth cycle. Inappropriate management may further reduce the fertility of soil (Rabbinge, 1995). Therefore, it was considered to evaluate growth and yield parameters of three selected high yielding varieties of groundnut in Nagapattinam district to identify the most suitable variety at the farmers field for higher income.

MATERIALS AND METHODS

The present on farm study was conducted on the Clay loam soil during *kharif* 2017 in three villages of Nagapattinam district. Five farmers' field were randomly selected and sown three high yielding improved varieties of groundnut namely Kadiri 9, CO 6 and IGCV 91114 in five replication with one check variety already grown by the farmers. The chemical fertilizer was applied through DAP, muriate of potash and urea as basal dose. The details of cultural practices were given in Table1.

The recommended weed control measures and irrigation were applied according to requirement of the crop. The data like average Germination percentage (%),plant population (plants per M^2), number of pods per plant, pod yield (q per ha), haulm yield (kg per ha), root rot incidence (%), leaf miner (%), leaf spot (%), Spodoptera damage (%) were recorded during investigation. To estimate the technology gap, extension gap and technology index formula given by Samui *et al* (2000) was used.

RESULTS AND DISCUSSION

The highest germination percentage was recorded in variety Kadiri 9 (97.22%) followed by CO 6 (92.14%), ICGV 91114(93.84%). The variety Kadiri 9 has recorded highest number of plant population per M^2 (33.02) followed by CO 6 (29.82), ICGV 91114 (27.24). The reason may be attributed to the genetic variability and varietal difference and environmental adaptability. (Table 2)

The variety Kadiri 9 recorded maximum number of pods/plant (21.2) which was significantly higher with variety CO 6 (20.58) and ICGV 91114 (1.20). Highest yield of Kadiri 9 may be attributed to the cumulative performance of the genotype in terms of seed/ pod .Similar results were reported by Saravannan *et al* (2018). Farmers' check variety had minimum pods/ plant (13.50). The data (Table2)

Table 2. Performance of Ground nut varieties at farmers' field (Average of five trials).

Sr. No	Parameter	Kadiri 9	CO 6	ICGV 91114	TMV 7 (Check)	S.Ed.	C.D.(0.05)
1.	Germination percentage (%)	97.22	92.14	93.84	92.68	0.84	2.59
2.	Plant population (plants/m^2)	33.02	29.82	27.24	25.14	0.84	2.60
3.	Number of pods per plant	21.12	20.58	19.20	13.50	0.62	1.90
4.	Pod yield (q /ha)	19.87	17.67	15.88	12.88	0.41	1.27
5.	Haulm yield (kg/ ha)	4618	4020	3651	3418	64.3	198.3
6.	Root rot incidence (%)	4.30	5.62	4.84	7.78	0.12	0.38
7.	Leaf miner (%)	7.80	9.00	12.20	31.80	0.39	1.21
8.	Leaf spot (%)	3.44	4.98	6.70	18.80	0.34	1.05
9.	Spodoptera damage (%)	12.40	14.80	24.00	36.80	0.41	1.28

showed that root rot disease incidence (%) ranged between 4.30 to 5.62 per cent in three varieties whereas the farmers' practice recorded 7.78 per cent. Groundnut varieties, Kadiri 9, CO 6 and ICGC 91114 and recorded 35.17, 27.10 and 18.89 per cent higher pod yield than check variety TMV 7, respectively.

The maximum yield of ground nut was recorded in Kadiri 9 which was significantly superior to CO 6 and ICGV 91114. However, Kadiri 9 recorded highest yield in comparison to farmers' practice. Thus, the local variety/farmers' practice may be replaced with high yielding varieties because of higher productivity. With regard to haulm yield, Kadiri 9 variety recorded highest haulm yield of 4618 kg/ha as compared to other varieties. Lowest haulm yield was observed with TMV 7 (3418 kg/ha).

The technology gap ranged between 1.47 and 5.13 q/ha. The observed technology gap was due to various constraints such as soil fertility, availability of low moisture content and climatic hazards *etc.* Hence, to reduce the yield gap location specific recommendations for varieties, soil testing and timely sowing appears to be necessary. A value of 3.00 to 6.99 q/ha of extension gap was found during 2017. There is a need to decrease this wider extension gap through latest techniques. (Table 3.) These findings were similar to the findings of Jain (2016) in pulses. The technology index showed the suitability of varieties at farmer's field. Lower technology values indicated that feasibility of variety among the farmers is more. The technology index ranged from 7.68 to 20.60 per cent. The finding was in accordance to finding of Sandhu and Dhaliwal (2016).

Gross and net returns were Rs.1,19,220/- and Rs.73,990/-ha, respectively by cultivating Kadiri 9 as against Rs.77,280/- and Rs.37,824/-ha in the check variety. The probable reason was lesser incidence of root rot disease coupled with higher number of pods/plant resulting higher pod and haulm yield, these results were in agreement with the findings of Vindhiyavarman *et al* (2010) and Murugan *et al* (2016). The gross cost of cultivation was almost similar for all the three varieties. Market preference for Kadiri 9 was good and fetched higher price. The yield, net return and B: C ratio was higher in Kadiri 9 due to higher market price followed by CO 6 and ICGV 91114.

CONCLUSION

The findings of the study revealed that cultivating Kadiri 9 and CO 6 in Cauvery delta districts like Nagapattinam district was more beneficial due to their yield contributing traits namely Germination

Table 3. Yield, technology gap, extension gap and technology index of Ground nut.

Name of Variety	Yield (q/ha.)			Per cent increase	Tech. gap (q/ha)	Ext. gap (q/ha)	Tech. index (%)
	Potential yield (q/ ha)	Improved practice Average	Farmers' Practice Average				
Kadiri 9	25.00	19.87	12.88	35.17	5.13	6.99	20.52
CO 6	19.14	17.67	12.88	27.10	1.47	4.79	7.68
ICGV 91114	20.00	15.88	12.88	18.89	4.12	3.00	20.6

Table 4. Yield and Economics of Ground nut varieties.

Variety	Yield (q/ha)	Economics of Trials (Rs./ha)			
		Gross cost	Gross income	Net income	B:C Ratio
Kadiri 9	19.87	45230	119220	73990	2.63
CO 6	17.67	43120	106020	62900	2.46
ICGV 91114	15.88	41560	95280	53720	2.29
TMV 7 (Check)	12.88	39456	77280	37824	1.95

percentage, plant population, number of pods per plant, yield which were recorded more as compared to farmers' choice variety i.e., TMV 7. The findings of the study concluded that the yield of Kadiri 9 was significantly higher than other varieties with recommended package and practices of Groundnut. Thus, the farmer's practice variety may be replaced with high yielding variety like Kadiri 9 in Nagapattinam district of Tamil Nadu.

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Practices Adopted for Backyard Poultry Rearing in Dungarpur District of Rajasthan

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ABSTACT

The present study covered four tehsils of Dungarpur district namely Dungarpur, Bicchiwada, Aspur and Sagwara and from each tehsil three villages and 15 poultry growers each from each village were selected for the study. Thus, a total of 180 backyard poultry growers were interviewed through a structured interview schedule to note down various feeding and breeding practices being followed by them. The Study revealed that in feeding practices (86.11%) used self-produced feed for poultry birds, 67.78 per cent respondents fed poultry bird twice a day, most of the respondents (86.11%) not used mineral mixture, 75.0 per cent were not using grits, 36.67 per cent used feeders of plastic and 32.78 per cent metallic waterer. In breeding practices, 75.56 per cent respondents were using their own male for breeding purpose.

Key Words: Feeding practices, breeding practices, management practices.

INTRODUCTION

Backyard poultry serves as an inexpensive means for households to generate highly nutritious food commodities at minimal cost. It is an age-old practice carried out by poor farmers and tribal population in rural areas. This backyard poultry production consists of keeping indigenous birds with poor production performances. About 66 per cent of the total population of country still lives in rural part, which predominantly constituted by farmers of poor socioeconomic status *i.e.,* poor, marginal farmers and landless labourer. Backyard poultry farming system profitability can be increased if we adopt an improved indigenous strain of poultry birds (Chatterjee and Rajkumar, 2015). Moreover, the consumers have liking for eggs and meat of indigenous poultry compared to those realized from farm bred chickens or exotic breeds of chicken (Jha and Chakrabarti, 2017). Similarly, backyard poultry manure can be used directly (Pal *et al*, 2020).

The backyard poultry birds have desirable plumage colour with high performance compared to local indigenous bird with very small change in husbandry practice followed for the indigenous fowl. Crossbred fowl produced using exotic breed is being used for backyard poultry farming (Das *et al,* 2008: Padhi *et al*, 2012). The poultry birds reared in the backyard poultry farming are also important from the biodiversity point of view as they act as a natural scavenger. Budharam *et al* (2021) reported that in health care management practices maximum respondents had veterinary facilities, but did not follow the vaccination schedule, however, respondents provide vaccine to bird after hatching. Hence, a study was conducted to note down various feeding and breeding practices being followed by them so that this information can be used for planning a welfare project for this faming category in the state.

MATERIALS AND METHODS

District Dungarpur comprises of total 8 tehsils, out of which 4 tehsils *i.e.,* Dungarpur, Bicchiwada, Aspur and Sagwara and from each tehsil three

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Table 1. Distribution of respondents on the basis of practices followed for backyard poultry rearing. N=80.

Particular	Number of respondents	Per cent (%)
Feed		
Formulated at household level	155	86.11
Purchased from market	35	19.44
Frequency of feeding		
Once in a day	58	32.22
Twice in a day	122	67.78
Mineral Mixture		
Yes	35	13.89
No	155	86.11
Fed Grits		
Yes	45	25.00
No	135	75.00
Type of feeder		
Earthen	57	31.67
Metallic	52	28.89
Plastic	66	36.67
Others	5	2.78
Type of waterer		
Earthen	58	32.22
Metallic	59	32.78
Plastic	58	32.22
Others	5	2.78

villages and 15 poultry growers each from each village were selected for the study. To select the villages, a comprehensive list of all the villages consisting backyard poultry farming in selected tehsils was arranged in consultation with the individual of revenue department and Agriculture Technology Information Center. Thus, a total of 180 backyard poultry growers were interviewed to note down various feeding and breeding practices being followed by them so that this information can be used for planning a welfare project for this faming category in the state. The data were recorded at fortnightly interval during investigation period. The questions were offered to them in their local language and Hindi confirming that they got the queries properly so as to escape any interpretational disparity of the query by the farmers. The answerers obtained from respondents were documented and only single respondent was questioned at a time. The data were analysed by using frequency, mean and percentage.

RESULTS AND DISCUSSION

Feeding practices followed

It was found 86.11per cent of respondents used self-produced feed for poultry, while 19.44 per cent used purchased feed. Only 32.22 per cent respondents fed their poultry bird once in a day while 67.78 per cent respondents fed twice a day (Table 1). It was apparent from the data that most of

Table 2. Distribution of respondents on the basis of criteria of selection of eggs for hatching.

Item	Number of respondents	Percent
Selection of eggs for hatching		
Egg size	5	2.78
Egg shape	9	5.00
Both egg shape and size	166	92.22
Tpe of poultry houses		
Kaccha	22	12.22
Pucca	25	13.89
Mixed	133	73.89

the respondents (86.11%) not used mineral mixture and a very few respondents (13.89 %) were using mineral mixture for backyard poultry. Likewise, most of respondents (75.00 %) were not using grits and used feeders of earthen, metallic, plastic and other materials as 31.67, 28.89, 36.67 and 2.78 per cent, respectively. Further, the respondents used waterer of earthen, metallic, plastic and other as 32.22, 32.78, 32.22, and 2.78 per cent, respectively. Most of the farmers fed own produced feed to poultry birds. These findings were in agreement to Chaturvedani *et al* (2016).

Breeding practices followed

The data (Table 2) revealed that respondents purchasing breeding male from outside was 24.44 per cent and rest of 75.56per cent were using their own male for breeding purpose. The overall percentage of selection criteria for egg hatching used by the respondents were 2.78, 5.00 and 92.22 for egg size, egg shape and both egg shape and size, respectively. The mean hatchability of the eggs was found to be 77.06 per cent. Perez and Polanco (2003) found higher hatchability of eggs at 87.2 per cent, which was in contradiction to the findings acquired in the present study.

The data (Table 2) revealed that respondents of study area used 12.22 per cent kaccha, 13.89 per cent pucca and 73.89 per cent used mixed of type poultry house. However, Monsi and Ayodele (1989) noticed that poultry birds were reared in open sided house with a concrete floor covered with wood shadings.

Constraints faced

The important constraints faced by the poultry farmers in Dungarpur district of Rajasthan were predator's problems, non-availability of balanced poultry feeds and lack of veterinary facilities.

CONCLUSION

Backyard provides quality nutrition as meat and egg which reduce the malnutrition among rural population of country. The overall aims of development of backyard poultry system are to reduce poverty, malnutrition and increase income of rural poor families. It helps in conserving the natural resources and maintaining biodiversity. Moreover, there is no special infrastructure required for running backyard poultry farm. It can be started in small covered structure surrounded by net wire. In this poultry farming system, rearing of local poultry breeds is an important and best choice for development of backyard poultry production. It is source of livelihood and employment generation tool for the rural population.

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Performance of Indian Pompano, *Trachinotus mookalee* in net cages

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ABSTRACT

The Indian pompano, *Trachinotus mookalee* is considered as a promising species for mariculture in India. Indian pompano seed were obtained from Central Marine Fishery Research Institute, Vishakhapatnam. The seed were stocked in 1m ×1m × 2m diameter cages in closed bay at Suryalanka near Bapatla, Guntur. Fishes were stocked at 4 different stocking densities; T_1 (4 No/m^3); T_2 (6 No/m^3); T_3 (8 No/m^3) and T_4 (10 No/m^3) for a duration of 92 days. Feeding of the fish was done twice per day, with each daily ration divided into two equal halves. Feed was applied at the rate of 10% of body weight. A feed ring (0.5 × 0.5 m) was fixed at middle of each cage. Feed rings are enclosures that float at the water surface. They hold floating feeds and prevent the escape of feed out of cage and thus reduce wastage of feed. The mean body weight of fish at the time of stocking was T_1 (10.1g $\pm$ 0.69.); T_2 (10.6g $\pm$ 0.56); T_3 (10.7g $\pm$ 0.74) and T_4 (10.2g $\pm$ 2.62) whereas mean total length was T_1 (7.6 cm$\pm$ 1.02); T_2 (7.1cm$\pm$ 0.86); T_3 (6.8cm $\pm$ 0.88) and T_4 (6.9cm $\pm$ 1.45) The fish have grown from T_1 (10.1g $\pm$ 0.69.) T_2 (10.6g $\pm$ 0.56) T_3 (10.7g $\pm$ 0.74) T_4 (10.2g $\pm$ 2.62) to T_1 (34.1g $\pm$ 1.24.) T_2 (26.91g $\pm$ 1.54) T_3 (25.15g $\pm$ 1.22) T_4 (22.76g $\pm$ 1.14) weight and T_1 (12.75cm$\pm$ 1.35) T_2 (11.98cm$\pm$ 1.81) T_3 (11.5cm $\pm$ 1.44) T_4 (11.26cm$\pm$ 1.73) length were observed. Cent per cent survival was reported in all stocking densities. Growth reduced with increasing stocking densities. The water quality parameters like temperature, D.O, pH, salinity, NH_3, NO_2, NO_3, alkalinity and hardness were analysed at every fortnightly interval and were within the optimum range for culture of Indian pompano.

Key Words: Net cages, Indian pompano, *Trachinotus mookalee.*

INTRODUCTION

Among the many high value marine tropical finfish that could be farmed in India, the Indian pompano, *Trachinotus mookalee* is an important spp., mainly due to its fast growth and high market demand (Gopakumar *et al*, 2012). The species is ideal for mariculture because of its fast growth rate and easy weaning to pellet feeds. Indian pompano larvae, fingerlings and adult are hardy and can be easily acclimatized to lower salinities. Sampaio *et al* (2003) found that pompano tolerate wide range of salinity, between 7 and 58 ppt on acute exposure of individuals acclimated to seawater (35 ppt), and on gradual exposure to diluted seawater with even lower salinities. Farming can be successfully carried out in ponds, tanks and floating sea cages. The species is pelagic, very active and is able to acclimatise and grow well even at a low salinity of about 8 per cent (Gopakumar *et al*, 2012). Length weight relation of *Trachinotus ovatus* was evaluated by Zhang *et al* (2016) for male and female separately.

Cage culture is the most predominant form of mariculture in the Asia-Pacific. Cage culture uses existing water resources (ponds, rivers, estuaries, open ocean, etc.) but confines the fish inside some type of mesh enclosure. Marine aquaculture is a growing industry worldwide (WRI, 1998) due to the increasing demand for marine products by the human population. The success in cage farming depends on the availability of seeds of appropriate size for stocking. The Central Marine Fisheries Research Institute (CMFRI) initiated research on captive brood stock development and seed production of silver pompano from 2008 and

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Table 1.Water quality parameters in floating net cages with Indian pompano.

Days of culture	Salinity	pH	Temperature	D.O	Alkalinity	Hardness	Ammonia	Nitrate	Nitrite
Initial Value	23	7.4	28	7.4	116	2500	0.2	0.03	0.01
15	25	7.6	29	7.5	118	2600	0.2	0.04	0.02
30	23	7.5	29	7.7	119	2800	0.3	0.04	0.03
45	22	7.7	28	7.6	112	2800	0.2	0.03	0.02
60	23	7.8	29	7.4	123	2900	0.4	0.04	0.02
75	24	7.5	28	7.3	117	2800	0.3	0.05	0.03
90	25	7.7	29	7.9	114	2900	0.4	0.05	0.02

the first successful induced breeding and larval production was achieved in 2011 (Gopakumar *et al*, 2012).

MATERIALS AND METHODS

Present study was conducted in the closed bay near closed bay at Suryalanka near Bapatla., Guntur District, Andhra Pradesh during August to October, 2018 for a duration of 92 days. It lies between latitude- 15◦51’ 04.54”N and longitude 80◦31’58.87”E.

Experimental fishes and cages

Indian pompano seed were obtained from Central Marine Fishery Research Institute, Vishakhapatnam. The size of fish at the time of stocking was T_1 (10.1g $\pm$ 0.69.) T_2 (10.6g $\pm$ 0.56) T_3 (10.7g $\pm$ 0.74) T_4 (10.2g $\pm$ 2.62) mean body weight and T_1 (7.6 cm$\pm$ 1.02) T_2 (7.1cm$\pm$ 0.86) T_3 (6.8cm $\pm$ 0.88) T_4 (6.9cm $\pm$ 1.45) mean total length. Indian pompano seed was acclimatized for one week under laboratory conditions. Floating net cages of 1 x 1x 2 m diameter were made with Bamboo of 3 inches diameter; 3 anchors of 25 Kg weight were provided. Polyethylene net materials were used for the net cages; Predatory and bird net were also provided. These nets were of HDPE materials. PVC drums filled with air were fixed to the cage frame for floatation. Fishes were stocked at four different stocking densities; T_1 (4 No/m^3); T_2 (6 No/m^3); T_3 (8 No/m^3)and T_4 (10 No/m^3).

Feeding

During the experiment the fishes were fed 1 mm size extruded floating pellet feed for entire experiment; with CP 10% and 10% CF. Fish were fed twice a day at 7:00 am. and at 5:00 pm; each daily ration divided into two equal halves. Feed was applied at the rate of 10% of body weight. Feeding rings are enclosures that float at the water surface. They hold floating feeds and prevent the escape of feed out of cage and thus reduce wastage of feed. A feeding ring of 0.5 × 0.5m were providing in each cage and it was fixed at middle of each cage to hold floating feeds and prevent the escape of feed out of cage and thus reducing wastage of feed. Feeding was given manually to ensure ingestion of feed completely by the fish. Total fish in each treatment was sampled to obtain weight with simple balance (INFRA DIGI, digital weighing machine, and model IN300, Chennai)

Water quality parameters

Water quality parameters like temperature (Celsius glass thermometer), Dissolved oxygen (Titrimetric, Winkler’s method APHA, 1995), pH (Digital pH meter), salinity (Hand held Refractometer), Alkalinity, Ammonia, Nitrite and Nitrate were measured at 8.00 hrs. at fortnightly interval. Water samples were transported to the laboratory after collection and analysed. Fulton’s condition factor was calculated according to Htun-han (1978).

Fish samplings

Periodic sampling was carried out every 15d for enumeration of growth parameters as below:

Weight increment = Final body weight (g) – Initial body weight (g).

Specific growth rate (SGR) = [(Ln FBW - Ln IBW) / day] x 100,

Where: - Ln = Natural logarithm, FBW = final body weight and IBW = initial body weight.

Survival Rate (%) = Total number of fish survived / Total number of fish stocked ×100

Biomass = Number of fish × average body weight (g)

Statistical analysis

The data obtained on growth, weight gain, survival and feed conversion ratio were treated statistically by applying two way ANOVA classifications according to (Snedecor and Cochran,1989]. The results were presented as mean ± standard error (SE).

RESULTS AND DISCUSSION

Growth performance

During the 92 days culture period, the fishes had grown from T_1 (10.1g ± 0.69 to 34.1g ± 1.24) T_2 (10.6g ± 0.56 to 26.91g ± 1.54) T_3 (10.7g ± 0.74 to 25.15g ± 1.22) T_4 (10.2g ± 2.62 to 22.76g ± 1.14) in weight and as T_1 (7.60 cm ± 0.21 to 12.75cm± 0.35) T_2 (7.12 cm ± 0.87 to 11.98cm± 1.81) T_3 (6.8 cm ± 0.74 to 11.5cm ± 1.44) T_4 (6.9 cm ± 0.62 to 11.26cm± 1.73) in length.

The details of the water quality parameters recorded during the study period in the floating cages are given in Table 1. Temperature, dissolved oxygen, pH, salinity, alkalinity, hardness, ammonia, nitrite and nitrate recorded in the cages were in the range 28^0C to 29^0C, 7.4 to 7.9 mg/l, 7.4 to 7.7, 23 to 25 ppt, 114 to 116 mg/l, 2500 to 2900 mg/l, 0.2 to 0.4 mg/l, 0.03 to 0.05 mg/l and 0.01 to 0.02 mg/l, respectively. In the present study temperature and salinity were fluctuated. These changes due the heavy to rains in that particular period and heavy inflow water into the bay. Increments of growth and biomass were shown in Fig 3. Water quality parameters estimated during the experiment were in the optimum range for the growth of Indian pompano. Cent per cent survival rate was observed in all treatments. Maximum SGR was recorded in T1 (0.60±0.02) and minimum SGR was observed in the T4 (0.39±0.04). In other treatments SGR is T2 (0.54±0.03) and T3 (0.44±0.03). The maximum average daily weight gain (ADWG) was observed in T1 (42.0±0.02g) and the minimum ADWG was observed in the T4 (22.7±0.04 g). The other treatments T2 and T3 recorded ADWG of 36.7±0.03 and 27.8±0.04, respectively. The Maximum biomass was recorded in T4 (194.5±0.25) and the minimum biomass was observed in the T1 (146.8).

Table 2. Growth performance, survival, weight gain, specific growth rate, condition index and biomass of Indian pompano (*Trachinotus mookalee*) in floating net cages.

Parameter	T1	T2	T3	T4
Stocking Density	4/m^3	6/m^3	8/m^3	10/m^3
Initial Weight (g)	10.1	10.6	10.7	10.2
Final Weight (g)	52.1	47.3	38.5	32.4
Survival Rate(%)	100	100	100	100
Weight Gain (g)	42	36.7	27.8	22.2
SGR	0.60	0.54	0.44	0.39
Condition Index	2.06	2.64	2.90	3.22
Biomass	146.8	166.8	177.6	194.5

The other treatments T2 and T3 recorded net yield of 166.8±0.11 and 177.6±0.20 respectively. The condition factor of Indian pompano during the experiment. The maximum condition index was recorded in the T4 (3.22±0.12) and the minimum SGR was observed in the T1 (2.06±0.74). The other treatments SGR is T2 (2.64±0.43) and T3 (2.90±0.23).

In the present study fishes at stocking density 4/ m^3 (T1) resulted in high final body weight, weight gain and SGR. Hannibal *et al* (2011) studied on the effect of stocking density on growth performance, survival and production of silver pompano in marine floating cages, and reported that silver pompano of 12-15g initial size can be stocked at 25 pcs. m^3 to 25 pcs m^3resulted in 100% Survival rate. Jayakumar *et al* (2014) studied on the growth and production performance of hatchery produced silver pompano *Trachinotus blochii,* fingerlings under brackish water ponds and reported that silver pompano of 2.0 ± 0.04 g has grown to 464.65 ±10.25 g. in 8 months. Results indicated that this species was suitable for Open cage farming, readily accepts pellet feed and tolerates varying salinities between 8 to 24 per cent in conformity with Kalidas *et al* (2012) and has reasonable growth rate.

Survival rate

In the present study 100% survival was recorded at all stocking densities. Cremer *et al*

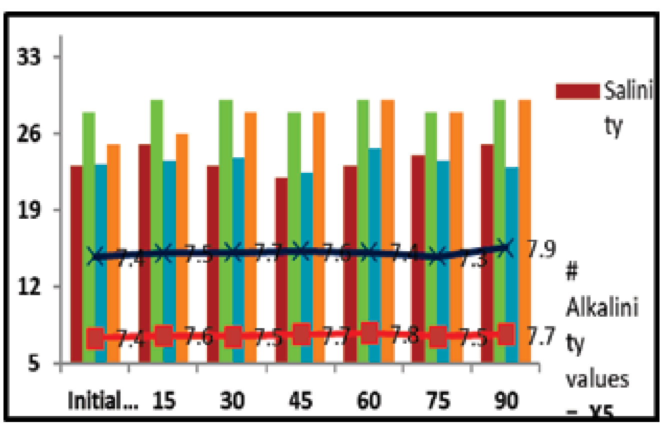

Fig. 1 Salinity, Temperature, Alkalinity, Hardness, D.O, pH parameters in floating net cages with Indian pompano (*Trachinotus mookalee)*

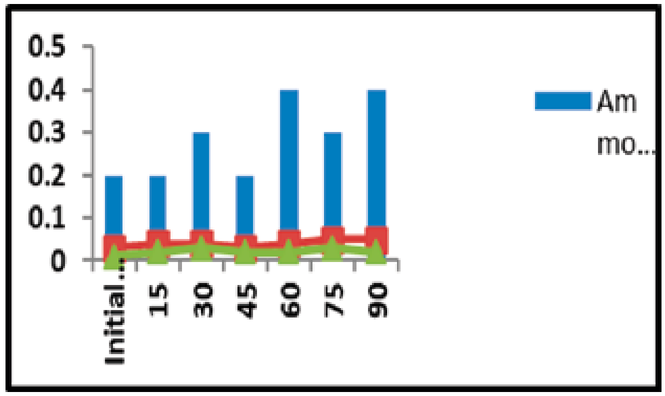

Fig. 2 Ammonia, Nitrate, Nitrite parameters in floating net cages with Indian pompano (*Trachinotus mookalee)*

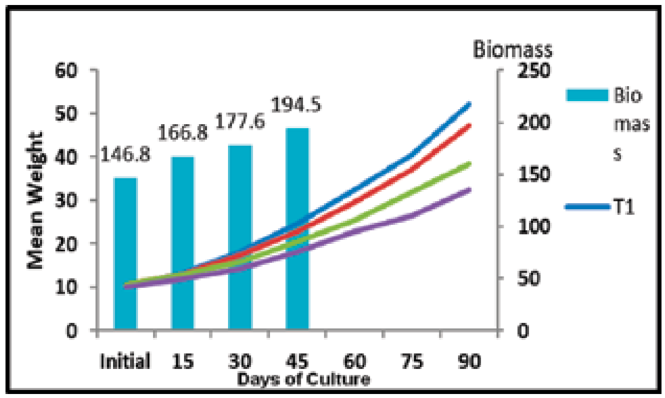

Fig. 3 Growth increment in floating net cages with Indian pompano(*Trachinotus mookalee)*

(2003) reputed a survival rate of 81.2 – 90.8% in golden fin pompano, *Trachinotus ovatus* at stocking densities of 250/m^2 or 375 / m^3. Cremer and Jim (1992) reported 72% survival in the same species when stocked at 400/ m^3 (Initial weight 2.7g). higher survival rate in the present study may be due to bigger initial size of fish (10+ g)

Growth

Cremer *et al* (2003) reported that there was no significant difference in growth performance of *Trachinotus ovatus* grows at stocking density of 250/ m^3 or 375 / m^3. and observed significant difference in gross production; higher stocking densities resulted in higher production (32.8% more fish biomass. Jayakumar *et al* (2014) reported a survival rate of 91.32% in Silver pompano (*T.blochii*) grown in B.W ponds. Cunha *et al* (2013) reported a survival rate of 97.3 – 100 per cent in *Trachinotus marginalis,* cultured in tanks; the initial weight was 4.1 g. Cunha *et al* (2013) reported an SGR of 2.61± 0.1 – 3.37 ± 0.1 when *Trachinotus marginalis* was fed at different feeding rates (4 -20% body weight) and different feeding frequencies (2- 10/ day).

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Physical Compatibility of Chemicals used in Paddy Ecosystem

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ABSTRACT

Laboratory studies were conducted during *kharif* 2017 to know the physical compatibility of recommended insecticides (Thiamethoxam 25 WG, Imidacloprid 17.8 SL, Profenophos 50 EC, Chlorpyriphos 20 EC, Flubendiamide 480 SC and Chlorantraniliprole 18.5 SC) and fungicides (Hexaconazole 5 SC, Tricyclazole 75 WP, Carbendazim 50 WP and Propiconazole 25 EC) against rice insect pests and diseases with most commonly used foliar nutrient. All the 24 combinations tested showed physical compatibility with no foaming and sedimentation. The pH value of majority of the insecticide and fungicides combinations tested was neutral to moderately acidic but when mixed with foliar nutrient, the solution turned to be strongly acidic.

Key Words : Physical compatibility, Paddy, Pesticide combinations.

INTRODUCTION

Paddy (*Oryza sativa* L.) is one of the major staple food for more than half of the world population. India is the second largest producer of rice next to China and is cultivated on almost one-fourth of the total cropped area, providing food to about half of the Indian population (Seni and Naik, 2017). Like other crops, paddy also suffers incidence of insect pests and diseases together which demands the spray of pesticides both insecticides and fungicides at a time. Farmers use tank mixing of majority of insecticides, fungicides and nutrients for the management of insect pests *viz*., leaf folder and stem borer and blast disease for which compatibility is not known. Due to this, there is loss in the efficacy of certain insecticides and fungicides against the target pest. At present, highly effective fungicides and insecticides with novel modes of action are available and these are becoming increasingly important in modern agriculture as a component of integrated pest management and resistance management strategies. Although, combined application of pesticides is a labour saving method, but an understanding and knowledge of pesticide compatibility is essential.

Pesticide combinations may show physical, chemical or phytotoxic incompatibility causing undesirable results. Physical incompatibility may result in an unstable mixture or a soapy flocculate. Usually this may be visualized as layering or balling up or sediment formation affecting the efficacy of the pesticides. It can be caused by improper mixing, inadequate agitation or lack of stable emulsifiers in some emulsifiable concentrates. In most cases, solids settle out of the mixture or the mixture separates into layers after agitation. So, physical compatibility of pesticides is a prerequisite for recommending combination of insecticides and fungicides under field conditions. Hence, an experiment was conducted under laboratory conditions to know the physical compatibility of recommended insecticides and fungicides against rice pests.

MATERIALS AND METHODS

Laboratory experiment on physical compatibility of six insecticides (Thiamethoxam 25 WG Imidacloprid 17.8 SL, Profenophos 50 EC, Chlorpyriphos 20 EC, Flubendiamide 480 SC and Chlorantraniliprole 18.5 SC) and four fungicides

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Parameter	pH value	Parameter	pH value
Extremely acidic	< 4.5	Very strongly acidic	4.5–5.0
Strongly acidic	5.1–5.5	Moderately acidic	5.6–6.0
Slightly acidic	6.1–6.5	Neutral	6.6–7.3
Slightly alkaline	7.4–7.8	Moderately alkaline	7.9–8.4
Strongly alkaline	8.5–9.0	Very strongly alkaline	> 9.1

(Hexaconazole 5 SC, Tricyclazole 75 WP , Carbendazim 50 WP and Propiconazole 25 EC) along with 19:19:19 foliar nutrient was carried out at Soil and Water Testing Laboratory, ICAR -Krishi Vigyan Kendra, Uttara Kannada, Sirsi, Karnataka during Kharif 2017. Jar compatibility test was followed to study the physical compatibility of pesticides. In this test, initially 500 ml of standard hard water (0.34 g calcium chloride and 0.139 g of magnesium chloride hexahydrate in one litre of double distilled water) was taken in one litre jar to which one insecticide and one fungicide were added in the order of Wettable powder (WP) followed by Dry flowables (DF), Flowables (F), Emulsifiable concentrates (EC) and finally by solubles designated as either solubles (S), soluble liquids (SL) or soluble concentrates (SC). The volume of insecticide, fungicide and foliar nutrient mixture was made up to 1 litre with hard water, agitated by shaking the jar and left undisturbed for 30 min. Observations were recorded after 30 and 60 min with respect to foaming and sedimentation. Also, pH of the insecticides and fungicides in combinations and also with 19:19:19 foliar nutrient were recorded and designated according to Bickelhaupt (2012) as following:

RESULTS AND DISCUSSION

The jar test studies conducted for foaming, sedimentation and pH of the tank mix insecticides / fungicides and 19 All foliar nutrient mixtures are presented in Table 1 and 2. Among 24 combinations, neither foaming nor sedimentation was observed in insecticide + fungicide combination and also after adding foliar nutrient indicating physical compatibility(> 20 ml / L as specified by ISI).

The pH readings of pesticide mixtures without the addition of foliar nutrients revealed that Thiamethoxam in combination with Hexaconazole, Carbendazim and Propiconazole was neutral (6.6, 7.0 and 6.9 respectively) but its combination with Tricyclazole was slightly acidic (6.5). All the remaining combinations were moderately acidic (5.6 - 6.5) except Chlorpyriphos in combination with Hexaconazole, Tricyclazole and Propiconazole which was strongly acidic (5.5, 5.4 and 5.4 respectively). The present findings are in line with works of Visalakshmi *et al* (2016), where the combination of Chlorantranaliprole @ 0.3 ml/l + Propiconazole @ 1.0 ml/l, Chlorpyriphos @ 2.5 ml/l + Propiconazole @ 1.0 ml/l, Flubendiamide @ 0.25 ml/l + Propiconazole @ 1.0 ml/l and Profenophos @ 2.0 ml/l + Propiconazole 1.0 ml/l were physically compatible. Prasad *et al (*2009) noticed physical compatibility with Imidacloprid 200 SL @ 0.25 ml/l + Propiconazole 25 EC @ 1.0 ml/l and Thiamethoxam 25 WG @ 0.25 ml/l + Propiconazole 25 EC @ 1.0 ml/l. Similar type of experiments conducted by Raju *et al* (2018) revealed that Profenophos in combination with either Tricyclazole or Hexaconazole or Propiconazole in standard hard water show neither foaming nor sedimentation indicating that the combinations were compatible. When foliar nutrient 19 - All was added to the pesticide mixture, all treatment combinations showed very strongly acidic pH results except Thiamethoxam in combination with four fungicides *viz.*, Hexaconazole, Tricyclazole, Carbendazim and Propiconazole which were strongly acidic with pH value 5.2, 5.2, 5.2 and 5.3, respectively.

Table 1. Physical compatibility of insecticides, fungicides and foliar nutrient used in Paddy ecosystem.

Sr. No.	Pesticide combination	Foaming (ml/l)	Sedimentation (ml/l)
1	Thiamethoxam 25 WG @ 0.2 g/l + Hexaconazole 5 SC @ 1 ml/l	0	0
2	Thiamethoxam 25 WG @ 0.2 g/l + Tricyclazole 75 WP @ 0.6 g/l	0	0
3	Thiamethoxam 25 WG @ 0.2 g/l + Carbendazim 50 WP @ 1 g/l	0	0
4	Thiamethoxam 25 WG @ 0.2 g/l + Propiconazole 25 EC @ 1 ml/l	0	0
5	Imidacloprid 17.8 SL @ 0.3 ml/l + Hexaconazole 5 SC @ 1 ml/l	0	0
6	Imidacloprid 17.8 SL @ 0.3 ml/l + Tricyclazole 75 WP @ 0.6 g/l	0	0
7	Imidacloprid 17.8 SL @ 0.3 ml/l + Carbendazim 50 WP @ 1 g/l	0	0
8	Imidacloprid 17.8 SL @ 0.3 ml/l + Propiconazole 25 EC @ 1 ml/l	0	0
9	Profenophos 50 EC @ 2 ml/l + Hexaconazole 5 SC @ 1 ml/l	0	0
10	Profenophos 50 EC @ 2 ml/l + Tricyclazole 75 WP @ 0.6 g/l	0	0
11	Profenophos 50 EC @ 2 ml/l + Carbendazim 50 WP @ 1 g/l	0	0
12	Profenophos 50 EC @ 2 ml/l + Propiconazole 25 EC @ 1 ml/l	0	0
13	Chlorpyriphos 20 EC @ 2 ml/l + Hexaconazole 5 SC @ 1 ml/l	0	0
14	Chlorpyriphos 20 EC @ 2 ml/l + Tricyclazole 75 WP @ 0.6 g/l	0	0
15	Chlorpyriphos 20 EC @ 2 ml/l + Carbendazim 50 WP @ 1 g/l	0	0
16	Chlorpyriphos 20 EC @ 2 ml/l + Propiconazole 25 EC @ 1 ml/l	0	0
17	Flubendiamide 480 SC @ 0.2 ml/l + Hexaconazole 5 SC @ 1 ml/l	0	0
18	Flubendiamide 480 SC @ 0.2 ml/l + Tricyclazole 75 WP @ 0.6 g/l	0	0
19	Flubendiamide 480 SC @ 0.2 ml/l + Carbendazim 50 WP @ 1 g/l	0	0
20	Flubendiamide 480 SC @ 0.2 ml/l + Propiconazole 25 EC @ 1 ml/l	0	0
21	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Hexaconazole 5 SC @ 1 ml/l	0	0
22	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Tricyclazole 75 WP @ 0.6 g/l	0	0
23	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Carbendazim 50 WP @ 1 g/l	0	0
24	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Propiconazole 25 EC @ 1 ml/l	0	0

*19:19:19 foliar nutrient was mixed in above all combinations

Table 2. pH of the insecticide and fungicide combinations with and without foliar nutrient (19:19:19).

Sl. No	Pesticide combinations	pH without foliar nutrient (19:19:19)	Nature	pH with foliar nutrient (19:19:19)	Nature
1	Thiamethoxam 25 WG @ 0.2 g/l + Hexaconazole 5 SC @ 1 ml/l	6.6	Neutral	5.2	Strongly acidic
2	Thiamethoxam 25 WG @ 0.2 g/l + Tricyclazole 75 WP @ 0.6 g/l	6.5	Slightly acidic	5.2	Strongly acidic
3	Thiamethoxam 25 WG @ 0.2 g/l + Carbendazim 50 WP @ 1 g/l	7.0	Neutral	5.2	Strongly acidic
4	Thiamethoxam 25 WG @ 0.2 g/l + Propiconazole 25 EC @ 1 ml/l	6.9	Neutral	5.3	Strongly acidic
5	Imidacloprid 17.8 SL @ 0.3 ml/l + Hexaconazole 5 SC @ 1 ml/l	5.7	Moderately acidic	4.9	Very strongly acidic
6	Imidacloprid 17.8 SL @ 0.3 ml/l + Tricyclazole 75 WP @ 0.6 g/l	5.7	Moderately acidic	4.9	Very strongly acidic
7	Imidacloprid 17.8 SL @ 0.3 ml/l + Carbendazim 50 WP @ 1 g/l	5.8	Moderately acidic	4.9	Very strongly acidic
8	Imidacloprid 17.8 SL @ 0.3 ml/l + Propiconazole 25 EC @ 1 ml/l	5.9	Moderately acidic	4.9	Very strongly acidic
9	Profenophos 50 EC @ 2 ml/l + Hexaconazole 5 SC @ 1 ml/l	5.7	Moderately acidic	4.7	Very strongly acidic
10	Profenophos 50 EC @ 2 ml/l + Tricyclazole 75 WP @ 0.6 g/l	5.6	Moderately acidic	4.7	Very strongly acidic
11	Profenophos 50 EC @ 2 ml/l + Carbendazim 50 WP @ 1 g/l	5.6	Moderately acidic	4.8	Very strongly acidic
12	Profenophos 50 EC @ 2 ml/l + Propiconazole 25 EC @ 1 ml/l	5.6	Moderately acidic	4.8	Very strongly acidic
13	Chlorpyriphos 20 EC @ 2 ml/l + Hexaconazole 5 SC @ 1 ml/l	5.5	Strongly acidic	4.6	Very strongly acidic
14	Chlorpyriphos 20 EC @ 2 ml/l + Tricyclazole 75 WP @ 0.6 g/l	5.4	Strongly acidic	4.6	Very strongly acidic
15	Chlorpyriphos 20 EC @ 2 ml/l + Carbendazim 50 WP @ 1 g/l	5.7	Moderately acidic	4.8	Very strongly acidic
16	Chlorpyriphos 20 EC @ 2 ml/l + Propiconazole 25 EC @ 1 ml/l	5.4	Strongly acidic	4.7	Very strongly acidic
17	Flubendiamide 480 SC @ 0.2 ml/l + Hexaconazole 5 SC @ 1 ml/l	5.8	Moderately acidic	4.6	Very strongly acidic
18	Flubendiamide 480 SC @ 0.2 ml/l + Tricyclazole 75 WP @ 0.6 g/l	5.6	Moderately acidic	4.6	Very strongly acidic
19	Flubendiamide 480 SC @ 0.2 ml/l + Carbendazim 50 WP @ 1 g/l	6	Moderately acidic	4.9	Very strongly acidic
20	Flubendiamide 480 SC @ 0.2 ml/l + Propiconazole 25 EC @ 1 ml/l	5.8	Moderately acidic	4.7	Very strongly acidic
21	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Hexaconazole 5 SC @ 1 ml/l	5.7	Moderately acidic	4.6	Very strongly acidic
22	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Tricyclazole 75 WP @ 0.6 g/l	5.6	Moderately acidic	4.6	Very strongly acidic
23	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Carbendazim 50 WP @ 1 g/l	5.9	Moderately acidic	4.8	Very strongly acidic
24	Chlorantraniliprole 18.5 SC @ 0.3 ml/l + Propiconazole 25 EC @ 1 ml/l	5.8	Moderately acidic	4.7	Very strongly acidic

CONCLUSION

The physical compatibility studies conducted with recommended insecticide and fungicide combinations did not produce any foaming or sedimentation indicating all 24 combinations were compatible. The pH value of majority of the insecticide and fungicides combinations tested was neutral to moderately acidic, but when mixed with foliar nutrient, the solution turned to be strongly acidic. It can be concluded that insecticide and fungicide tank mix combinations can be recommended to farmers after assessing the performance under field conditions for bioefficacy and phytotoxicity studies. Another important factor was quality of water used for spraying which may also alter the pH of the spray solutions.

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Production Constraints in Groundnut Crop in Kadapa District of Andhra Pradesh

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ABSTRACT

The study was to find out the root causes of drastically declining the area under groundnut crop in Kadapa District of Andhra Pradesh. Results revealed that most of the groundnut farmers were marginal and small who expressed their options ranked in the following manner. The rank I was less remunerative prices for the produce (93%) followed by high cost of cultivation (91.67%) ranked II, uncertainty weather conditions (rainfall)(90%) ranked III, labour scarcity at crucial operations (sowing, weeding & harvesting) (85%) ranked IV facing difficulty in controlling the damage caused by the wild boars in their field (83.33%) ranked V, high wages of labour (80%) ranked VI, damage caused by monkeys (75%) ranked VII, root rot disease (73.33%) ranked VIII, low yields & high seed cost (70%) ranked IX, virus diseases (50%) ranked X, untimely availability of seed (38.33%) ranked XI, red hairy caterpillar damage (33.33%) ranked XII, insufficient groundnut water (25%) ranked XIII, and high weed problem (16.67%) ranked XIV. For the above reasons most the farmers were not able to grow groundnut crop in the district.

Key Words: Groundnut, Area, Production, Productivity, Constraints and Suggestions

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the most important food and oilseed crops cultivated and consumed in most parts of the world. It is widely accepted as an excellent source of nutrition to both human and animals due to its high protein content. Groundnut is grown on nearly 23.95 Mha worldwide with the total production of 36.45 Mt with an average yield of 1520 kg/ha). Groundnut is grown mostly in five states namely, Andhra Pradesh, Gujarat, Tamil Nadu, Karnataka and Maharastra, and together they account for about 90 per cent of the crop's total area. In Andhra Pradesh, it is mainly cultivated in Rayalaseema districts *viz.,* Anantapur, Kadapa, Kurnool and Chittoor districts followed by Telangana and coastal districts. The study was undertaken in Kadapa district purposively because the area under groundnut crop was drastically reduced. In order to find out the reasons for decreasing area under groundnut crop this study was undertaken with the objective to study socio economic characteristics of the farmers and find out the reasons for not cultivating groundnut crop.

MATERIALS AND METHOD

Ex-post facto research design was used for the study. The study was done in Kadapa district of Andhra Pradesh purposively. Six mandals of YSR district were selected purposively namely C K Dinne, Kadapa, Vempalle, Ramapuram, Chinnamandem and Chennur. From each mandal one village was selected namely Apparajupalli, Ramrajualli, Alireddypalli, Sarasswathipalli, Devagudipalli and Nazirbegpalli. From each village 10 farmers were selected constituting a sample size of 60 farmers. Secondary data were collected from the online sources. The primary data were selected by using a well-structured interview schedule. The collected data were tabulated in excel and used statistics tools such as frequency, percentage for analysis and interpreted the results.

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RESULTS AND DISCUSSIONS

It was found (Fig 1) that the area under groundnut crop was drastically decreased for the past 5 years in Kadapa district of Andhra Pradesh. Hence, the study was undertaken in Kadapa district in order to find out the reasons for not cultivating the groundnut crop by the farmers. We can infer that as the area was decreased automatically production as well as productivity was also decreased.

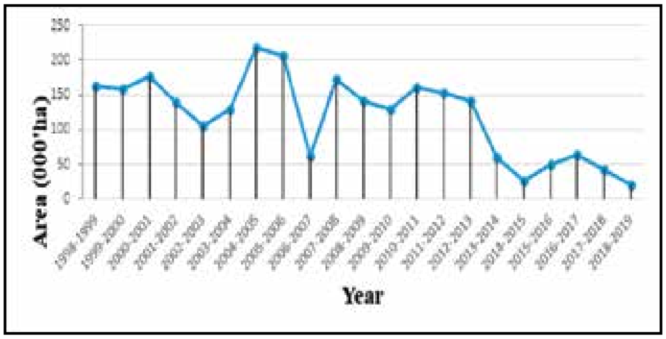

Fig:1 Area of groundnut crop in Kadapa district of Andhra Pradesh

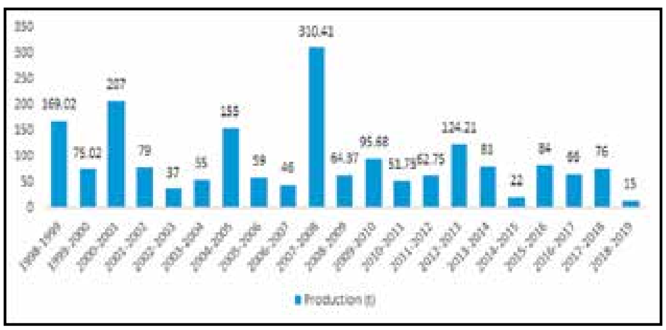

Fig:2 Production of Groundnut crop in Kadapa district of the Andhra Pradesh

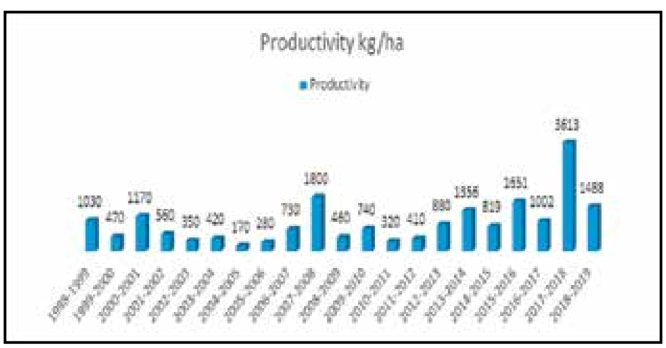

Fig 3. Productivity of Groundnut crop in Kadapa district of Andhra Pradesh

Source: Agricultural statistics at a glance for the year 2018-19

Source: Directorate of economics

The data (Table 1) showed that the majority of groundnut cultivators (61.67%) came from the middle age category after which came the young (20%) and the old (18.33%). Further, the majority (50%) of the respondents were illiterate followed by primary, middle, high school of education with same percentage (11.67%), functionally literate (8.33%), and middle school (6.67%). The majority (75%) of the groundnut farmers were under Open category followed by backward caste (20%), schedule caste (3.33%) and schedule tribes (1.67%). It was also revealed that that 38.33 per cent of the groundnut farmers having low level of farming experience followed by 36.67 per cent with high level farming experience and 25 per cent of groundnut farmers having medium level of farming experience.

An over view of the table 1 indicated that 61.67 per cent of the groundnut farmers had low level of annual income followed by medium and high 25 and 13.33 per cent, respectively. Majority (43.33%) of groundnut farmers belonged to marginal land holdings followed by small (36.67%), medium (10%), semi-medium (8.33%), and large farmers (1.67%). Likewise, the majority of groundnut farmers (35%) were getting information from neighbors, followed by relatives (31.67%), scientist (15%), AEO (8.33%), AO (6.67%) and ADA (3.33%). It could be comprehended that a majority of the groundnut farmers were having small family size (58.33%) and large family size (41.67). Data furnished in table 2 indicated that majority of the groundnut farmers were having nuclear type of family followed by joint family (33.33%). The results revealed that 88.33 per cent of the groundnut farmers were not having membership and 11.67 per cent of the groundnut farmers were having membership.

It was evident (Table 2) that the most of the groundnut farmers expressed less remunerative prices for their produce (93%) ranked I followed by high cost of cultivation (91.67%) ranked II, uncertainty weather conditions (rainfall) (90%) ranked III, labour scarcity at crucial operations

Table 1. Socio Economic Characteristics of the Groundnut Farmers.

The respondents were distributed different categories based on their selected profile characteristics and were presented in the following tables and interpreted through frequencies, mean and percentage.

Sr. No.	Variable	Category	Respondent	
			F	P
1	Age	Young (<41 yr)	12	20
		Middle (42- 62 yr)	37	61.67
		Old (>63 yr)	11	18.33
2	Education	No schooling/illiterate	30	50.00
		Functionally literate	5	8.33
		Primary school	7	11.67
		Middle school	4	6.67
		High school	7	11.67
		College education	7	11.67
3	Caste	Schedule caste	2	3.33
		Schedule tribe	1	1.67
		Backward caste	12	20.00
		Open category	45	75.00
4	Farming Experience	Low (<18 yr)	23	38.33
		Medium (19-40 yr)	15	25.00
		High (>41 yr)	22	36.67
5	Annual Income (Rs)	Low (<50000)	37	61.67
		Medium (50001-200000)	15	25.00
		High (>200000)	8	13.33
6	Land Holdings (ha)	Marginal – less than 1	26	43.33
		Small – 1-2 ha	22	36.67
		Semi-medium – 2-4 ha	5	8.33
		Medium – 4-10 ha	6	10.00
		Large – 10 ha and above	1	1.67
7	Source of information	AEO	5	8.33
		AO	4	6.67
		ADA	2	3.33
		Scientist	9	15.00
		Input dealers	21	35.00
		Relatives	19	31.67
8	Family size	Small (up to 5)	35	58.33
		Large (>5)	25	41.67
9	Family type	Nuclear	40	66.67
		Joint	20	33.33

10	Social participation	No membership	53	88.33
		Membership	7	11.67
11	Extension contact	Low	28	46.67
		Medium	18	30.00
		High	14	23.33

(sowing, weeding & harvesting) (85%) ranked IV facing difficulty in controlling the damage caused by the wild boars in their field (83.33%) ranked V, high wages of labour (80%) ranked VI, damage caused by monkeys (75%) ranked VII, root rot disease (73.33%) ranked VIII, low yields & high seed cost (70%) ranked IX, virus diseases (50%) ranked X, untimely availability of seed (38.33%) ranked XI, red hairy caterpillar damage is more (33.33%) ranked XII, insufficient groundnut water (25%) ranked XIII, and high weed problem (16.67%) ranked XIV. Because of the above reasons most the farmers are not able to grow groundnut crop in the district. These findings were in agreement to those reported by Raviya *et al (2016)* and Shinde *et al* (2009).

CONCLUSION

It can be concluded that the most important problems as expressed by most of the respondents were less remunerative prices for the produce, high cost of cultivation, uncertainty in weather condition especially rainfall and high labour scarcity at crucial operations like sowing, weeding and harvesting. The most important suggestions offered by the groundnut growers to overcome the constraints for cultivating the crop were remunerative price should be given to groundnut growers, market facilities should be strengthened), drought tolerant varieties should be developed , sufficient labour should be made available.

Table 2. Reasons of the respondents for not cultivating groundnut crop in Kadapa district

Sr. No.	Reason	Frequency	Percentage	Rank
1	Less remunerative prices for their produce	56	93.33	I
2	High cost of cultivation	55	91.67	II
3	Uncertainty weather conditions (rainfall)	54	90	III
4	Labour scarcity at crucial operations (sowing, weeding & harvesting)	51	85	IV
5	Damage caused by the wild boars	50	83.33	V
6	High wages of labour	48	80	VI
7	Damage caused by monkeys	45	75	VII
8	Root rot disease	44	73.33	VIII
9	Low yields & high seed cost	42	70	IX
10	Virus diseases	30	50	X
11	Untimely availability of seed	51	38.33	XI
12	Red hairy caterpillar damage	20	33.33	XII
13	Insufficient groundnut water	15	25	XIII
14	High weed problem	10	16.67	XIV

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Response of Different Cultivars of Basmati Rice (*Oryza sativa*) on Nutrient Uptake and Quality Parameters under Direct Seeding

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ABSTRACT

A field experiment was conducted at Student's Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana. The experiment was conducted in split plot design with 12 treatment combinations *viz.,* two basmati cultivars (Pusa Basmati 1121 and Punjab Basmati 2) in main plots and combination of three N rates and two time of application in sub plots (40 kg/ha at 0, 15, 50 DAS, 40 kg/ha at 0, 21, 65 DAS, 60 kg/ha at 0, 15, 50 DAS, 60 kg/ha at 0, 21, 65 DAS, 80 kg/ha at 0, 15, 50 DAS and 80 kg/ha at 0, 21, 65 DAS) with four replications. The findings of the study revealed that the nutrient uptake of rice in Pusa Basmati 1121 was found to be significantly higher than Punjab Basmati 2. It was observed that 60 kg N/ ha performed better over recommended 40 kg N/ ha when applied in 3 splits (0, 21 and 65 DAS). The soil status after harvest of the soil showed non-significant difference in organic carbon, available P and K except N with varying nitrogen levels. Pusa Basmati 1121 was also better in quality than Punjab Basmati 2 as indicated by its higher hulled rice recovery, milled rice recovery, head rice recovery, grain L:B ratio, water absorption, elongation ratio and cooking co-efficient. The sensory evaluation parameters were significantly better in Pusa Basmati 1121 than Punjab Basmati 2.

Key Words: Basmati cultivars, quality parameters, nutrient uptake and sensory evaluation parameters.

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food of about 3 billion people and the demand continues to grow with increasing population (Carriger and Vallee, 2007). India accounts for 22.3 per cent of the world's production of rice. Rice is the most widely grown *kharif* crop in Punjab and occupied an area of 30.46 lakh hectares with a production of 189.57 lakh tons in 2016-17 (Anonymous, 2019). In India, rice is commonly grown by transplanting rice seedlings into puddle soils in Indo-Gangetic plains and other regions. As a result, the underground water is being over exploited by excessive pumping to meet the water need of transplanted paddy causing a sharp decline in ground water table. The preliminary research conducted at Punjab Agricultural University, Ludhiana indicated that direct seeded rice could be a viable alternative to transplanted rice. Plant genotypes are also considered as an important yield determinant on account of their morphological and physiological characteristics. The Pusa Basmati 1121 variety is famous for its unique characters of aroma, extra long slender grains with good cooking quality, longest cooked rice length (Bhattacharjee *et al*, 2002) among all the aromatic rice varieties recommended for Punjab, etc. Punjab Basmati 2 possesses extra long slender grains with excellent cooking and eating qualities. Grains of this variety are strongly scented, almost double upon cooking, are non- sticky and soft to eat.

Nitrogen is an essential constituent of proteins, chlorophyll and metabolites such as nucleotides, phosphatides, alkaloids, enzymes, hormones and vitamins etc. which have great physiological importance in plant metabolism. Apart from promoting vegetative growth, it also increases crop yield and protein content in grains. Nitrogen is an important nutrient element for rice plants,

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as 75 per cent of leaf nitrogen is associated with chloroplast which physiologically helps in dry matter production through photosynthesis (Somasundaram *et al*, 2002). With this view, an attempt is made in the present study to evaluate the effect of different levels and time of application of nitrogen on nutrient uptake, nutrient status of the soil and quality parameters of different cultivars of basmati rice under direct seeding.

MATERIALS AND METHODS

The field experiment was conducted at Student's Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana which is situated at 30°56' N latitude and 75°52' E longitude with a mean height of 247 meter above the mean sea level. The soil of the experimental field was loamy sand in texture throughout soil profile. The experiment was conducted in split plot design with 12 treatment combinations *viz.,* two basmati cultivars (Pusa Basmati 1121 and Punjab Basmati 2) in main plots and combination of three N rates and two time of applications in sub plots with four replications viz. T_1- 40 kg/ha at 0, 15, 50 DAS, T_2- 40 kg/ha at 0, 21, 65 DAS, T_3- 60 kg/ha at 0, 15, 50 DAS, T_4- 60 kg/ha 0, 21, 65 DAS T_5- 80 kg/ha at 0, 15, 50 DAS and T_6- 80 kg/ha at 0, 21, 65 DAS. The seed rate of 20 kg/ha was used in direct seeding using 20 cm row spacing. Nitrogen was applied as per treatments *i.e.,* 40, 60 and 80 kg/ha. It was applied through urea in three equal installments according to the treatments as 1/3rd applied as basal, 1/3 at 15 DAS (days after sowing) or 21 DAS and last 1/3rd dose of nitrogen applied at 50 DAS or 65 DAS. The whole dose of P_2O_5 and K_2O was applied at the rate of 30 kg/ha at the time of field preparation. For determining NO_3-N and NH_4-N, soil samples were taken in 0-15, 15-30, 30-60, 60-90 and 90-120 cm soil layers. A 10 g portion of the soil was extracted with 100 ml of 2M-KCl solution after shaking for 1 hr. Suspension was filtered and filtrate was analyzed for NO_3-N and NH_4-N by steam distillation using Devarda's alloy and MgO respectively (Bremner, 1965). Organic carbon was determined by Walkley and Black's rapid titration method (Walkley and Black, 1934). Available nitrogen was determined by modified alkaline permanganate method as described by Subbiah and Asija (1956) and phosphorus by method described by Olsen *et al* (1954). The intensity of colour in the extract was developed by ascorbic acid (Watanable and Olsen, 1965) and measured at 760 nm on spectrophotometer. Available potassium was extracted with neutral normal ammonium acetate solution as described by Piper (1966) and it was determined by using flame photometer. Nitrogen, phosphorus and potassium in plant (uptake) was determined by using Kjeldahl's distillation method, Vanado-Molybdo-Phsophoric yellow colour method in nitric acid (Jackson,1967) and Lange's Flame Photometer (Jackson, 1967) respectively. The per cent nitrogen in the grain was estimated using Micro Kjeldahl's method of Mckenzine and Wallace (1964) and it was multiplied by 5.95 to compute the crude protein content in grain. The grain length and breadth were measured before and after cooking of basmati samples and expressed in mm of respective values of L/B for each treatment. A panel of six semi-trained judges was formed for evaluation of sensory parameters viz., aroma, tenderness, cohesiveness and colour. The quality parameters were calculated by using the following formulas:

$$\text{Brown rice recovery (\%)} = \frac{\text{Brown rice obtained (g)}}{\text{Total paddy taken (g)}} \text{ X } 100$$

$$\text{Milled rice recovery (\%)} = \frac{\text{Milled rice obtained (g)}}{\text{Total paddy taken (g)}} \text{ X } 100$$

$$\text{Head rice recovery (\%)} = \frac{\text{Head rice obtained (g)}}{\text{Total paddy taken (g)}} \text{ X } 100$$

Elongation ratio (ER) = $\frac{LcLc}{LrLr}$ where, Lc = Length of cooked grain (mm) and Lr = Length of raw grain (mm)

Water Absorption Ratio (WAR) =$\frac{WcWc}{WrWr}$ where, Wc = Weight of cooked grain (g) and Wr = Weight of raw grain (g)

Cooking coefficient (CC) = $\frac{Lc-\mathrm{Lr}\,Lc-\mathrm{Lr}}{\mathrm{Bc}-\mathrm{Br}\mathrm{Bc}-\mathrm{Br}}$ where, Lc = Length of cooked grain (mm), Lr = Length of raw grain (mm), Bc = Breadth of cooked grain (mm) and Br = Breadth of raw grain (mm)

RESULTS AND DISCUSSION

Soil Analysis at harvest for Nitrate-N and Ammonical-N

The NO_3-N and NH_4-N accumulated in the soil profile at various stages of rice growth presented in Table 1 indicated that the concentration of NO_3-N in the soil profile decreased with increasing stage of crop growth in each of the treatment, irrespective of the nitrogen levels. The non-significant difference in NO_3-N and NH_4-N content was observed with the different cultivars. This decrease in NO_3-N in the soil profile with increasing period of rice growth can be ascribed to higher N requirement of crop with increasing time period. Maximum NO_3-N and NH_4-N accumulation occurred in Punjab Basmati 2 closely followed by Pusa Basmati 1121. Chemical treatments supply NH_4-N to the plant for a short period but in excess amounts as reported by Hao and Chang (2002). Among nitrogen levels, maximum NO_3-N and NH_4-N accumulation was accrued in plots receiving 80 (3 splits; 0, 21, 65 DAS) kg N/ ha which was statistically at par with 60 (3 splits; 0, 15, 50 DAS) kg N/ha in case of NO_3-N accumulation and 80 (3 splits; 0, 15, 50 DAS) kg N/ ha in case of NH_4-N accumulation. Interaction effect between cultivars of basmati rice and nitrogen levels was observed to be non-significant.

Organic carbon, Available N, P and K status of the soil at harvest

The organic carbon per cent differed significantly and the available N status of the soil varied significantly amongst cultivars (Table 1). In contrast to this, the available P (19.9 kg/ ha) and K (146.1 kg ha^{-1}) status of the soil was improved in all the treatments over its initial value. It continued to increase with added fertilizers but there was no significant difference in the available P content of soil w.r.t different cultivars and nitrogen levels.

Table 1. Effect of nitrogen levels on nitrate-N, ammonical-N, organic carbon (OC), available status of soil after harvest of DSBR cultivars.

Treatment	Nitrate-N (mg/ kg)	Ammonical-N (mg/ kg)	Organic carbon (%)	Available N (kg/ ha^{1})	Available P (kg/ ha^{1})	Available K (kg/ ha^{1})
Cultivars						
Pusa Basmati 1121	4.21	15.33	0.54	196.2	21.9	148.1
Punjab Basmati 2	4.23	15.89	0.48	194.4	21.8	147.8
CD at 5%	NS	NS	0.21	NS	NS	NS
Nitrogen levels (kg ha^{-1})						
T_1	3.83	15..05	0.49	174.3	21.9	147.9
T_2	4.23	15.43	0.50	175.0	21.7	148.3
T_3	4.25	15.90	0.51	199.9	21.5	147.8
T_4	4.33	16.10	0.51	204.4	21.9	147.9
T_5	4.34	16.23	0.52	207.5	22.0	148.1
T_6	4.35	16.48	0.52	210.7	21.8	147.9
CD at 5%	0.10	0.30	NS	3.9	NS	NS
Interaction	NS	NS	NS	NS	NS	NS
Initial status	-	-	0.39	252.7	19.9	146.1

Table 2. Effect of nitrogen levels on uptake of nitrogen (N), phosphorus (P) and potassium (K) of DSBR cultivars

Treatment	N uptake (kg/ ha)		P uptake (kg/ ha)		K uptake (kg/ ha)	
	Grain	Straw	Grain	Straw	Grain	Straw
Cultivars						
Pusa Basmati 1121	44.6	40.3	17.9	11.0	26.7	142.8
Punjab Basmati 2	37.6	37.2	14.5	10.1	23.0	135.3
CD at 5%	2.4	2.1	1.0	0.6	1.4	7.3
Nitrogen levels (kg ha^{-1})						
T_1	36.0	34.1	13.2	8.7	21.1	123.4
T_2	36.9	35.8	14.2	9.2	21.9	130.4
T_3	41.4	38.7	16.4	10.4	25.1	137.9
T_4	42.2	39.9	16.7	10.7	25.5	142.8
T_5	44.7	41.1	18.1	11.7	27.4	146.3
T_6	45.4	42.8	18.9	12.2	28.0	153.4
CD at 5%	4.0	3.7	1.6	1.0	2.4	13.4
Interaction	NS	NS	NS	NS	NS	NS

Maximum organic carbon content (0.54%), available N (196.2 kg/ ha), available P (21.9 kg/ ha), available K (148.1 kg/ ha) was obtained in cultivar Pusa Basmati 1121 which was statistically at par with Punjab Basmati 2. The increase in organic carbon content may be attributed to the higher yields under these treatments and a positive relationship also exists between shoot and root weight therefore more production of root and their subsequent decomposition might have increased the organic carbon status of soil. These results are in agreement with the findings of Singh *et al* (2000a).

The organic carbon content, available P and available K status of the soil after the harvest of crop, did not vary significantly with varying nitrogen levels whereas the available N status of the soil varied significantly with varying nitrogen levels, its content was significantly more at 80 (3 splits; 0, 21, 65 DAS) kg N/ ha which was statistically at par with 80 (3 splits; 0, 15, 50 DAS) kg N/ ha but significantly more than 40 (3 splits; 0, 15, 50 DAS) kg N/ ha, 40 (3 splits; 0, 21, 65 DAS) kg N/ ha, 60 (3 splits; 0, 15, 50 DAS) kg N/ ha and 60 (3 splits; 0, 21, 65 DAS) kg N/ ha. However, interaction among different cultivars of basmati rice with levels of nitrogen found to be non-significant.

Nitrogen (N), Phosphorus (P) and Potassium (K) uptake by grain and straw

The uptake of nutrient is a function of various factors such as climate, soil properties, application of fertilizer, rate of increase in dry matter and varieties of rice plant. Nitrogen content (percent) in grain and straw multiply with their total yield in respective treatments gives total uptake. Amongst the cultivars, (Table 2) significantly higher values for N-uptake (44.6 kg/ ha and 40.3 kg/ ha), P-uptake (17.9 kg/ ha and 11.0 kg/ ha) and K-uptake (26.7 kg/ ha and 142.8 kg/ ha) of grain and straw were found in Pusa Basmati 1121 as compared to Punjab Basmati 2. The higher N uptake may be due to more biomass attained by Pusa Basmati 1121 as compared to Punjab Basmati 2 on account of its more DMA and tillering in grain. Ramarao (2004) reported that the partitioning of N and P was more towards reproductive structure while the partitioning of K was more towards the stem in all the cultivars under evaluation. Nitrogen, an integral part of different enzymes, proteins and chlorophyll etc; has been reported to increase the cell size and cell number. Nitrogen levels significantly influenced the uptake of nitrogen, phosphorus and potassium in grains. The maximum uptake of nitrogen, phosphorus and potassium in grains was obtained with 80 (3 splits; 0, 21, 65 DAS) kg N/ ha which was found statistically at par with 80 (3 splits; 0, 15, 50 DAS) kg N/ ha and 60 (3 splits; 0, 21, 65 DAS) kg N/ ha but significantly more than other nitrogen levels. Increased phosphorus uptake in grain with increasing nitrogen levels was also reported by Rao *et al* (2007). The increase in nutrient uptake was more probably due to improvement of soil environment, which encouraged the root proliferation that in turn drew more nutrients from larger area. Similar results were also reported by Singh *et al* (2000a). The application of nitrogen had a beneficial effect on phosphorus uptake by rice, which was mainly associated with increase in yield and greater exploitation of available pool of phosphorus from the soil (Majumdar *et al*, 2005).

Quality parameters and Sensory evaluation parameters

The data on quality parameters (hulled/brown, milled, head rice recovery, grain length: breadth ratio, minimum cooking time, water absorption ratio, elongation ratio, cooking coefficient, protein) and sensory evaluation parameters (aroma, cohesiveness, tenderness, colour, overall acceptability) presented in Table 3 indicated that Pusa Basmati 1121 gave higher brown rice recovery (76.3%), milled rice recovery (67.6%), head rice recovery (51.9%) and L:B ratio (4.42) than Punjab Basmati 2 (75.4%) with non-significant difference. The long super fine kernels often exhibit white belly resulting in breakage, which lowers the head rice out-turn (Rani and Krishnaiah, 2001). Among nitrogen levels, 80 (3 splits; 0, 21, 65 DAS) kg N ha^{-1} performed better and gave significantly higher brown rice (77%), milled rice recovery (69.2%) and L:B ratio (4.48). Similar results were recorded by Vikram *et al* (2018).

Similarly, the non-significant differences were observed amongst the cultivars and the different levels of nitrogen with respect to time required for cooking, water absorption ratio and cooking coefficient. Punjab Basmati 2 (13.27 min) took maximum time for gelatinization of starch followed by Pusa Basmati 1121 (13.26 min). The size and surface area of the grain of different cultivars might be responsible for raised difference in cooking time. In contrast to this, Pusa Basmati 1121 showed higher elongation ratio (1.69), cooking coefficient (5.25) and more water absorption (3.29) as it required more time for cooking followed by Punjab Basmati 2. Both cultivars were statistically at par with each other. High grain elongation during cooking is generally considered a characteristic property of basmati rice (Kamath *et al*, 2008). In addition to this, protein content in grains is one of the important characters to judge the quality of rice. The cultivars had non-significant effect on protein content. The protein content (6.8%) was recorded in both cultivars. Levels of nitrogen increased the protein content in grains and the differences were significant.

Simultaneously, the scores for sensory evaluation for cooked basmati rice grain are given in Table 3 which indicated that aromatic compound and their intensity was affected by cultivars and different levels of nitrogen. The cultivars showed significant differences with respect to aroma. Grains of Pusa Basmati 1121 showed significant higher aroma score (3.47), cohesiveness (3.49), tenderness (3.43), colour score than Punjab Basmati 2 but there was not much variation in aroma and colour score, cohesiveness of grains at different levels of nitrogen. Therefore, the overall acceptability score (Table 3) was the mean score for all sensory attributes which depicted that there was significant difference among cultivars and different levels of nitrogen. Amongst cultivar Pusa Basmati 1121 (3.51) have significantly higher acceptability than Punjab Basmati 2 (3.43). Amongst nitrogen levels 80 (3 splits; 0, 15, 50 DAS) kg N ha^{-1} and 80 (3 splits; 0, 21, 65 DAS) kg N/ ha

Table 3. Influence of nitrogen levels on quality parameters of DSBR cultivars.

Treatment	Hulled rice recovery (%)	Milled rice recovery (%)	Head rice recovery (%)	L:B ratio	Minimum cooking time	Water absorption ratio	Elongation ratio	Cooking coefficient	Protein	Aroma	Cohesiveness	Tenderness	Colour	Overall acceptability
Cultivars														
Pusa Basmati 1121	76.3	67.6	51.9	4.42	13.26	3.29	1.69	5.25	6.8	3.47	3.49	3.43	3.68	3.57
Punjab Basmati 2	75.4	67.4	51.7	4.32	13.27	3.15	1.63	5.14	6.8	3.36	3.38	3.37	3.62	3.51
CD at 5%	NS	NS	NS	NS	NS	0.63	0.61	0.74	NS	0.38	0.37	0.38	0.44	0.42
Nitrogen levels (kg ha^{-1})														
T_1	74.6	65.2	49.3	4.25	13.28	3.15	1.63	5.15	6.8	3.29	3.31	3.30	3.55	3.43
T_2	75.1	66.5	49.6	4.29	13.25	3.15	1.65	5.15	6.7	3.32	3.34	3.33	3.58	3.46
T_3	75.6	67.4	51.4	4.37	13.28	3.20	1.65	5.20	6.8	3.39	3.41	3.40	3.65	3.54
T_4	76.1	67.6	51.3	4.38	13.25	3.23	1.65	5.20	6.9	3.40	3.43	3.42	3.67	3.55
T_5	76.6	69.0	55.1	4.46	13.25	3.28	1.68	5.23	6.9	3.53	3.56	3.48	3.73	3.62
T_6	77.0	69.2	53.9	4.48	13.28	3.30	1.70	5.25	7.0	3.54	3.56	3.48	3.73	3.62
CD at 5%	0.9	0.8	0.6	NS	NS	0.68	0.39	NS	0.1	0.76	0.77	0.76	0.82	0.78
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

treatments showed maximum overall acceptability score (3.58). However, interaction among different cultivars of basmati rice with levels of nitrogen found to be non-significant.

CONCLUSION

It was concluded from the study that the nutrient uptake of rice in Pusa Basmati 1121 were found to be significantly better than Punjab Basmati 2. It was observed that 60 kg N ha^{-1} performed better over recommended 40 kg N/ha when applied in 3 splits (0, 21 and 65 DAS). The soil status after harvest of the soil revealed that there is non-significant difference in organic carbon, available P and K with varying nitrogen levels whereas the available N status of the soil varied significantly with varying nitrogen levels. Pusa Basmati 1121 was also better in quality than Punjab Basmati 2 as indicated by its higher hulled rice recovery, milled rice recovery, head rice recovery, grain L: B ratio, water absorption, elongation ratio and cooking co-efficient. The sensory evaluation parameters *viz.,* aroma, cohesiveness, tenderness, colour and overall acceptability were significantly better in Pusa Basmati 1121 than Punjab Basmati 2.

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Role of ICTs in transforming Agriculture as Perceived by Tribal Farmers in Southern Rajasthan

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ABSTRACT

The role of ICT in Agriculture is of paramount importance and facilitates transfer of agricultural information. Agriculture helps in empowering the rural people by providing better access to improved agricultural technologies, effective production strategies, markets, banking and financial services etc. This article explores the role of ICT in agricultural sector. The study was conducted on southern Rajasthan covering two districts i.e. Banswara and Dungarpur. The districts were selected on the basis of the availability of maximum facilities and infrastructures to promote ICT use. The empirical data were collected personally from 160 farmers through a pre-tested structured interview schedule and analyzed using standard methodology. The study revealed direct role of ICT in providing latest technological information about agriculture and allied fields. Live shows to get the first hand agricultural information, agricultural news for quick solution of farmers' problem, scientific package of practices of crops helped in timely decision making on matters related to agriculture and plant protection measures were the major roles of ICT as perceived by the farmers of Banswara and Dungarpur districts. The findings also indicated that there was no significant perceived difference in direct role of ICT tools in transfer of agricultural technology between the farmers of Banswara and Dungarpur districts.

Key Words: Dissemination, Information, Communication Technology (ICT), Transforming, Tribal Farmers.

INTRODUCTION

The present era is the era of information and communication technologies (ICTs). There are several ICT tools used in modern day for the dissemination of information. These are radio, television, mobile phone, internet, kisan call centre, touch screen computer, information kiosk, etc., which are capable of spreading the information to masses as fast as possible with less involvement of manpower. The process of information dissemination through these ICT tools is very cost-effective and time-saving. The advent of modern ICT tools has cut short the geographical distances of the people. The digitalization of the whole communication process from the source to the receiver by using ICT tools narrows down the physical barrier among the people throughout the world. In India, the use of various ICT tools in the dissemination of information is gaining its speed day by day through various public and private initiatives.

Information plays a vital role in empowering farmers to improve their livelihoods. Important information such as sowing, improving soils, seeking

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the best price for their produce and ways to combat pests and diseases all empower the farmer and their decision-making capabilities. Seasonal variability in weather patterns, deterioration of soil condition and sporadic climatic events such as drought, floods, pest and disease outbreaks complicate the decision-making process of the farmers and influences their information requirements. Providing such knowledge can be challenging as the information must be tailored specifically to distinct conditions. Given these challenges the arrival of ICTs is well timed.

ICTs has the abilities of reaching large number of people simultaneously, therefore have a greater role in the extension work. Extension services are required to improve agricultural productivity by providing farmers with requisite information helping them to optimize use of limited resources (Muyanga and Jayne, 2006; Singh *et al,* 2017). Worldwide agriculture has witnessed a shift in the past few decades and extension mechanism need to stay ahead and equip the farmers by enhancing their management and decision making skills (Singh *et al*. 2018; Singh *et al,* 2020a).

ICTs can broadcast the precise and authentic information at right time to the farmers so that they can utilize it and get benefits. The decision support system through ICTs facilitate farmers for planning type of crops, practising good agricultural practices for cultivating, harvesting, post harvesting and marketing their produce to get better results (USAID, 2010).Varied information is required in agriculture based on the different agro climatic regions, size of land holdings, types of crops cultivated, technology followed, market orientation, weather condition, etc. As reported by many researchers, question and answer service was perceived as the best facility by majority of the farmers to get personalized solutions to their specific agricultural problems (Meera *et al,* 2004). Keeping in view the above facts, the study was conducted with the objective the role of information and communication technology in transforming of agriculture as perceived by tribal farmers in Southern Rajasthan.

MATERIALS AND METHODS

The present study was conducted in Dungarpur and Banswara districts of Southern Rajasthan. The districts were purposively selected based on the availability of maximum number of facility centres for promoting use of ICT. The selection of tehsils was made on the basis of availability of maximum number of facility centres for promoting use of ICTs. Two tehsils from each district were selected for the purpose of investigation. Further, selection of two gram panchayats from each selected tehsil was made based on the availability of maximum number of facility centres for promoting use of ICT in identified gram panchayats. Thus, in total eight gram panchayats were included in the study sample. Again for selection of villages, two progressive villages from each selected gram panchayats were taken for inclusion in investigation. Thus, in all sixteen villages were taken for the study purpose. For selection of respondents, only those respondents who were using at least one of the ICT tools for seeking agricultural information were selected. Total ten respondents were selected from each identified village by random sampling technique, thus, making a sample of 160 respondents for the investigation purpose. The data was collected by a pre-tested structured interview schedule through personal interview method. To measure the role of ICTs in transforming agriculture, a suitable schedule was developed. The schedule consisted of 21 statements pertaining to roles of ICTs. To measure the degree of importance of roles, the responses were recorded on a three point continuum *viz.* most important, important and least important, which were assigned 3, 2 and 1 score respectively. The recorded responses were counted and converted into mean per cent score for each role and were ranked accordingly. The mean per cent score for each role was calculated by using the formula:

$$\text{Mean per score} = \frac{\text{Score obtained by the respondents}}{\text{Maximum obtainable score}} \times 100$$

Table 1. Role of ICTs in transformation of agriculture as perceived by tribals. n = 160

Sr. No.	Role of ICT	Banswara district		Dungarpur district		Total	
		MPS	Rank	MPS	Rank	MPS	Rank
1.	Weather forecast	55.4	VI	55.4	VII	55.4	VIII
2.	Scientific package of practices of crops	63.3	IV	62.0	V	62.7	V
3.	Market information	5.7	VII	50.4	IX	52.1	X
4.	Agricultural news	72.0	II	69.6	III	70.8	III
5.	Post harvest technology	36.2	XVII	38.3	XVI	37.3	XIX
6.	Input prices	52.0	VIII	49.6	X	50.8	XI
7.	Plant protection measures	63.3	IV	58.8	VI	61.0	VII
8.	Organic farming practices	44.5	XII	48.8	XI	46.7	XIV
9.	Value addition to farm products	34.1	XVIII	34.2	XIX	34.2	XXI
10.	Decision making on agricultural issues	59.1	V	51.7	VIII	55.2	IX
11.	Skill training	40.0	XV	37.1	XVII	38.5	XVIII
12.	Information on agricultural development programs and policies	46.6	XI	42.9	XIII	44.8	XV
13.	Latest technological information on agriculture and allied field	77.0	I	78.8	I	77.9	I
14.	Quick solution of farmers problem	68.7	III	64.6	IV	66.7	IV
15.	Live shows to get first hand agricultural information	72.0	II	72.9	II	72.5	II
16.	Qualitative and quantitative information on crops of the areas	42.9	XIII	40.4	XIV	41.7	XVI
17.	On farm communication	49.5	IX	49.6	X	49.6	XII
18.	Effective dialogues between experts and farmers for learning	48.3	X	45.4	XII	46.9	XIII
19.	Timely decision making on matters related to agriculture	59.2	V	64.6	IV	61.9	VI
20.	Profitable making of agricultural products	41.3	XIV	39.6	XV	40.4	XVII
21.	Sustainable agriculture production	37.9	XVI	36.3	XVIII	37.1	XX

MPS = Mean Per cent Score

$$\text{Mean percent Score} = \frac{\text{Score obtained by the respondents}}{\text{Maximum obtainable score}} \times 100$$

To find out the difference between the respondents of Banswara and Dungarpurn districts about the role of ICTs in transforming agriculture, 'Z' test was used and results were discussed accordingly. Open-ended response instead of closed-related responses were invited from the farmers in case of identifying the benefits and problems in using ICT in Southern Rajasthan. Descriptive statistics like frequency, percentage and ranking were used to analyze the raw data.

Table 2. Difference between the respondents of Banswara and Dungarpur districts with respect to role of ICTs in agricultural transformation.

Sr. No.	Category of respondent	Mean	S.D.	'Z' Value
1	Banswara district	33.54	5.58	0.839^{NS}
2	Dungarpur district	32.73	6.62	

NS: Non Significant

RESULTS AND DISCUSSION

Role of ICTs in transforming agriculture as perceived by tribal farmers

The results (Table 1) revealed that important roles of ICTs as perceived by tribal farmers in a chronological order. The latest technological information on agriculture and allied field was perceived as major role by 78% of the respondents in both the districts and was accorded with 1st rank with mean percent score (MPS) of (77% and 78.7%). The statement 'Live shows to get first hand agricultural information' was perceived as another major role of ICTs by (73%) of the respondents and was accorded 2nd rank. Similarly, agricultural news, quick solution of farmers problem, scientific package of practices of crops and timely decision making on matters related to agriculture showed most important direct roles with MPS of 70.8, 66.7, 62.7, and 61.9 and were placed at 3rd, 4th, 5th and 6threank respectively.

The other significant roles of ICT as expressed by tribals were; plant protection measures (61.0%), weather forecast (55.4%), decision making on agricultural issues (55.2%), market information (52.1%), input prices (50.8%), on farm communication (49.6%), effective dialogues between experts and farmers for learning (46.9%) and organic farming practices (46.7%) and these were ranked 7th, 8th, 9th, 10th 11th, 12th, 13th and 14th respectively.

The roles which were expressed with little less importance were; information on agricultural development programs and policies (44.8%), qualitative and quantitative information on crops of the areas (41.7%), profitable marketing of agricultural products (40.4%), skill training (38.5%), Post harvest technology (37.3%), Sustainable agriculture production (37.1%), and Value addition to farm products (34.2%) thus were placed at 15th, 16th, 17th, 18th, 19th, 20th and 21st respectively. The present findings were in line with the findings of Chhachhar *et al* (2008), Dhaka and Chayal (2010) and Chandra *et al* (2018).

Difference between the respondents of Banswara and Dungarpur districts with respect to perceived roles of ICT in transforming agriculture by tribals

Perusal of data (Table 2) show that calculated 'Z' value 0.839 was found to be less than the tabulated value. So the null hypothesis (NH_{01}) "There was no difference between the respondents of Banswara and Dungarpur districts regarding perceived roles of ICTs in agricultural transformation was accepted and research hypothesis (RH_1) was rejected. From the above results, it could be concluded that there was no significant difference in role of ICT among the respondents of Banswara and Dungarpur districts, as perceived by them. It means that respondents of both the districts expressed more or less similar roles played by ICTs in agricultural transformation in the study area.

Further, analysis of table revealed that non-significant difference was observed between the districts with respect to the roles of ICT. The mean value of the respondents of Banswara district about role of ICTs was little higher than the respondents of Dungarpur district, which indicates that farmers of Banswara district had perceived relatively more

Table 3. Benefits of using ICTs as perceived by the tribal farmers. n=160

Sr. No.	Benefits of Using ICT tools	Frequency	Per centage	Ranking
1	Easy access to information	147	91.87	I
2	Reliable and timely information	138	86.25	II
3	Time saving	127	79.38	III
4	Cost effective	121	75.63	IV
5	Timeliness in getting information	119	74.38	V
6	More coverage of subject matter	114	71.25	VI
7	Helping in making correct decisions	107	66.88	VII

roles played by ICT than the farmers of Dungarpur district. It might be due to the fact the farmers of Banswara district were more aware and explored the benefits of ICT more than the farmers of Dungarpur district. The present findings were in contradictory to the findings of Dhaka and Chayal (2010).

Benefits of ICTs as perceived by the tribal farmers

The benefits of using ICTs as perceived by the tribal farmers were identified as per order of merit (Table 3) and these were; easy access to information, cost-effective, timeliness in getting information, more coverage of subject matter, help in making correct decisions, time saving and reliable and timely information. ICT reduces the physical barrier of distance and helps in communicating the message in less time and cost without the involvement of huge manpower. The messages were mostly multimedia messages covering more subject matter in a very lucid manner which attracts the every sense of the receivers. The timely information on weather and market helps the farmers to decide their activities accordingly to minimize the losses and harvest as much profit as possible.

The above findings of the study regarding the benefits of using ICT tools as perceived by the farmers were in conformity with the findings of Dhaka and Chayal (2010), Shandhu *et al.* (2012) and Chandra *et al.* (2018). The promise of ICTs in agricultural extension is that they can energize the collection, processing, and transmission of data, resulting in a faster extension of quality information to more farmers in a bottom-up and interactive channel of communication (Singh, 2011).

Problems encountered by tribals in using ICTs

A perusal of data (Table 4) shows that majority of the farmers perceived high price of ICT tools as the main problem in using ICT services (85.63%), followed by lack of awareness of using ICT tools (80.63%), poor finance (79.38%), language barrier in comprehending ICT directed messages (76.88%), lack of skill in handling ICT tools (75%), low ICT literacy (72.50%), low network connectivity (70.63%), irregular power supply (67.50%), lack of confidence in operating ICTs (65.63%), insufficient ICT infrastructure (61.88%), lack of location-specific information (60%), and negative attitude towards ICTs (56.88%). ICT is not a new thing to the younger generation but it is a new thing to the older farmers who used to be habituated in traditional transfer of technology processes. They are not very much aware of using modern ICT tools. The proper use of ICT tools requires training which was found to be lacking on the farmer's part and this resulted in the lack of skill in using ICT tools. Sometimes ICT messages are sent in English and scientific languages which are hard to comprehend by the farmers. The messages which are spread by radio and television are sometimes very much general in nature which are not applicable to the local situation. Sometimes the poor farmer cannot afford to buy a good quality radio/television/mobile phone due to its high price. The common internet facility like village kiosks/ village cyber café is very

Table 4. Problems encountered by tribals in using ICT tools. **n=160**

Sr. No.	Problems of Using ICT tools	Frequency	Per centage	Ranking
1	High price of ICT tools	137	85.63	I
2	Lack of awareness of using ICT tools	129	80.63	II
3	Poor Finance	127	79.38	III
4	Language barrier	123	76.88	IV
5	Lack of skill in handling ICT tools	120	75.00	V
6	Low ICT literacy	116	72.50	VI
7	Low Network connectivity	113	70.63	VII
8	Irregular/ Erratic power supply	108	67.50	VIII
9	Lack of confidence in operating ICTs	105	65.63	IX
10	Insufficient ICT infrastructure	99	61.88	X
11	Lack of location specific information	96	60.00	XI
12	Negative attitude towards ICTs	91	56.88	XII

rare to find at hill villages. There are a huge signal and tower problem reported in villages which are geographically isolated. The problem in catching signal and tower makes the ICT tools like radio, television, and mobile inoperative in those villages.

The above findings of the study regarding the problems of using ICT tools as perceived by the farmers were in line with the findings of Singh *et al* (2008),Dhaka and Chayal (2010), Sharma *et al* (2014) and Chandra *et al* (2018) who reported in their study that role of helpline services in technology dissemination was poor connectivity, lack of awareness among farmers and incomprehensible technical information provided through helpline services were perceived as constraints in effective on-line information dissemination to the farmers.

CONCLUSION

The results of the study concluded that the role ICTs in transformation agriculture is tremendous as expressed by tribal respondents. The framers perceived latest technological information and observed live shows to get the first hand information. Further another role perceived by tribals was agricultural news which fulfilled their information need. Considering the significant roles played by ICTs, it is suggested that the use of ICTs the promoted in the study area so as to minimize the information gap and to fulfil the information needs of the farmers.

It was further inferred that easy access to information is the main benefits of using ICT tools and reliable & timely information and high price of ICT tools and lack of awareness is the major problems of using ICT tools as perceived by the farmers of Banswara and Dungarpur districts.

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Root Biomass and Phosphorus Availability as influenced by Soil Salinity, Phosphorus Sources and Biofertilizers in Cowpea (*Vigna unguiculata* L.)

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ABSTRACT

A pot experiment was conducted at S.K.N. College of Agriculture, Jobner using cowpea crop to determine root biomass and phosphorus availability as influenced by soil salinity, phosphorus sources and biofertilizers in cowpea (*Vigna unguiculata* L.) during *kharif* 2015. The experiment included soil salinity (three levels of EC *i.e.,* 1.22, 4.0 and 6.0 dS/m), phosphorus sources (SSP, DAP and PROM), and biofertilizers (control, PSB and PSB + VAM) laid out in completely randomized design replicated thrice. The results showed that soil salinity S_1 (EC 1.22 dS/m) recorded highest root biomass (0.643 g/pot), phosphorus content in both roots (0.246 %) and soil (0.032%) over S_4 and S_6. Results further revealed that phosphorus rich organic manure (P_3) obtained significantly higher root biomass (0.636 g/pot), phosphorus content in both roots (0.240 %) and soil (0.033 %) over P_1 and P_2. Seed inoculation with PSB + VAM (B_2) gave significantly higher root biomass (0.684 g/pot), phosphorus content in both root (0.243%) and soil (0.032%) over B_0 and B_1. Among different combinations, application of phosphorus rich organic manure and biofertilizers (PSB+VAM) under normal water (EC 1.22 dS/m) proved better root biomass and phosphorus availability in the soil.

Key Words: Biofertilizers, Cowpea, Phosphorus, Root Biomass, Salinity.

INTRODUCTION

Cowpea is *kharif* pulse crops grown for vegetable, grain, forage and green manuring. Cowpea has great importance because of high yielding, short duration and quick growing varieties available. Green tender pods of cowpea are used as vegetable purpose. Cowpea pods contain protein (4.3%), moisture (84.6%), fat (0.2%) and carbohydrate (8.0%). In major portion of arid and semi-arid regions poor quality groundwater is used as a source of irrigation. The continuous use of poor quality irrigation water creates salinity or sodicity problems in soil. The problem is noted in the areas where scarcity of good quality water and use saline / sodic ground water as a major source of irrigation. Salt affected soils have an area of about 13.8 M ha in the country (Yadav *et al,* 2007) and 1.24 M ha in Rajasthan and found in almost all the district of Rajasthan (Sharma *et al,* 2004). Physical and chemical properties of irrigated soils adversely affect and cause accumulation of soluble salts in the root zone further unscientific and indiscriminate usages of saline water for irrigation reduce crop productivity (Chauhan *et al,* 1988). Phosphorus is most essential nutrient for pulse crop and very significant nutrient next only to nitrogen for the plant growth and development. It is a constituent of amino acids, phosphatides, proteins, nucleic acids,

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Table 1. Different salts and their ionic composition added in base for creating different salinities.

EC (dS/m)	mmol/kg					Final ECe (dS/m)
	Na^{+}	Ca^{+2}	Mg^{+2}	Cl^{-}	SO_4^{-2}	
1.00	9.6	1.2	1.2	2.2	6.0	1.22
4.00	16.6	5.6	5.6	7.8	24.0	4.14
6.00	25.6	11.2	11.2	1.28	39.0	6.10

phytin and several co-enzymes *viz*., pyrophosphate, thiamine and pyrodoxyl phosphate (Yadav *et al,* 2009). Vesicular arbuscular mycorrhiza can play a vital role in improving availability of phosphorus to plant in P deficient soils and reduce P-fertilizer application by about 25-30%. It is well recognized that VAM fungi improve growth and development of plant through increased availability of relatively immobile nutrients to the plants such as phosphorus and zinc (Tarafdar and Rao, 1997). The phosphate solubilizing bacteria (PSB) are heterotrophic and aerobic in character and it can solubilize nearly 20-30% of insoluble phosphate from the fixation sites (Tilak and Annapurna, 1993). An effort was consequently made to experiment the phosphorus availability under different levels that are soil salinity, phosphorus sources and biofertilizers to discover the effect of phosphorus availability and root biomass of cowpea.

MATERIALS AND METHODS

A pot trial was conducted at Department of Plant Physiology, College of Agriculture, Jobner during 2015 in cage house in completely randomized design (CRD) with three replications in which three salinity levels (S_1: 1.22, S_4: 4.0 and S_6: 6.0 dS/m), phosphorus sources (P_1: SSP, P_2: DAP and P_3: PROM) and biofertilizers levels (B_0: control, B_1: PSB and B_2:PSB + VAM) are used and by this means, making nine combinations of treatments with three replications. The physico-chemical properties of experimental soil were bulk density (1.51 Mg/m^3), particle density (2.59 Mg/m^3), Na (9.50 me/L), Ca (1.2 me/L), Mg (1.2 me/L), CEC (7.8 cmol (P^+) kg/soil), exchangeable Na (0.65 cmol/kg) and ESP (9.55 %). To attain the ECe level of 4 and 6 dS/m Cl^- and SO_4^{-2} of Na, Ca and Mg were added as solution keeping the ratio of 3:1 of Cl^- : SO_4^{-2} and thoroughly mix in the soil before seeding (Table 1). The experimental soil consist pH (8.40), organic carbon (1.83 g/kg), nitrogen (127.10 kg/ha), phosphorus (21.24 kg P_2O_5/ha) and potassium (147.50 kg K_2O/ha) before the sowing of cowpea. Cylindrical ceramic pots (28 cm height and 20 cm diameter) were filled with 10 kg of soil before the sowing. During filling the pots, the broken pieces of stone were placed in the bottom hole to allow free drainage of water. The variety 'RC-19' of cowpea was sown on 7th July, 2015 with sowing of 5 seeds per pot. Following the physiological maturity, harvested the cowpea on 15th September, 2015. After the harvest of crop the roots were removed and weighed on electronic balance for the calculation of total root mass per pot. Total soil phosphorus was determined by $HClO_4$ digestion (Jackson, 1973) Olsen's method and available phosphorus by colorimetrically extracting the soil with 0.5N $NaHCO_3$ at pH 8.5 (Olsen *et al,* 1954). For microbial biomass phosphorus (P mic) soil samples were fumigated with liquid ethanol free chloroform ($CHCl_3$) in desiccators (Srivastava and Singh, 1988).

RESULTS AND DISCUSSION

Effect of soil salinity

A perusal of results revealed that root biomass of cowpea was decreased significantly ($P<0.05$) with higher levels of salinity (Table 2). Root biomass were decreased significantly up to 11.50 and 17.88 per cent under S_4 and S_6 treatments over S_1 (normal soil), respectively. Higher soil salinity levels reduced nutrient availability due to fixation

Table 2. Effect of salinity, phosphorus sources and biofertilizers on root biomass, P content in roots, total P, available P_2O_5 and microbial biomass P in soil

Treatments	Root biomass (g/pot)	P content in roots (%)	Total P content (%)	Available P_2O_5 (kg/ha)	Microbial biomass P (µg/g soil)		
					Month I	Month II	At harvest
Salinity							
S_1	0.643	0.246	0.032	22.07	28.71	25.87	21.89
S_4	0.569	0.235	0.028	21.43	26.32	23.54	19.61
S_6	0.528	0.217	0.025	20.74	22.23	20.70	16.64
SEm. ±	0.008	0.004	0.0004	0.28	0.51	0.38	0.35
C.D.(P=0.05)	0.021	0.012	0.0011	0.80	1.43	1.08	1.00
Phosphorus							
P_1	0.535	0.221	0.024	20.75	22.36	20.94	16.78
P_2	0.569	0.236	0.029	21.47	26.20	23.40	19.51
P_3	0.636	0.240	0.033	22.02	28.70	25.77	21.86
S. Em. ±	0.008	0.004	0.0004	0.28	0.51	0.38	0.35
C.D.(P=0.05)	0.021	0.012	0.0011	0.80	1.43	1.08	1.00
Biofertilizers							
B_0	0.520	0.217	0.026	20.75	22.31	20.88	16.85
B_1	0.572	0.237	0.029	21.46	26.29	23.35	19.30
B_2	0.648	0.243	0.032	22.03	28.66	25.88	21.99
S. Em. ±	0.008	0.004	0.0004	0.28	0.51	0.38	0.35
C.D.(P=0.05)	0.021	0.012	0.0011	0.80	1.43	1.08	1.00

and transformation of nutrients in soils and affect with the absorption and uptake of nutrients due to water stress by disproportionate ionic composition have reduced nutrient metabolisms mainly which cause poor plant root growth and development (Shrinivasrao *et al,* 2004). An examination of results revealed that total phosphorus, available P_2O_5 content in soil were decreased significantly ($P<0.05$) under at higher salinity levels (Table 2). In S_4 and S_6 total P were decreased up to 12.50 and 21.87 per cent in soil to over S_1 (Normal soil), respectively. The result further revealed that per cent decrease in available P_2O_5 up to 2.98 and 6.41 under treatment S_4 and S_6 over S_1, respectively in the soil (Table 2). Higher levels of soil salinity significantly ($P<0.05$) decreased the microbial biomass P with development of growth stages (Table 2). The microbial biomass P decreased up to 8.32 and 22.57 per cent under S_4 and S_6 over normal soil at the time of one month growth stage, respectively. The subsequent decrease was 9.00 and 19.98 per cent at second month growth stage and it was 10.41 and 23.98 per cent at the time of harvest. Decreased in availability of phosphorus might be due to higher saline conditions in soil and this magnitude of decrease in phosphorus was more prominent in Ca dominated soil than the Na dominated soil. This might due to the accumulation of toxic ion in soil (Rao *et al,* 1993).

The results clear that phosphorus content in root biomass of cowpea was decreased significantly ($P<0.05$) with higher levels of soil salinity (Table 2). The highest decreased in P content in root biomass was observed under S_6 treatment and it was

Table 3. Effect of salinity, phosphorus sources and biofertilizers on calcium, sodium and magnesium content in grain and straw of cowpea

Treatments	Ca content (%)		Na content (%)		Mg content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Salinity						
S_1	0.216	0.617	0.250	0.264	0.124	0.079
S_4	0.227	0.639	0.254	0.273	0.128	0.084
S_6	0.255	0.739	0.265	0.284	0.085	0.085
SEm. ±	0.003	0.008	NS	NS	0.002	0.002
C.D.(P=0.05)	0.008	0.023	0.012	0.019	NS	NS
Phosphorus sources						
P_1	0.216	0.619	0.289	0.294	0.125	0.080
P_2	0.232	0.642	0.255	0.283	0.127	0.083
P_3	0.249	0.735	0.234	0.248	0.128	0.084
S. Em. ±	0.003	0.008	0.004	0.007	0.002	0.002
C.D.(P=0.05)	0.008	0.023	0.012	0.019	NS	NS
Biofertilizers						
B_0	0.217	0.612	0.284	0.298	0.121	0.079
B_1	0.232	0.648	0.256	0.272	0.129	0.083
B_2	0.248	0.735	0.239	0.256	0.130	0.084
S. Em. ±	0.003	0.008	0.004	0.007	0.002	0.002
C.D.(P=0.05)	0.008	0.023	0.012	0.019	NS	NS

lower by 4.47 and 11.78 per cent in root biomass respectively in comparison to S_4 and S_1. A data pertaining to P content in grain and straw of cowpea show that P content reduced significantly with higher soil salinity levels (Fig.1). The P content was decreased under treatment S_4 and S_6 up to 20.87 and 28.66 per cent in grain and 8.49 and 16.33 per cent in straw respectively as compared to S_1. This reduction in phosphorus might be due to synergism effect between PO_4^{3-} and SO_4^{2-} and antagonism effect between PO_4^{3-} and Cl^- ions. Antagonism effect between Cl^- and P also find out in wheat (Manchanda *et al,* 1991). Further experimental results show that Ca content in grain and straw of cowpea increased significantly (P<0.05) under higher soil salinity level (Table 3). An improvement in Ca content in grain was recorded up to 12.33 and 18.05 per cent and in straw 15.64 and 19.77 per cent due to S_6 over the rest of the treatments, respectively. The effect of soil salinity treatment on both Na and Mg was observed non significant in the grain and straw of cowpea (Table 3). This may be due to Ca absorption in Cl^- salinity and SO_4^{2-} salinity because of activity of Ca reduce and activity of Cl in later higher and also reduced Ca absorption in SO_4^{2-}dominated salinity may have improved Mg absorption in to the soil (Manchanda *et al*.1991). These results were in accordance with the findings of Virdiya *et al* (2008) who reported improvement in Ca, Mg and Na, content in plant with higher soil salinity levels.

Effect of phosphorus sources

The results revealed that root biomass of cowpea was significantly (P<0.05) increased under the application of phosphorus rich organic manure (PROM) over SSP and DAP (Table 2). The soil amendment with PROM significantly improves root biomass by 11.77 and 18.87 per cent over the other treatments, respectively. This could be attributing higher uptake of nutrients enhance carbohydrate synthesis and photosynthetic and then translocations to different parts inter calary meristems for improving meristematic development in apical buds and which at the end improved root growth of the plant (Sharma *et al,* 2001; Shekhawat and Sharma, 2001). The results showed that different phosphorus sources significantly ($P<0.05$) improved the total P content, available P_2O_5 and microbial biomass P in soil (Table 2). The increment in total P content was up to 13.79 and 37.50 per cent under application of PROM over DAP and SSP, respectively. The available P_2O_5 in soil was recorded up to 2.56 and 6.12 per cent higher under the application of PROM over DAP and SSP (Table 2). Further result showed that application of phosphorus as PROM also improve the microbial biomass phosphorus by 9.54 and 28.35 per cent over the rest of the treatments at one month growth stage, respectively. The consequent improvement was 10.12 and 23.06 per cent at second month growth stage and 12.04 and 30.27 per cent at the time of harvest stage over DAP and SSP. During the decomposition of organic matter released organic acids like acetic acid, formic acid, citric acid, oxalic acid and these organic acids turn unavailable phosphate into available phosphate form (Kumawat *el al,* 2013) and significantly improved the available P in soil compared to other treatments. It provided substances important for microbial activity and growth, which was responsible for improvement in soil microbial biomass P in the soil. Similar findings also reported by Majumdar *et al* (2007) and Mahanta and Rai (2008).

The experimental data showed that phosphorus content in root biomass of cowpea significantly ($P<0.05$) increased under the different sources of P (Table 2). The highest P content in root biomass was significantly increased up to 8.56 per cent under application of PROM over SSP and remained at par with DAP, respectively. Different phosphorus sources have positive result on the phosphorus content in grain and straw of cowpea, in which, under PROM recorded a significant increase in grain up to 46.20 and 69.02 per cent and in straw up to 10.71 and 22.04 per cent over the remaining treatments (Fig.1). The greater availability of nutrients enhanced the plant root system which resulted in greater P accumulation in the crop (Basak and Subodh, 2002). The data indicated that application of PROM significantly ($P<0.05$) improved Ca content in grain and straw of cowpea (Table 3). An increment in Ca content under PROM application in grain and straw was recorded up to 7.36 and 15.27 and 14.48 and 18.73 per cent over DAP and SSP, respectively. Further Na content in cowpea grain and straw tend to decreased significantly ($P<0.05$) under PROM application as phosphorus sources (Table 3). The decrement in Na content in grain and straw was obtained under PROM application and it was lower in grain by 11.77 and 19.04 per cent and in straw was lower by 3.75 and 15.63 per cent over rest of the treatments. Phosphorus sources were obtained non significant in Mg content in grain and straw of cowpea (Table 3). Cation like Ca, K and Mg content in grain and straw increased at the same time, whereas Na cation decreased significantly under PROM application. The Na+ ion counters with soil-P and get fix in insoluble form (Na-phosphate) in the soil so that Na availability reduced to plant with higher levels of phosphorus. A decrease in Na absorption occur by plants ultimately Ca, Mg content increase and Na^+ cation may also replace by $H_2PO_4^-$ anion from exchangeable site so that Na content reduced in grain and straw Yadav and Jakhar (2001) .

Effect of biofertilizers

The root biomass of cowpea significantly ($P<0.05$) increased under the dual inoculation of PSB+VAM (Table 2). Root biomass was increased significantly up to 13.28 and 24.11 % under PSB+VAM over PSB and control, respectively. This might be due to the VAM had favorable effect on the root establishment and development so that P availability enhanced in soil. In other words better root environment by PSB + VAM besides secretion

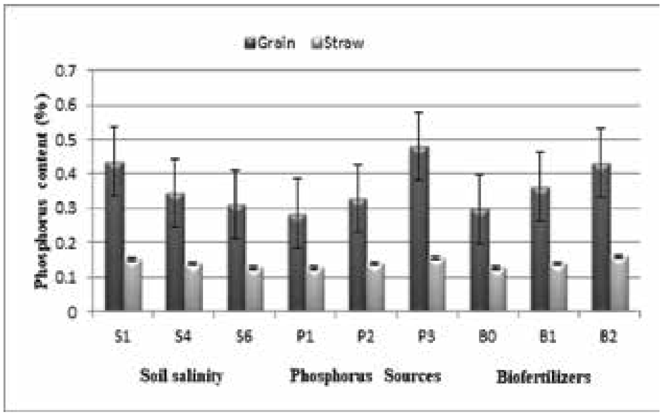

Fig. 1 Effect of salinity, phosphorus sources and biofertilizers on phosphorus content in grain and straw of cowpea

of growth promoting substances like auxins, Cytokinin etc. and improved the availability of phosphorus (Totawat *et al*. 2000). Moreover total P content, available P_2O_5 and microbial biomass P were found significantly ($P<0.05$) superior under dual inoculation of PSB +VAM in soil over rest of the treatments (Table 2). Total P increased up to 10.34 and 23.07 % under PSB+VAM, respectively over PSB alone and no inoculation. Seed inoculated with PSB and soil inoculated with VAM (PSB+VAM) significantly ($P<0.05$) recorded the maximum available P_2O_5 up to 2.64 and 6.16 per cent in soil over the other treatments, over PSB and no inoculation, respectively. The microbial biomass P increased significantly ($P<0.05$) biofertilizers over no inoculation at all growth stages and further decreased at later crop growth stages. Microbial biomass P increased up to 9.01 and 28.46 per cent under PSB alone and PSB + VAM over control at one month growth stage, respectively. The equivalent increase at second month growth stage was 10.83 and 23.94 per cent and at the time of harvest stage was 13.93 and 30.50 per cent. The available phosphorus content in soil increase due to stimulate the microbial activity in soil and after decaying of their bodies in soil by the phosphorus solubilizing bacteria. Highest soil microbial biomass P in soil was found under dual inoculation of PSB+VAM and lowest in soil under control (no inoculation). A similar finding in SMB-P with application of PSB+VAM was also recorde by Saini *et al* (2005) and Singh *et al* (2012).

Data explained that dual inoculation of PSB+VAM significantly increased P content in root biomass of cowpea (Table 2). The highest biomass was observed under PSB+VAM, which remained at par with PSB and 11.98 per cent higher over control, respectively. Further results indicated that biofertilizers significant increased phosphorus content in grain and straw of cowpea (Fig.1). The highest phosphorus content in grain and straw were observed under application of PSB+VAM and noted an increment in grain up to 19.33 and 44.96 per cent and in straw up to 13.66 and 26.40 per cent, respectively over rest of the treatments. It might be due to improvement in root growth by the increased in availability of P under PSB + VAM besides secretion of growth promoting substances (Totawat *et al,* 2000). Combined effect different organisms and solubilization effect of two or more organisms improved phosphorus content by the PSB or better phosphorus uptake under VAM applied pots was also reported by Rao (1998), Tarafdar and Rao (1997) and Saini *et al* (2005). It is obvious from the data that inoculation with biofertilizers Ca content increased significantly ($P<0.05$) in grain and straw of cowpea (Table 3). An improvement in Ca content in grain was recorded by 6.89 and 14.28 per cent and in straw was 13.42 and 20 .09 per cent due to inoculation of PSB+VAM over the other treatments, respectively. Further that the significantly ($P<0.05$) lower Na content was observed under cowpea grain inoculated with PSB and soil inoculated with VAM produced in grain and straw over rest of the treatments. Application of PSB+VAM was recorded lowest value of Na content in grain and straw of cowpea and it was lower up to 9.85 and 18.82 per cent in grain and 8.73 and 14.11 per cent in straw over rest of the treatments. The Mg content in grain and straw was found to be non significant biofertilizers (Table 3). Application of biofertilizers increase Ca^{2+} and Mg^{2+} content and decreased Na^{+}

content be due to improve in phosphorus availability by the increase in phosphorus availability from fixed phosphate and then Na which counters with soil-P and get fixed in their unavailable form (Na-phosphate) become very less available to plant and higher Ca and Mg availability. These findings also find out by Parsad *et al* (2012).

CONCLUSION

Application of PROM and PSB+VAM increased the phosphorus content in grain and straw indicated that phosphorus fertilization with PSB+VAM mitigates the adverse effect of soil salinity by inducing tolerance to salinity in the crop. This showed that salinity tolerance in cowpea could possibly be enhanced to some extent by application of PROM as source of phosphorus along with inoculation of PSB + VAM.

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Scale to Measure Working Self-Confidence of Youth to Adopt Dairy Farming as an Occupation

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ABSTRACT

To find out the gap between existing and advisable working self-confidence to adopt dairy farming as a dependable occupation, it is necessary to have the tool to measure it. Thus, a scale to measure working self-confidence of youth to adopt dairy farming was developed using "Scale Product Method' which is a combination of Thurston's technique of Equal Appearing Interval Scale for an assortment of the statements and Likert's method of summated rating for determining the response on the scale. A provisional list of 33 statements was prepared to keep in view the applicability of statements matched with the topic of study. The collected statements were edited as per the suggested standard. The score of each individual item on the scale was calculated by summing up the weightage of the individual items. The Median or Scale and Q values were found out by using Thurston and Chave inter-quartile range. Finally, 10 statements where median (scale) values greater than Q values were selected. However, when a few statements had the same scale values, statements with the lowest Q value were chosen by arranging the scale value in order. Reliability was tested with 20 farmers and its value was 0.88 and validity of the scale was examined. After measuring the working self-confidence to be a successful dairy farmer with the ten selected statements, it was concluded that majority (95.50 %) of the dairy farmers' sons had a very high level of the overall operational or working self-confidence to be a successful dairy farmer.

Key Words: Scale, Dairy Farming, Working Self Confidence.

INTRODUCTION

Animal Husbandry contributes significantly to the socio-economic development of our country. It plays a considerable role in supplementing family incomes and generating employment in the rural sector. However, nowadays availability of the required vigorous practicable self-confident human resource for managing dairy farming for a sustainable future of animal husbandry is a big problem experienced by the planners, trainers and policymakers concerned in the expansion of rural India. It is expected that practising farmers' sons should be encouraged to develop working self-confidence to adopt dairy farming as a permanent occupation. The working self-confidence is a feeling of dependence on own abilities, qualities and judgement to perform various work and activities needed to be a successful human resource of animal husbandry occupation. To find out the gap between existing and advisable working self-confidence to adopt dairy farming as a dependable occupation, it was necessary to have the tool to measure it. There was no such tool available earlier, realizing this, a scale to measure the working self-confidence of youth to adopt dairy farming was developed.

MATERIALS AND METHODS

Among the methods available for the construction of the scale, the "Scale Product Method' which is a combination of Thurstone's

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Table 1. Calculation of S values and Q values to Measure Working Self-Confidence of Youth to Adopt Dairy Farming as an Occupation.

Sr. No	Statement	Scale Value	Quartile Value	Decision
1	I am confident in my working ability to manage dairy farming.	1.4	1.062	**Selected**
2	I have the expertise to select the ideal breed of milch animals.	1.5	1.154	**Selected**
3	I can recognize symptoms of heat in dairy animals.	1.6	1.610	Rejected
4	I can select an ideal bull for the reproduction of dairy animals.	1.8	1.267	Rejected
5	I enjoy offering water to our dairy animals.	2.1	1.538	**Selected**
6	I know how to feed milch animals.	1.7	1.104	Rejected
7	I have the ability to use a chaff cutter.	1.7	1.208	Rejected
8	I get pleasure cleaning animal shed.	1.8	1.234	Rejected
9	I enjoy cleaning milch animals.	1.9	1.047	**Selected**
10	I know milking dairy animals.	1.5	1.194	Rejected
11	I know growing all season green fodder for dairy animals.	1.7	1.190	Rejected
12	I enjoy grazing dairy animals.	2.1	1.967	Rejected
13	I feel self-reliant in adopting dairy farming permanently.	2.2	1.738	**Selected**
14	I am familiar with butter-milk making procedure.	1.9	1.241	Rejected
15	I enjoy offering daily roughage to dairy animals.	2.0	1.122	Rejected
16	I like giving daily green fodder to dairy animals.	1.9	1.067	Rejected
17	I know the ideal time for colostrums feeding to a newborn calf.	1.4	1.069	Rejected
18	I am confident in maintaining cattle during pregnancy.	1.6	1.043	**Selected**
19	I am confident in managing the health of dairy animals.	1.8	0.987	**Selected**
20	I am able to buy ideal concentrate for dairy animals.	1.7	1.023	**Selected**
21	I can prepare urea treated straw for dairy animals.	1.8	1.234	Rejected
22	I can diagnose the illness of dairy animals.	1.6	1.248	Rejected
23	I know giving first aid treatment to dairy animals.	1.6	1.190	Rejected
24	I can handle the successful marketing of dairy products.	2.0	0.788	**Selected**
25	I am able to maintain the milk production record of dairy animals.	1.5	1.238	Rejected
26	I know cleaning newborn calves of our dairy animals.	1.7	1.082	Rejected
27	I know the schedule of vaccination in milch animals.	1.5	1.286	Rejected
28	I have ability of profitable ways of milk selling.	1.4	1.120	Rejected
29	I participate in dairy milk cooperative of my village.	1.7	1.104	Rejected

30	I am familiar with different schemes related to dairy farming.	1.8	1.197	Rejected
31	I know rearing of calves of dairy animals.	1.7	1.028	Rejected
32	I can start animal husbandry occupation on my own ability.	1.4	1.155	Rejected
33	I have the practical ability needed to be a successful dairy farmer.	1.3	1.097	**Selected**

method of equal appearing interval scale to choose the perfect items and Likert's method of summated rating for ascertaining the response on the scale as proposed by Eysenck and Crown (1949) was used. The procedures adopted by Gulkari and Chauhan (2014), Patel and Chauhan (2015), Khatri and Chauhan (2018) and Tankodara and Chauhan (2021) were utilized.

Item collection: As a first step in budding the scale, 33 statements were collected from the appropriate literature, learning from the academicians, researchers and extension educators. The chosen statements were corrected using the standard procedure advocated by Thurstone and Chave (1928), Wang (1932), Likert (1932) and Edward and Kilpatrick (1948) before sending them for the judgement.

Judge's rating: To decide the degree of acceptance or agreement to rejection or disagreement of each statement on the five-point equal appearing interval continuum, a team of 50 judges was selected. The judges selected for the study were extension educators, experts from Veterinary College of Anand Agricultural University and economists as well as the statisticians from different State Agricultural Universities. The judges were contacted with a letter of instructions to guide for rating each statement in the desired manner. The selected judges were requested to give their responses, whether each of the listed statements should be included in scale to measure the working self-confidence to be a successful dairy farmer or not.

Determination of Median or Scale and Quartile Values: The five points of the rating scale were assigned, ranging from 1 for the most rejection or most disagreement and 5 for most approval or most agreement. On the base of judgment, the Median Value or Scale Value of the distribution and the Quartile Values for the statement concerned were worked out, the interquartile range for each statement was also worked out for determination of ambiguity involved in the statement from the following formulas.

Where,

S = The Median or Scale value of the statement

L = Lower limit of the interval in which the Median (50th centile) falls

ΣPb = The sum of proportion below interval in which Median (50th centile) falls

Pw = The proportion within the interval in which Median (50th centile) falls

i = The width of the interval and is assumed to be equal to 1.0

Thurstone and Chave (Edwards, 1957) used the inter-quartile range Q as a means of the variation of the distribution of the judgments for a given statement. To determine the value of Q, two other points viz. the 75th centile and 25th centile were calculated using the following formulas.

The 25th centile value was obtained by the following formula

Where,

= The 25th centile value of the statement

L = Lower limit of the interval in which the 25th centile falls

= The sum of proportion below interval in which 25th centile falls

Table 2. Final selected statements to measure Working Self-Confidence of Youth to Adopt Dairy Farming as an Occupation

No.	Statements	SA	A	UD	DA	SDA
1	I am confident in my working ability to manage dairy farming.					
2	I have the practical ability needed to be a successful dairy farmer.					
3	I feel self-reliant in adopting dairy farming permanently.					
4	I have the expertise to select the ideal breed of milch animals.					
5	I am confident in maintaining cattle during pregnancy.					
6	I am able to buy ideal concentrate for dairy animals.					
7	I am confident in managing the health of dairy animals.					
8	I enjoy offering water to our dairy animals.					
9	I enjoy cleaning milch animals.					
10	I can handle successful marketing of dairy products.					

= The proportion within the interval in which 25th centile falls

i = The width of the interval and is assumed to be equal to 1.0

The 75th centile value was obtained by the following formula

Where,

= The 75th centile value of the statement

L = Lower limit of the interval in which the 75th centile falls

= The sum of proportion below interval in which 75th centile falls

= The proportion within the interval in which 75th centile falls

i = The width of the interval and is assumed to be equal to 1.0

Then the inter quartile range or Q value was calculated by - .

Statements or Items for final scale : When there was a good agreement among the judges, in judging the degree of agreement or disagreement of a statement, values of Q was noticed smaller as compared to the S values, when there was relatively low agreement among the judges it was reverse. Only those statements were selected, whose Median values (S value) were greater than Q values. However, when a few items had the same scale values, items having the lowest Q values were selected as advocated by (Thurstone, 1946). Based on the Median and Q values, 10 statements were finally selected to constitute scale.

Reliability of the scale : The split-half method of testing reliability was used. The 10 statements were divided into two halves with five odd-numbered in one half and the other five even-numbered statements in the other half. These were administered to 20 farmers. Each of the two sets of the statements was treated as a separate scale and then these two subscales were correlated. The coefficient of reliability was calculated by Rulon's formula (Guilford, 1954), which was 0.80. The reliability coefficient has been calculated as the value of half size of the original scale. Thus, correction factor was calculated by using the Spearman-Brown formula as applied by (Naveenkumar and Chauhan, 2020) and Tankodara and Chauhan (2021) as mentioned below.

rtt= Coefficient of reliability of original test

roe= reliability of coefficient of odd and even score

The coefficient of reliability was calculated by the Spearman-Brown formula which came to be 0.88. Thus, the scale developed has been found highly reliable.

Table 3. Per cent of dairy farmers' son according to their working self confidence.

No.	Overall self working confidence	Number	Per cent
1	Very low (Up to 10 score)	00	00.00
2	Low (above 10 to 20 score)	00	00.00
3	Medium (above 20 to 30 score)	00	00.00
4	High (above 30 to 40 score)	09	04.50
5	Very high (above 40 to 50 score)	191	95.50

Content validity of the scale: The content validity of the scale was examined through discussion with specialists, extension academicians and statisticians. It was concluded that the present scale satisfied content validity.

Scoring system: The finally selected 10 statements for the final format of the scale were randomly arranged to avoid response biases, which might contribute to low reliability and detraction from the validity of the scale. The responses can be collected on five points continuums *viz.,* strongly agree, agree, undecided, disagree and strongly disagree with respective weights of 5, 4, 3, 2, and 1 for the favourable statements and with the respective weights of 1, 2, 3, 4 and 5 for the unfavourable statements. The working self-confidence to adopt the dairy farming score of each respondent can be calculated by adding the scores of all the ten statements.

The final scale was called to be the standardized one which contains 10 statements. The scale developed to measure the working self-confidence of youth to adopt dairy farming as an occupation, where responses have to be recorded on a five-point continuum as mentioned earlier. This statements were used in interview schedule and measured the working self confidence of 200 dairy farmers.

RESULTS AND DISCUSSION

It can be seen from Table 3 that the overwhelming majority (95.50 %) of the dairy farmers sons had a very high level of the overall operational or working self-confidence to be a successful dairy farmer, followed by 4.50 per cent of them were with the high level of the overall operational or working self-confidence to be a successful dairy farmer, while none of them was with a very low, low or medium level of the overall operational or working self-confidence to be a successful dairy farmer.

Thus, it can be concluded that the overwhelming majority (95.50 %) of the dairy farmers' sons had a very high level of the overall operational or working self-confidence to be a successful dairy farmer. The positive attitude, high level of basic and animal husbandry related knowledge, expected level of practical skill and ability to do the tasks confidently, high level of working exposure to many of the animal husbandry related activities and association with this occupation from childhood might have helps them to have high to a very high level of the overall operational or working self-confidence to be a successful dairy farmer.

CONCLUSION

This standardized scale was made available to measure the working self-confidence of youth to adopt dairy farming as an occupation. This tool is helpful to measure the working self-confidence of rural youth and agricultural graduates. After measuring the working self-confidence to be a successful dairy farmer with the ten selected statements, it was concluded that majority (95.50 %) of the dairy farmers' sons had a very high level of the overall operational or working self-confidence to be a successful dairy farmer. This scale is useful to the planners and policymakers in developing policies for the development of animal husbandry workability of the rural youth.

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Scientific Selection and Breeding is Required to Conserve The Genetic Pool of Nattukuttai Cattle in Tamil Nadu

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ABSTRACT

Indigenous non- descript cattle play a key role in the ecosystem and livelihood of small and marginal farmers. Nattukuttai cattle, short stout indigenous cattle are being reared under zero input system in Villupuram, Tiruvallur and Kancheepuram districts of Tamil Nadu. An exploratory study was carried out to bring forth the adoption behaviour and constraints faced by Nattukuttai cattle owners. Forty respondents were selected from each of the three districts and thus the total respondents accounted to be 120. The study revealed that majority of the farmers had the practice of housing cattle adjacent to their home (62.5 %) under open type and storing farm manure by heap method (100 %). A meager per cent of owners only fed concentrate feed (15 %) and green fodder (6.67%) to their cattle. The common diseases affecting Nattukuttai cattle were FMD, LSD and worm infestation. Around eighty-seven per cent of the farmers adopted natural service in breeding and few farmers were resorting to artificial insemination. Non availability of land to house the cattle adjacent to their homes and limited breed conservation measures were ranked as the major constraints by majority of farmers. Hence, selective breeding of cattle and capacity building on scientific dairy practices need to be initiated to conserve Nattukuttai breed of cattle in Tamil Nadu.

Key Words: Adoption, Behaviour, Cattle, Constraints.

INTRODUCTION

India, the world largest producer of milk with a production of 187.7 Mt of milk in 2018-19 with an annual growth of 4.2 per cent is expanding steadily since 2000. The milk cooperative system, introduction of crossbred animals, domestic milk price stability played a significant role in expanding India's dairy sector (Maurice *et al*, 2017). The total crossbred cattle population showed 26.9 per cent increase in the country over the last eight years, while the indigenous cattle population has decreased by 6 per cent as per the 20th livestock census. Farmers are replacing local cattle with crossbred animals due to their high milk yield potential (Torsten, 2003). The indigenous breeds of cattle need to be conserved for their unique characteristics such as heat tolerance, disease resistance, sustaining zero input farming, ecosystem protection and draught capacity (Balaraju *et al*, 2017; Ullaand Katriina, 2017). Srivastava *et al* (2019) stated that conservation of indigenous breeds of cattle includes preservation along with improvement of genetic potential and management of a breed for use in future. The production performance of cattle depends on adoption of scientific dairy practices (Sathiadhas *et al,* 2003). Hence documentation of adoption of indigenous dairy farmers and constraints faced by them play a key role in capacity building and policy implications. Nattukuttai breed of cattle is a short stout cattle reared in Villupuram,

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Table 1. Distribution of respondents based on herd size of Nattukuttai cattle. n=119

Sr. No.	Herd size	Frequency (f)	Per cent (%)
1.	2-16	95	79.83
2.	17-34	16	13.45
3.	35-51	3	2.52
4.	52-68	5	4.20

Tiruvallur and Kancheepuram districts of Tamil Nadu (Vinothkumar, 2014). The documentation of management practices adopted in Nattukutai breed of cattle and constraints faced by Nattukuttai cattle owners will facilitate sensitizing stakeholders towards the conservation of Nattukuttai breed of cattle. Thus, an exploratory study was conducted to study the adoption behaviour and constraints faced by Nattukuttai breed of cattle in Villupuram, Tiruvallur and Kancheepuram districts of Tamil Nadu.

MATERIALS AND METHODS

An exploratory study was designed to investigate the adoption behaviour and constraints faced by Nattukuttai cattle owners in Villupuram, Tiruvallur and Kancheepuram districts of Tamil Nadu. Forty farmers rearing Nattukuttai cattle were selected randomly from each of the three districts and thus the total respondents accounted to 120 owners. A pre-tested structured interview schedule was employed to elicit data on adoption behaviour and constraints faced by Nattukuttai cattle owners. The data were tabulated and analyzed using measures of central tendency and dispersion and other appropriate statistical techniques. Rank Based Quotient (RBQ) method was employed to rank the constraints faced by the farmers rearing Nattukuttai cattle.

RESULTS AND DISCUSSION

Adoption behaviour and constraints of dairy farmers rearing Nattukuttai cattle

It could be observed (Table 1) that in majority of the households (79.83%) the Nattukuttai cattle herd size ranged between 2 to 16 cattle. Thesinguraja (2017) and Nisha (2019) stated that majority of dairy farmers who followed semi-intensive system rearing maintained small herd size. Due to shrinkage of land size, labour shortage, and attraction towards cross bred cows, the herd size of Nattukuttai cattle drastically reduced in the last decade. Srivastava *et al* (2019) divulged that the reasons for depletion of native breeds were crossbreeding with exotic breeds, low production, losing utility, reduction in herd size and the large-scale mechanization of agricultural operations.

Housing practices adopted by Nattukuttai cattle farmers

The data(Table 2) revealed that majority of the farmers (62.50 %) adopted the practice of housing the Nattukuttai cattle adjacent to their homes, followed by 29.17 per cent and 8.33 per cent of them who housed their animals in far off places and near cultivable lands respectively. On the contrary, Thesinguraja (2017) opined that majority of the Pulikulam cattle owners housed their cattle near their cultivable land.

It could be inferred that majority of the respondents (47.50 %) had open type animal houses as animals were let free in open field round the year without restraining, whereas 45.83 per cent housed their animals in kutcha type sheds. This was in line with the findings of Thesinguraja (2017) but contrary to the findings of Vinothkumar (2014) who stated that majority of farmers provided kutcha type of roofing to their Nattukuttai cattle.

About 54.17 per cent of the respondents had the practice of collecting the cattle dung twice daily while the remaining 45.83 per cent of the Nattukuttai cattle owners collected the cattle dung only once. This was in contrast with the findings

Table 2. Distribution of respondents based on herd size of Nattukuttai cattle.

Sr. No.	Housing management	Frequency (f)	Per cent (%)
A.	**Location of house**		
1.	Adjacent to home	75	62.50
2.	Cultivable land	10	8.33
3.	others	35	29.17
B.	**Housing Structures**		
4.	Kutcha	55	45.83
5.	Pucca	8	6.67
6.	Open type	57	47.50
C.	**Frequency of dung collected/day**		
7	Once	55	45.83
8.	Twice	65	54.17
D.	**Method of storage of manure**		
9.	Heap method	120	100.00
10.	others	0	0
E.	**Disposal of manure**		
11.	Own farm use	35	29.17
12.	sold	69	57.50
13.	Both	16	13.33

of Thesinguraja (2017) who reported that majority of the farmers collected dung once a day. With regard to utilization of manure, about 57.50 per cent of the respondents sold the cattle manure to neighbouring agricultural farms, whereas 29.17 per cent used the cattle manure for their own farm use. This was partially in agreement with the study of Thesinguraja (2017) who reported that majority of the Pulikulam cattle owners stored the cattle farm manure by heap method and sold cattle manure on a weekly basis. Bhise *et al* (2018) divulged that majority of the dairy farmers in Maharashtra had knowledge about scientific disposal of manure with full adoption by 49.50 per cent respondents.

The feeding practices revealed that 85 per cent of the respondents had not adopted the practice of concentrate feeding to their cattle round the year. This was in accordance with the findings of Akila and Chander (2010), and Thesinguraja (2017) who stated that majority of the indigenous dairy farmers did not provide concentrate feed and maintained animals on grazing. With respect to feeding of green fodder, only 6.67 per cent of the respondents provided green fodder to the Nattukuttai cattle, while 93.3 per cent of the farmers did not adopt the practice of feeding green fodder to their cattle.

Regarding feeding of dry fodder, about 77.5 per cent of the respondents provided dry fodder to their cattle while the remaining 22.5 per cent of the respondents did not provide dry fodder to the cattle. The findings indicated that majority of Nattukuttai cattle owners provided dry fodder to their cattle on a seasonal basis based on the availability of dry fodder. This was not in agreement with the findings of Vinothkumar (2014) who stated that only 5.56 per cent of Nattukuttai cattle owners provided dry fodder. Meena *et al* 2012 opined that 100 per cent of the tribal farmers in Udaipur district of Rajasthan fed dry fodder to their cattle.

It was observed that Nattukuttai farmers of Kancheepuram district who own cultivable land provided ad libitum green fodder and dry fodder to their cattle. The study results revealed that Nattukuttai cattle fed with balanced diet yielded 1.5-2.5 liters of milk daily, whereas the average milk yield of Nattukuttai cattle maintained on zero input farming was 0.5 -1.0 liter per day. Hence, it could be inferred that balanced feed ration will significantly improve the milk yield potential of Nattukuttai cattle.

Grazing system

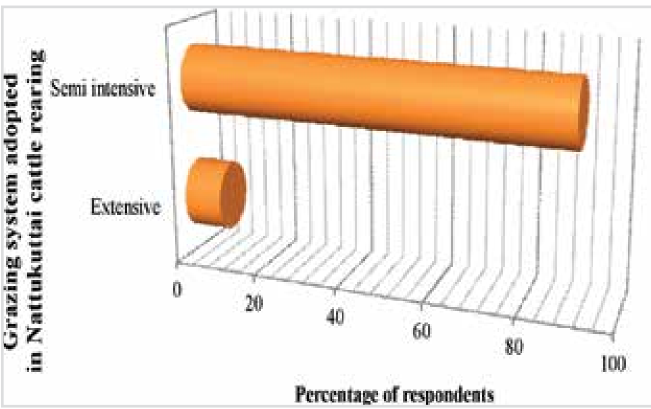

Fig.1. Distribution of respondents according to the grazing system followed in Nattukuttai cattle rearing.

Figure 1 indicates that 90.83 per cent of the respondents adopted semi-intensive system of grazing in community land, whereas 9.17 per cent of the respondents adopted extensive system of grazing. Interestingly, some of the respondents in Tiruvallur district had the practice of letting their animals to graze freely in community lands throughout the year without providing housing facilities. This finding is in line with the findings of Sudhanshu *et al* (2019). On the contrary, Thesinguraja (2017) reported that nearly 80.0 per cent of Pulikulam owners followed extensive system of grazing.

Breeding practices

It was found that 86.67 per cent of the respondents adopted the practice of natural service in Nattukuttai cattle at their farm itself. Majority of respondents had their own bulls and followed uncontrolled system of mating. This was in line with the findings of Singh *et al* (2016), Sudeepkumar *et al* (2016), Thesinguraja (2017) who inferred that majority of the respondents preferred natural service in their cattle. Sathiadhas *et al* (2003) reported that majority of the dairy farmers in the coastal agro system of Kerala adopted the practice of Artificial insemination in cattle.

Common diseases encountered in Nattukuttai cattle

About 62 per cent of the respondents reported that Foot and Mouth disease (FMD) incidence was observed in their Nattukuttai cattle while 56.67 per cent of the respondents reported the incidence of Lumpy skin disease (Table 3). An equal number of respondents (56.67%) reported that worm infestation was observed in Nattukuttai cattle. Thesinguraja (2017) opined that 100 per cent of respondents reported incidence of FMD in their cattle. Majority of the respondents stated that the calf mortality was reported due to Lumpy Skin Disease during last year. It was observed that worm infestation was high in Nattukuttai cattle

Table 3. Common diseases encountered in Nattukuttai cattle.

Sr. No.	Commonly encountered diseases	Frequency* (f)	Per cent (%)
1.	FMD	75	62.50
2.	LSD	68	56.67
3.	Worm infestation	68	56.67
4.	others	35	29.17

* Multiple responses

due to poor scientific awareness among farmers on deworming of Natukuttai cattle. Amphistomes were the common worm infestation reported in Nattukuttai cattle. The other endemic diseases like Black quarter and Haemorrhagic septicemia were also reported in Nattukuttai cattle.

It was highlighted that most of the farmers (65.83%) vaccinated their cattle against Foot and Mouth Disease. This was in line with the study of Sathiadhas *et al* (2003), Sudhanshu *et al* (2019) and Gupta (2020). On the contrary, Vinothkumar (2014) and Thesinguraja (2017) in their study stated that majority of the farmers did not vaccinate their cattle. With regard to deworming, majority of the respondents (81.67%) did not deworm the cattle while the remaining respondents (18.33%) practiced deworming in their cattle as and when needed. This was in agreement with the findings of Sathiadhas *et al* (2003), Vinothkumar (2014) and Jagdeep Gupta (2020). Majority of the respondents reported that restraining Nattukuttai cattle is a major issue in carrying out vaccination in cattle.

Constraints in rearing Nattukuttai cattle as perceived by the owners

It was observed (Table 5) that non availability of land to house the cattle was considered as the foremost common constraint faced by cattle owners as there was major shrinkage of land (93.40%) due to partition of land between siblings. Though some farmers were marginal farmers, the location of agricultural land was far away from the house and they also felt that it was not safe to house their cattle in agricultural lands due to theft. It was observed that most of the farmers had the practice of housing their cattle on road side. The second most constraint perceived by the respondents (76.41%) was limited breed conservation measures taken as there was a drastic reduction in the number of people rearing Nattukuttai cattle in last two decades. Anjali and Senthilkumar (2020) reported that lack of government support to encourage Vechur cattle farming as the prime most policy related constraints faced by dairy farmers rearing V cattle in Kerala.

The third rank constraint perceived by the farmers (66.47%) was low milk price. Since restraining Nattukuttai cattle was difficult, majority of the farmers depend on milk vendors, who used to milk the cattle and procure the same for lower price. It was reported that on an average, the milk vendor was fixing the price of milk as Rs.20-22/l. This was in agreement with the study of Sathiadhas *et al* (2003), Athilakshmy *et al* (2013) and Princejot Singh (2015). Shortage of grazing land was ranked as the fourth constraint (66.15%) and this might be due to the fact that most of the farmers were landless farmers and it was prohibited to graze the cattle near paddy and vegetable fields during harvest season and in addition urbanization also contributed to shrinkage of land. It was also reported that inadequate or shortage of grazing land during harvest season has lead to quarrel among the cattle farmers.

The fifth rank constraint was difficulty in milking cows (52.18%) as it was difficult to restrain the Nattukuttai breed of cattle. Majority of the farmers stated that they were milking the cows which were very cooperative and the other animals were let free for providing milk to its calves. Lack of motivation/willingness among younger generation in indigenous cattle rearing was ranked as the sixth constraint, which might be due to the fact that the younger generation are more attracted towards work in the organized industry sector. On the contrary, Thesinguraja (2017) divulged that lack of willingness among younger generation in Pulikulam cattle rearing as the least constraint faced by the farmers.

The next (seventh and eighth) constraints faced by the farmers were lack of knowledge on scientific breeding practices (39.17%) and non-availability of quality breeding bulls (25.58%) respectively. This was in contrary to the findings of Nisha (2019) who stated that lack of knowledge and skill in scientific animal husbandry practices as the fore-most constraint among Attappadi tribal farmers. Some farmers, who owned one or two cattle, reported non

Table 4. Constraints ranked by the farmer in Nattukuttai cattle rearing.

Sr. No.	Constraint	RBQ value	Rank
1.	Non availability of land adjacent to their home to house the cattle	93.40	I
2.	Limited breed conservation measures	76.41	II
3.	Low milk price	66.47	III
4.	Shortage of grazing land	66.15	IV
5.	Difficulty in milking cows	52.18	V
6.	Lack of willingness among younger generation in indigenous cattle rearing	44.81	VI
7.	Lack of knowledge about breeding practices	39.17	VII
8.	Non availability of quality breeding bulls	25.58	VIII
9.	Unavailability of Nattukuttai bull semen straws for AI	18.46	IX
10.	Middle man involvement	17.63	X
11.	Poor reproductive performance	16.86	XI
12.	High labour cost	13.21	XII
13.	Lack of drinking water	12.37	XIII

availability of breeding bulls as a constraint. Non-availability of Nattukuttai bull semen straws for AI was ranked as the ninth constraint (18.46%), as few farmers who were opting for AI in their Nattukuttai cattle able to inseminate with cross breed cattle semen straws. This was in line with the findings of Anjali and Senthilkumar (2020). Middle man involvement and poor reproductive performance were ranked as tenth constraint (17.63%) and eleventh constraint (16.86%) respectively. The farmers were entirely dependent on middlemen for sale of milk as well as male calves.

High labour cost was ranked as the twelfth constraint (13.21%) since, the family member's especially old aged people and women were assigned farm related activities. Lack of drinking water was ranked as the least constraint (12.37%). This was in contrary to the findings of Patil *et al* (2009) who reported that majority of the respondents in Nagpur district perceived lack of drinking water for animals as an important constraint.

CONCLUSION

Nattukuttai breed of cattle, indigenous to Tamil Nadu were reared under zero input system in Tiruvallur, Villupuram and Kancheepuram districts. Majority of the Nattukuttai cattle owners housed their cattle adjacent to their homes under open type housing. The common diseases affecting Nattukuttai cattle were observed to be FMD, LSD and worm infestation. Majority of the farmers adopted natural service in breeding their Nattukuttai cattle and few farmers only were resorting to artificial insemination. The milk yield of Nattukuttai cattle during first three months of lactation period ranges from 0.5 liter to 1.5 liters/day and it reduces to less than half liter in subsequent month. Majority of the farmers were selling milk to local vendors. Nattukuttai cattle owners had limited awareness on scientific dairy farming. The scientific feeding practices and disease management has a direct impact on the productivity of the animal and hence capacity building programmes on scientific dairy management practices will encourage the farmers to continue rearing Nattukuttai cattle. Non availability of the land adjacent to their homes to house Nattukuttai cattle and limited breed conservation measures were the foremost most serious constraints faced by the Nattukuttai cattle owners. Hence, policy intervention on scientific selection and selective breeding of Nattukuttai cattle is recommended to conserve the genetic pool of Nattukuttai cattle in Tamil Nadu.

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Seed Treatment with Thiamethoxam 30 FS is Suitable for the management of Sorghum Shoot fly, *Atherigona soccata* (Rondani) in Sorghum, *Sorghum bicolor* (L)

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ABSTRACT

The field experiment was conducted during *kharif,* 2019 to study the efficacy of seed treatment with thiamethoxam 30 FS for the control of sorghum shoot fly, *Atherigona soccata* (Rondani) against the recommended practice *i.e.,* spraying of malathion @ 625 ml/ha. Treated seed samples with the test insecticide were obtained from the Forage and Millets Section, Department of Plant Breeding and Genetics, PAU, Ludhiana. The seed was treated with 10 ml Slayer 30 FS (thiamethoxam) per kg seed. Seed treatment with thiamethoxam 30 FS @ 10 ml/kg seed was found better than spraying of malathion @ 625 ml/ha and control for the management of shoot fly in sorghum but seed treatment with thiamethoxam was not effective for the management of maize borer in sorghum. Significant higher fodder yield was obtained (600 q/ha) in the treatment T_1 followed by T_2 (562.5 q/ha) in the district Amritsar. Similarly, 580 and 550 q/ha fodder yield were obtained in the treatment T_1 and T_2, respectively in the district Tarn Taran. No phytotoxicity symptoms of the insecticide either by spraying or as seed treatment were observed in any of the treatment in any of the district.

Key Words: Malathion, Seed treatment, Sorghum, Thiamethoxam 30 FS, Sorghum Shoot fly.

INTRODUCTION

Sorghum, *Sorghum bicolor* (L) plays a vital role in the economy of rural India and is an important source of fodder for animals. Sorghum is mostly grown in *kharif* season in Punjab. In India, nearly 32 per cent of sorghum crop is lost due to insect pests. Sorghum is attacked by over 150 insect species from sowing till harvest. The shoot fly, *Atherigona soccata* (Rondani) is one of the serious pests and attacks sorghum seedlings during initial one to four weeks during the rainy season. Pawar *et al* (1984) reported maximum yield losses of 75.6 per cent in grain and 68.6 per cent in fodder. The larva of this pest attacks on central whorl of the plant and causes dead heart formation. The damaged seedling is generally killed and plant grows side tillers which are further attacked under high pest population leading to considerable loss. The incidence increases as the sowing is delayed. At the boot stage, twisting of top leaves and emergence of panicles is prevented in case of severe infestation (Subbarayudu *et at*, 2002). Further, rapid population build up occurs due to its high fecundity and shorter generation span. It feeds on several other plant species including cereal crops and weeds. In view of its effects on plant stand and losses in grain yield, considerable research efforts have been made to develop strategies for its management. Plant protection during early stage of crop is very much essential, as losses through early season pest could be minimised by seed treatment of insecticides. Also, seed treatment with systemic insecticides is considered to be more selective for targeted pests, provides protection to natural enemies with least environmental pollution and hazards. Seed treatment is the easiest and economical method for timely management of shoot flies. Several chemicals are available in the market for seed treatment but thiamethoxam 30 FS

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commonly available with the Brand name Slayer 30 FS was selected because it interfere with the nicotinic acetylcholine receptors and therefore, have specific activity against the insect nervous system. This unique mode of action makes it desirable for the control of insects that are developing resistance to conventional organophosphate, carbamate and pyrethroid insecticides. It has minimal effect on beneficial insects, low toxicity towards mammals and does not produce teratogenic or mutagenic effects. Because of this selectivity, it is recommended for treatment of seeds. Therefore, present study was planned to test systemic insecticide, thiamethoxam 30 FS against sorghum shoot fly.

MATERIALS AND METHODS

The field experiment was laid out in the *kharif* season 2019 to study the efficacy of seed treatment with thiamethoxam 30 FS (T1) for the control of sorghum shoot fly against the recommended practice *i.e.,* spraying of malathion @ 625 ml/ ha (T2) whereas untreated plot was considered as T3. Treated seed samples with the test insecticide were obtained from the Forage and Millets Section, Department of Plant Breeding and Genetics, PAU, Ludhiana. The seed was treated with 10 ml Slayer 30 FS (thiamethoxam) per kg seed. The sowing of the trial was done on 20.06.2019 in the district Amritsar and on 29.05.2019 in the district Tarn Taran with plot size of 500 m^2 for each treatment. Both the treatments were compared with control plots. The crop was grown in rows 22 cm apart using all the recommended package of practices *i.e.,* fertilizer application, irrigation etc. The observations on per cent dead hearts due to sorghum shoot fly were collected at 14, 21 and 28 days after germination of the crop from all the 3 treatments. The data for dead heart formation was recorded from 10 different locations per treatment. Dead heart incidence (dead hearts and total number of plants per 1m row length) was recorded from 10 randomly selected locations from each treatment.

Per cent dead hearts were calculated using the formula

$$\text{Per cent DH} = \frac{\text{Number of DH}}{\text{Total number of Plants per 1 m row length}} \times 100$$

Dead hearts formed due to the attack of maize borer, *Chilo partellus* were also recorded one month after sowing of the crop. The phytotoxicity symptoms, if any, were also recorded in 20 days old seedlings. Besides, the natural enemy population was also recorded in all the treatments. At last, the green fodder yield was recorded at 60-70 days after sowing or 50 per cent flowering. The data thus obtained were subjected to statistical analysis and critical difference was calculated at 5 per cent level of significance.

RESULTS AND DISCUSSION

The experimental results revealed significant differences in dead heart formation by shoot fly in sorghum among all the treatments at 14, 21 and 28 days after germination of the crop in comparison to control in the district Amritsar. No dead heart formation was recorded in the treatment T_1 while 3.11 per cent dead heart formation was seen in the treatment T_2, 14 days after germination of the crop (Table 1). The dead heart formation was 0.23 and 3.58 per cent in the treatments T_1 and T_2, 21and 28 days after germination of the crop, respectively.

The experimental results revealed significant differences in dead heart formation by shoot fly in sorghum among all the treatments at 14, 21 and 28 days after germination of the crop in the district Tarn Taran also. Dead heart formation recorded was nil in the treatment T_1 while 3.28 per cent dead heart formation was seen in the treatment T_2, 14 days after germination of the crop. The dead heart formation was 0.47 and 3.93 per cent in the treatments T_1 and $T_{2,}$ respectively, 21 days after germination of the crop while it was 0.23 and 3.59 in the treatments T_1 and $T_{2,}$ respectively, 28 days after germination of the crop (Table 2).

Table 1. Percent dead hearts formed due to sorghum shoot fly in district Amritsar.

Treatment	Per cent dead hearts formed due to sorghum shoot fly after		
	14 days	21 days	28 days
Seed treatment with Thiamethoxam 30 FS (T_1)	0.00	0.23	0.23
Spray of Malathion (T_2)	3.11	3.58	3.58
Untreated control (T_3)	5.02	5.50	5.74
CD (p=0.05)	1.40	1.54	1.48

Treatment T_1 gave better control of the sorghum shoot fly in sorghum than the treatment T_2 and control in both the districts. Treatment T_1 provided effective control of the shoot fly damage even up to 28 days of germination of the crop in both the districts. Hence, it can be concluded that Treatment T_1 was better than any other treatment for the management of shoot fly in sorghum. The efficacy of thiamethoxam 30 FS can be attributed to the systemic properties of the insecticide which means that it is quickly absorbed by plants and transported to all of its parts, including pollen, where it acts to deter insect feeding. An insect can absorb it in its stomach after feeding or through direct contact, including through its tracheal system. Seed treatment with thiamethoxam 30 FS @ 5 ml/ kg seed was also found effective in reducing shoot fly incidence by Sandhu (2016). Similarly, seed treatment with thiamethoxam 70 WS @ 3 g/ kg seed was found very effective against sorghum shoot fly (Daware *et al,* 2012). Khandare *et al* (2014) suggested that sorghum seed treatment with thiamethoxam 35 FS @ 5 ml/ kg provided highest germination percentage (92%) and minimum number of dead hearts (9.56%) as compared to control (51.28%). Vadodaria *et al* (2001) confirmed the efficacy of thiamethoxam as seed dresser against sucking pests of cotton.

The observations were also recorded for the attack of other insect pests particularly maize borer, *Chilo partellus* at the two locations (Table 3). Seed treatment with thiamethoxam 30 FS was not found effective for the control of maize borer when compared with the control treatment in both the districts. Per cent dead heart formation recorded due to maize borer was 8.63 and 8.03 in the district Amritsar and Tarn Taran, respectively in the treatment T_1. However, spraying of the crop with malathion at 2-4 leaf stage of the crop has been found effective in controlling the dead heart formation due to maize borer as compared to control in both the districts. The per cent dead hearts formation was 5.51 and 5.13 in the treatment with spray of malathion, whereas in the control treatment it was 9.67 and 10.22 per cent in the district Amritsar and Tarn Taran, respectively. Hence, it can be concluded that seed treatment with thiamethoxam 30 FS was not effective for the management of maize borer in sorghum. Alam (2020) tested diamide and neonicotinoid group of insecticides against maize borer, *Chilo partellus* (Swinhoe) as seed treatment.

Table 2. Percent dead hearts formed due to sorghum shoot fly in district Tarn Taran.

Treatment	Per cent dead hearts formed due to sorghum shoot fly after		
	14 days	21 days	28 days
Seed treatment with Thiamethoxam 30 FS (T_1)	0.00	0.47	0.23
Spray of Malathion (T_2)	3.28	3.93	3.59
Untreated control (T_3)	5.65	6.45	6.22
CD (p=0.05)	1.34	1.24	0.98

Table 3. Incidence of other insect-pests after one month of sowing (Maize borer).

Treatment	Per cent incidence of maize borer	
	Location 1 (Amritsar)	Location 2 (Tarn Taran)
Seed treatment with Thiamethoxam 30 FS (T_1)	8.63	8.03
Spray of Malathion (T_2)	5.51	5.13
Untreated control (T_3)	9.67	10.22
CD (p=0.05)	2.15	2.99

Table 4. Green fodder yield at 60 days after germination

Treatment	Green fodder yield (q/ha)	
	Location 1 (Amritsar)	Location 2 (Tarn Taran)
Seed treatment with Thiamethoxam 30 FS (T_1)	600	580
Spray of Malathion (T_2)	562.5	550
Untreated control (T_3)	512.5	500
CD (p=0.05)	10.49	9.96

Among the tested insecticides (Tetraniliprole 480 FS, Imidachloprid 600 FS and thiamethoxam 30 FS), thiamethoxam 30 FS @ 2.4 g/kg of seed was found least effective for the management of maize borer as seed treatment in maize (Alam, 2020).

Observation on the fodder yield was also recorded in both the districts. Significant difference in the fodder yield was obtained in all the treatments as compared to control in both the districts. The fodder yield obtained was 600 q/ha in the treatment T_1 followed by the treatment T_2 (562.5 q/ha) in the district Amritsar (Table 4). Similarly 580 and 550 q/ ha fodder yield was obtained in the treatment T_1 and T_2, respectively in the district Tarn Taran. The results of present investigation regarding yield Khandalkar (2006), Balikai (2011) and Daware (2011) who recorded grain yield of 19.77, 22.05 and 30.71 q/ha with thiamethoxam as seed treatment. No phytotoxicity symptoms of the insecticide with spraying and as seed treatment on the crop were observed in any of the treatment in any of the district.

CONCLUSION

The results revealed significant differences in dead heart formation by shootfly in sorghum when seed was treated with thiamethoxam @ 10 ml/ kg seed at 14, 21 and 28 days after germination of the crop in the district Amritsar and Tarn Taran. Hence seed treatment with thiamethoxam may be recommended for the control of sorghum shootfly, *Atherigona soccata* (Rondani) in sorghum.

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Selection of Softener Combination for Softening of Jute Fabric

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ABSTRACT

Jute is a very important fibre crop in reference to India as it has a number of benefits but due to its harsh nature, rough texture and undesirable feel can not be ventured into primary applications. Therefore, there is an urgent need to treat jute in a manner which not only makes it soft and supple but also is non-toxic towards nature. Realizing the importance of development of an eco-friendly treatment, three softeners *i.e.,* Abrosil RUC, Abrosoft Redico and Abrosoft NI were applied on the jute fabric in 18 different combination ratios with 4 per cent concentration at 40º C for 30 minutes with 1:8 material to liquor ratio at 5-6 pH through exhaust method. These treated samples were got assessed by a committee over the parameters of hand feel and appearance. The combination 100 per cent Abrosil RUC (aminosilicone softener) depicted highest weighted mean scores 4.6 (hand feel) and 4.8 (appearance) was considered to be the best and most suitable for softening of jute fabric. Aminosilicone softener acted on the jute substrate and provided a supple feel and bright texture by masking the surface irregularities of jute substrate. Softening by employing softener instead of chemicals is a novel approach and it is not only ecofriendly but also fabric friendly.

Keywords: Softener, jute, harsh, appearance

INTRODUCTION

Jute fibre is a ligno-cellulosic fibre and falls into the bast fibre category along with kenaf, industrial hemp, flax (linen), ramie, etc. The fibres are usually off-white to brown in colour, with a length of 1 to 4 m and can be spun into coarse, strong yarns. It is produced from plants belonging to genus *Corchorus*, family *Tiliaceae*. It is extensively used in industrial applications like sacking, packaging, carpet backing and to some extent it also finds its usability in geotextiles (Debnath and Madhusoothanan, 2011). It has many beneficial properties such as high tensile strength and modulus with good dimensional stability, moisture absorption, heat and sound insulation. These qualities make it a promising fibre to be used most widely in sectors such as industrial textiles, home textiles, geotextiles, apparels etc. Fabrics made of jute fibres are carbon-dioxide neutral and naturally decomposable. It has low extensibility and ensures better breathability of fabrics (Vigneswaran and Jayapriya, 2010). Besides its beneficial properties, it has a few drawbacks such as a meshy structure, poor wrinkle recovery and high fibre shedding. Jute fibres contain very low quantity of natural fats and waxes and show prominent stiffness and harshness, which offer hindrance in smooth and trouble-free applications (Basu *et al,* 2008). Harshness, one of the main limitations of the jute fabric, can be overcome by applying different softening agents.

The softening of jute fibres is an age-old procedure where dextrin, glycerin, sulfonated oils, sulfated tallow and sulfated alcohols are added to the fibres in order to make them softer and render better spinnability. However, these agents are toxic in nature as in addition to causing detrimental effect on environment, synthetic softening agents also lead to weakening of the fibre by thinning down its diameter as well as by affecting its tensile properties, strength and change in the colour of the fabric (Akhila et al, 2005, Jayapriya and Vigneswaran, 2010).

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Table 1. Combinations of softeners.

Sr. No	Ratio	Combination of softeners
1	100 %	Abrosoft Redico
2	100 %	Abrosil RUC
3	100 %	Abrosoft NI
4	50: 50	Abrosoft Redico + Abrosil RUC
5	50: 50	Abrosil RUC + Abrosoft NI
6	50: 50	Abrosoft NI + Abrosoft Redico
7	60 : 40	Abrosoft Redico + Abrosil RUC
8	60 : 40	Abrosil RUC + Abrosoft NI
9	60 : 40	Abrosoft NI + Abrosoft Redico
10	80 : 20	Abrosoft Redico + Abrosil RUC
11	80 : 20	Abrosil RUC + Abrosoft NI
12	80 : 20	Abrosoft NI + Abrosoft Redico
13	90 : 10	Abrosoft Redico + Abrosil RUC
14	90 : 10	Abrosil RUC + Abrosoft NI
15	90 : 10	Abrosoft NI + Abrosoft Redico
16	30 : 30 : 40	Abrosoft Redico + Abrosil RUC + Abrosoft NI
17	30 : 30 : 40	Abrosil RUC + Abrosoft NI + Abrosoft Redico
18	30 : 30 : 40	Abrosoft NI + Abrosoft Redico + Abrosil RUC

With the advancement in science and technology, novel approaches have been developed for softening of harsh jute fibres. A variety of commercial softeners, classified on the basis of their chemical nature into cationic, anionic, non-ionic and silicone are also used for softening. For last several years, specially organo-modified silicones have been used in textile finishing because they contain additional reactive organic groups, such as amines, amides and epoxides, that normally contribute to the softness and/or durability. The methods of softening, using commercial softeners are environmentally benign and non-toxic. Thus, the present study was planned in order to assess the effect of softeners and their combinations for application on jute fabric.

MATERIALS AND METHODS

Materials

Three softeners namely Abrosil RUC (aminosilicone), Abrosoft Redico (cationic) and Abrosoft NI (non-ionic) were procured from ABH Biochemicals Private Limited, Gurugram. All the softeners were used as received without any further purification. Jute fabric in grey state (9 × 6 ends and picks per sq. inch, weighing 232.6 g/m^2, 3.250 mm thickness) was procured from Himanshu Jute Fab, Delhi, India. The enzymes EBzyme Amylase (200000 EBU/gm) and EBzyme Pectinase (30000 EBU/gm), were procured from Enzyme Bioscience Private Limited, Surat, India.

Enzymatic desizing and scouring

The jute fabric was desized with 2.5 percent EBzyme Amylase at 60º C for 1 hr with material to liquor ratio 1:20 by maintaining the pH at 7. The treatment liquor was drained out and the fabric was given one hot and one cold wash. Then the fabric was dried. After desizing, the fabric was scoured in a bath containing 2 per cent EBzyme Pectinase at 60º C temperature with 1:15 material to liquor ratio at 7 pH for 60 min. The fabric was rinsed in hot and cold water and dried on a flat surface.

Application of commercial softeners and their combinations

Commercial softeners from three different categories were selected based on the literature, suitability for application on cellulosic fabric, eco-friendliness of nature, easy availability and economic soundness. Three softeners *i.e.,* Abrosil RUC (aminosilicone), Abrosoft Redico (cationic) and Abrosoft NI (non ionic) were applied on the jute fabric in 18 different combination ratios with 4 per cent concentration at 40º C for 30 min. with 1:8 material to liquor ratio at 5-6 pH through exhaust method, following the specifications given by the suppliers. After the treatment, the samples were taken out and rinsed thoroughly. After rinsing, the samples were dried at ambient temperature and stored in airtight packets.

Selection of experts

Five experts from Department of Textile and Apparel Designing, Department of Extension Education and Communication Management and Department of Family Resource Management, CCS Haryana Agricultural University, Hisar, were purposively selected as experts on the basis of their knowledge and availability.

Assessment of treated fabric samples

The fabric samples treated with different softener combination in different ratios were exhibited before the members of advisory committee and their preference was noted on different parameters of hand feel (smooth, smooth and light, rough, coarse, rough and coarse) and appearance (lustrous, brightly whitish, bright, grey, dull brownish grey). Weighted mean score was calculated on five-point continuum scale.

Statistical analysis

Frequency: Frequencies were calculated and used to calculate weighted mean scores.

Weighted mean score: To quantify the data regarding selection of commercial softener combination weighted mean scores were calculated and ranks were allotted on that basis. Weighted mean score of each feature was worked out separately using equation 1:

$$\text{Weighted Mean Score} = \frac{\text{WI XI + W2 X2+------ +WnXn}}{\text{Total number of respondents}} \quad (1)$$

where,

W1, W2---------------Wn are weights

X1, X2-----------------Xn are frequencies

RESULTS AND DISCUSSION

The data elucidates the preference of experts for 18 different applied combinations of commercial softeners regarding parameters of hand feel and appearance (Table 1). Igarashi and Nakamura (2019) also applied softener on cotton threads and conducted a sensory evaluation where the threads were touched with bare hands in order to feel it and the softness was found to increase. It was clear from the table that 100 % Abrosil RUC (aminosilicone) softener ranked I in the list with weighted mean score of 4.6 (hand feel) and 4.8 (appearance). Second rank was achieved by combination 30 % + 30 % + 40 % Abrosoft Redico + Abrosoft NI + Abrosil RUC with weighted mean score 4.4 (hand feel) and 3.4 (appearance). Likewise, the combination 30 % + 30 % + 40 % Abrosil RUC + Abrosoft NI + Abrosoft Redico got rank III for hand feel with weighted mean score 4.0 and combination of 90 % + 10 % Abrosoft Redico + Abrosoft NI got III rank in appearance with weighted mean score 3.2.

The improvement in hand feel and appearance after aminosilicone softener treatment may be attributed to masking of the microvoids by the softener, thus giving a supple and smooth handle to the fabric. The findings of Islam *et al* (2015) also suggested that silicone softener improved the quality of the treated fabric by imparting silk soft hand, very good lubricity and abrasion resistance etc. Manjulatha and Mahale (2017) applied cationic, non-ionic and silicone softener on deccani woollen blanket for softening treatment. They observed changes in drape coefficient 60.48 (control), 57.84

Table 2. Selection of softener combination for softening treatment of jute fabric.

Sr. No.	Commercial softener combination	Hand feel		Appearance	
		WMS	Rank	WMS	Rank
	100% Abrosoft Redico	2.0	XI	2.4	VII
	100% Abrosil RUC	4.6	I	4.8	I
	100% Abrosoft NI	2.4	IX	2.8	V
	50+50 Abrosoft Redico + Abrosil RUC	3.2	V	2.4	VII
	50+50 Abrosil RUC + Abrosoft NI	1.6	XII	2.6	VI
	50+50 Abrosoft Redico + Abrosoft NI	2.4	IX	1.8	IX
	60+40 Abrosoft Redico + Abrosil RUC	2.2	X	2.8	V
	60+40 Abrosil RUC + Abrosoft NI	2.8	VII	3.0	IV
	60+40 Abrosoft Redico + Abrosoft NI	3.4	IV	3.4	II
	80+20 Abrosoft Redico + Abrosil RUC	3.2	V	3.4	II
	80+20 Abrosil RUC + Abrosoft NI	2.2	X	2.4	VII
	80+20 Abrosoft Redico + Abrosoft NI	2.0	XI	1.8	IX
	90+10 Abrosoft Redico + Abrosil RUC	2.4	IX	1.8	IX
	90+10 Abrosil RUC + Abrosoft NI	3.0	VI	2.4	VII
	90+10 Abrosoft Redico + Abrosoft NI	1.2	XIII	**3.2**	**III**
	30+30+40 Abrosoft Redico + Abrosil RUC + Abrosoft NI	2.6	VIII	2.6	VI
	30+30+40 Abrosil RUC + Abrosoft NI + Abrosoft Redico	**4.0**	**III**	2.0	VIII
	30+30+40 Abrosoft Redico + Abrosoft NI + Abrosil RUC	4.4	II	3.4	II

(cationic softener), 59.05 (non-ionic softener) and 56.94 (silicone softener) and hence suggested silicone softeners to be the best for softening treatments.

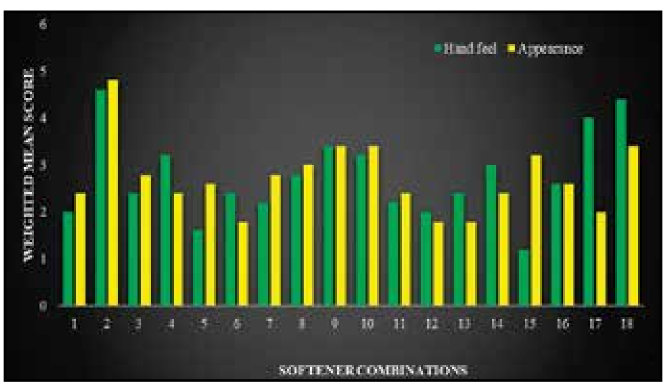

Fig. 1: Selection of softener combination for softening treatment of jute fabric

CONCLUSION

The application of aminosilicone softener will help in reduction of harshness and roughness by adding to a soft and supple feel to jute fabric. Therefore, jute fabric will be utilized in several fields of primary uses which will help in increase in its consumption directly and in the income of jute farmers and people engaged and employed in jute industries indirectly.

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Skill Development Training on Mushroom Farming for Income Generation

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ABSTRACT

Skill development training on mushroom cultivation was organized to unemployed youth, farmers and farm women by ICAR KVK, Mandya with the objective of providing employment and micro entrepreneurship. The present study revealed that the trainees differed in their socio-economic status based on age, education, occupation, and landholding. Out of 283 trained participants, 46 established mushroom production units. Irrespective of the components considered to test the knowledge level regarding mushroom production technologies of the trainees varied from 2.12 to 34.62 per cent in pre-training where as in post training recorded 42.04 to 85.87 per cent. However, change in knowledge level varied between 26.14 to 74.91per cent. An economic analysis of five units revealed that the average income of Rs.35,335/- earned by selling 3.87q per crop. Proper training and guidance to the farmers is essential and would help the interested growers to sustain and earn their livelihood.

Key Words: Skill Development, Knowledge, Mushroom Farming, Self – employment

INTRODUCTION

Rural population in India comprises of marginal, landless farmers and unemployed youth hence, there is a need for a low cost and maximum profit enterprises to enhance socio-economic status. One such activity is mushroom farming with minimum capital maximum revenue for providing an additional source of income. Mushroom farming has the potential to solve many problems such as quality food demand, environmental pollutions, unemployment and certain ecological issues in an amicable manner to a significant extent. Mushroom cultivation improves the socio-economy of the farming community through additional revenue by utilizing farm wastes (Nagaraj *et al*, 2017). In addition to this, it paves ways for employment generation in significant amount (Markam *et al*, 2018). In Mandya district, Paddy, Ragi and Sugarcane are the major crops cultivated in the irrigated pockets of the district. The straw is major bi-products left after paddy and Ragi harvest. The available straw can be properly utilized to grow mushroom. The substrate remains after cultivation of mushroom is more readily digestible and palatable to livestock. Additionally, it can be exploited as a source of manure and mulch for soil. In this context, ICAR- Krishi Vigyan Kendra, Mandya has conducted 11 short and long term skill development training courses on mushroom cultivation and its value addition for farmers, farm women and rural unemployed youth during the year 2017-2020 with the objective to motivate the establishment of mushroom units in the District.

MATERIALS AND METHODS

The skill development trainings on mushroom cultivation were organized to unemployed youth, farmers and farm women by ICAR KVK, Mandya. A total of 283 participants were present in the training, out of which 181 males and 102 females. A questionnaire was formulated comprising of general information, background of participants, landholding etc. To assess the impact and effectiveness of training, pre and post evaluation test was conducted. While preparing questionnaire to test the knowledge of trainees,

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Table1. Socio economic status of trainees. (N= 283).

Sr. No	Particular	Trainees	
		Frequency	Percentage
1	Sex		
	Male	181	63.96
	Female	102	36.04
2	Age		
	20 - 30 yr	71	25.09
	31- 40 yr	98	34.63
	41 -50 yr	114	40.28
3	Caste		
	Scheduled caste	17	6.01
	Scheduled Tribe	2	0.71
	Others	264	93.28
4	Education		
	Primary School	108	38.16
	High School	89	31.45
	Pre University	57	20.14
	Graduate	29	10.25
5	Occupation		
	Agriculture	194	68.55
	Housewife	74	26.15
	Others (Retiree, student)	15	5.30
6	Landholding		
	Landless	12	4.24
	Marginal (<1ha)	219	77.39
	Small (1-2 ha)	52	18.37

regarding mushroom species, health and medicinal benefits, cultivation techniques, preparation of spawn, substrates preparation, pest and disease management, marketing of fresh product, processing and preservation, record keeping, value addition of mushroom were considered. The change in perception level was calculated from the difference of scores obtained in pre and post knowledge gain by the trainees. The data were tabulated and statistically analyzed using frequency and percentage. Apart from the skill training, one day training programme was also conducted at frequent intervals to upgrade their skills and to overcome problems. Frequent visits were made to the established mushroom units in order to know the socio-economic constraints. Later on, five well established mushroom units were selected to study economic analysis. The data collected from five randomly selected units were analysed for calculating cost, the actual cost of inputs and actual

Table 2. Change in the perception level of mushroom growers (N=283).

Sr. No.	Particulars	Pre-training knowledge of trainees		Post-training knowledge trainees		Change in knowledge
		No.	(%)	No.	(%)	(%)
1	Kinds of mushroom species	45	15.90	119	42.04	+26.14
2	Nutritive and medicinal benefits of mushroom	34	12.01	217	76.68	+64.67
3	Materials and methods used for different types of mushroom farming	29	10.25	225	79.50	+69.25
4	Pest and disease management in mushroom	14	4.95	226	79.86	+74.91
5	Value added products of mushroom	58	20.49	243	85.87	+65.38
6	Material used for spawn production	11	3.89	168	59.36	+55.47
7	Harvesting and storage process	19	6.71	218	77.03	+70.32
8	Cost benefit ratio of mushroom production	29	10.25	226	79.85	+69.60
9	Packaging and labelling	22	7.77	209	73.85	+66.08
10	Marketing linkages	6	2.12	199	70.31	+68.19
11	Financial facilities, provided by public or private sector for mushroom unit	98	34.62	239	84.45	+49.83

Table 3.Trainings conducted and units established by mushroom growers (2017-2020).

Year	No. of training	No. of Trainees	Mushroom Unit established (No.)	Rate of adoption (%)
2017-18	03	82	13	15.85
2018-19	04	93	31	33.33
2019-20	04	108	46	42.59
Total	11	283	90	31.80

price paid by the consumers. The net returns were calculated by deducting the respective cost from the gross returns.

$$\textbf{Change in knowledge} = \frac{\text{After training-Before training}}{\text{Total trainees}} \times 100$$

Net income = Gross income - Cost of production

RESULTS AND DISCUSSION

The present study revealed that the trainees differed in their socio-economic status based on age, education, occupation, and landholding. The results showed that 36.04 per cent of the trainees were female whereas 63.96 per cent were male. The age range of trainees was between 20 to 50 yr. Majority of them (40.28%) were in age group of above 41 yr, whereas 34.63 per cent were between 31-40 yr and 25.09 per cent were below 30 yr of age. Information with respect to caste showed that 93.28 per cent of the trainees belong to other backward class followed by scheduled caste (6.01%). Trainees with respect to education indicated that 38.16 per cent studied up to primary school followed by high school (31.45%), pre university level (20.14%) and graduation (10.25%). Information with respect to occupation revealed that 68.55 percent of them were agriculture followed by housewife (26.15%) and only 5.30 per cent belonged to others. It was found that, 77.39 per cent of the trainees were marginal farmers followed by small (18.37%) and remaining 4.24 per cent were landless labours (Table 1), the similar findings were obtained by the Kavitha *et al* (*2019*). Pre and post training scores were computed for all the sub-components of mushroom cultivation (Table 2). Irrespective of the components considered to test the knowledge level regarding mushroom production technologies of the trainees varied from 2.12 to 34.62 per cent in pre-training where as in post training recorded 42.04 to 85.87 per cent. However, change in knowledge level varied from 26.14 to 74.91 per cent. Similar results were observed by Kaur (2016).

During the year 2017 to 2020, 11 training programmes were conducted and in which 283 trainees were participated. Initially 13 units were established and with the adoption rate of 15.85 per cent during 2017-18 and later on increased up to 46 units having the adoption rate of 42.59 per cent during 2019-20 (Table 3). Out of 46 mushroom units established during 2017-2020 only five units were selected randomly for economic analysis as depicted in Table 4. They produced and sold on an average of 3.87q of mushroom in the local market and earned Rs.35334/- for one crop. The production of mushroom ranged from 2.5 to 6.0q and net returns obtained varied from Rs. 27633/- to 40500/. The present study corroborated with the study conducted by Rachna and Goel (2016) and Chaitra *et al* (2018). The socio-economic constraints faced by mushroom growers were depicted in Table 5. The perishable nature of Oyster mushroom was primary constraint (98.59%) followed by timely non-availability of quality spawn (98.60%), selling fresh mushroom is quite difficult when compared to Agriculture produce (95.05%). Lack of financial support for production from financial institutions, lack of awareness among consumers about nutritional and medicinal importance of mushroom, mushroom is a non vegetarian food and unaffordable to poor as it is costly were the other constraints faced by the mushroom growers.

Table 4. Economic analysis of mushroom production units in Mandya District.

Particular	Unit-1	Unit-2	Unit-3	Unit-4	Unit-5	Average
Mushroom yield per crop (q.)	2.50	3.00	3.50	4.36	6.00	3.87
Cost of production (Rs)	9867	16500	13770	24210	19500	16769
Gross income (Rs)	37500	45000	52500	65520	60000	52104
Net income (Rs)	27633	28500	38730	41310	40500	35335

Table 5. Socio-economic constraints faced by mushroom growers.

Sr. No.	Constraint	No. of trainees	Percentage
1	Perishable nature of Oyster mushroom	279	98.59
2	Lack of financial support for production of mushroom	235	83.00
3	Sale of produce is quite difficult when compared to agriculture produce	269	95.05
4	Lack of awareness among consumers about nutritional and medicinal importance of mushroom	255	90.11
5	Timely non-availability of quality spawn	279	98.60
6	Unaffordable to poor as it is costly	176	62.20
7	Mushroom is a non vegetarian food	98	34.62

CONCLUSION

The trainees inspired by the easy method of mushroom production and gained knowledge after exposure to skill training. Trainees motivated to establish mushroom production units as it requires less capital and even landless trainees can take up the activity. Proper training and guidance to the trainees is essential and would help the interested growers to sustain and earn their livelihood. Trainees realized that mushroom production helped in additional income generation. As the trainees understood clearly the nutritional importance of mushroom and incorporated in their daily diet. The regular supply of quality spawns, perishable nature of the commodity and market linkages are the most important constraints that need to be addressed for mushroom entrepreneurship to sustain.

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Social-Economic Constraints Toward Women Enterprises Growth in Uttar Pradesh

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ABSTRACT

Women entrepreneurs can play a powerful role in confidence building and creating awareness in other women to promote self-reliance. On the other hand, women entrepreneurs have to face more problems than men entrepreneurs. They have to devote more time to the family and maintain a balance between their family responsibility and business. Other obstacles faced by women entrepreneurs include being accepted as a woman in business, lack of role model, lack of professional interaction, difficulties in gaining the confidence of their clients and suppliers, lack of adequate training and lack of related experience. The primary objective of this study was to examine the problems faced by women entrepreneurs. The present study was carried in district Hardoi. One block Bawan was selected in this study area. From this selected block, three villages namely Tatyora, Rukmanapur and Mujahidpur were selected and 50 respondents were selected purposively from each village. Thus, total 150 respondents were selected for the study. The data were analyzed and tabulated according to statistically. It was found that the economic constraints viz; lack of family income restrict the women not for doing any extra/other enterprises was ranked I with mean score value of 2.78 and social constraints viz., negative social attitude about women role outside the home was ranked-II with mean score value of 2.64.

Key Words: Entrepreneurship, women entrepreneur, constraints, micro enterprises.

INTRODUCTION

Entrepreneurship amongst women is a recent phenomenon. When an enterprise is established and controlled by women, it not only boosts economic growth but also has many desirable outcomes. The role of micro-credit is to improve the social-economic development of women and improve the status of women in households and communities. The micro entrepreneurship is strengthening the women empowerment and removes the gender inequalities (Nazar *et al,* 2011). Micro credit is promoting the small-scale business enterprises and its major aim is to alleviate poverty by income

(Backingyavathy,2004). Economic development is one of the factors that have changed the entire scenario of social and cultural environment within the country, especially, for the women. The rural women are engaged in small scale entrepreneurship programme with the help of self help groups (Ahirrao, 2009). Entrepreneurship development among rural women provides economic security, power for self-expression and empowers them as an individual (Chander, 2020). Agriculture allied activities viz; dairy farming, mushroom farming and apiculture etc. provide employment and additional income to farming families if adopted on scientific lines (Ahmed *et al,* 2019).

Gender gap in entrepreneurship is one of the major research interests for most of the economic researchers. Especially in underdeveloped and developing economy it is firmly accepted that women entrepreneurship is one best alternative to resolve the

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Table 1. Seriousness of Economic constraints. **N=150**

Sr. No.	Constraint	Symbol	Total Scores	Mean Score Value	Rank Order
	Lack of family income restrict the women not for doing any extra/other enterprises	A	418	2.78	I
	Lack of financing institutions particularly for women in rural areas	B	352	2.35	II
	Lack of money as well as their right to have the money	C	337	2.25	III
	No personal command of women over money	D	299	1.99	IV

problems arising from poverty. It has been reported that personal, social and environmental factors have affected the development of entrepreneurial learning and competencies that are crucial for the success of women social entrepreneurs (Agarwal *et al,* 2020). Therefore, this study focus on the problems faced by women entrepreneurs in Hardoi district of Uttar Pradesh.

MATERIALS AND METHODS

To complete the above objectives, by employing the appropriate research methodology, the study was conducted in district Hardoi during the year 2017-2018. District Hardoi divided into 18 blocks. One block Bawan was selected in this study area. From this selected block, three villages Tatyora, Rukmanpur, Mujahidpur were selected. Fifty respondents were selected purposively from each village. Thus, total 150 respondents were selected. The recorded data were tabulated and analyzed with the help of appropriate statistical tools.

RESULTS AND DISCUSSION

The rank order of economic constraints *viz.,* lack of family income restrict the women not for doing any extra/other enterprises was ranked I with mean score value of 2.78, followed by lack of financing institutions particularly for women in rural areas was ranked II with mean score value of 2.35, lack of money as well as their right to have money was ranked III with mean score value of 2.25 and no personal command of women over money was ranked IV with mean score value of 1.99, respectively.

The rank order of social constraints *viz.,* negative social attitude about women role outside the home was ranked I with mean score value of 2.64, followed by women suffer from family conflict was ranked II with mean score value of 2.57 and due to *Parda Pratha* in women is restricted within the boundary of their home was ranked III with mean score value of 2.55 and so on as for as each constraint in descending order is concerned.

CONCLUSION

Farm women are important assets of our country. As a whole, women are half of population of the country. Rural areas encompass 80 per cent of the total women's population to sustain and maintain the expected economic boom, the country needs to fully mobilize and utilize all its resources including women too. The participation of women in the entrepreneurial activities is necessary not only from human resource point of view but essential even from the objectives of raising the status in the society. The Government should come forward to organize programs that would be beneficial to the entrepreneurs. These programs could be organized to update the women about the latest updates of the industries, latest technical updates, and organize programmes to imbibe the managerial skills in the entrepreneurs.

Table 2. Seriousness of Social constraints. N=150

Sr. No.	Constraint	Total Scores	Mean Score Value	Rank Order
1.	Negative social attitude about women role outside the home.	396	2.64	I
2.	Women suffer from family conflict.	386	2.57	II
3.	Due to Parada pratha, women's are restricted within the boundary of the home.	383	2.55	III
4.	Unequal distribution of household work.	370	2.47	IV
5.	Men think that women are meant for only indoor house work.	368	2.45	V
6.	In the male dominating society, it hurts man's ego when they take advice from women.	345	2.30	VI
7.	Lack of security when perusing any job/ work/ enterprises performance.	340	2.27	VII
8.	Women do not possess respectable place in the society.	335	2.24	VIII
9.	Lack of social mobility	325	2.17	IX
10.	Resistance from family member.	320	2.13	X
11.	Problem of more competition with men as well as women.	282	1.88	XI
12.	Tendency of others to underestimate a women's capability.	233	1.55	XII

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Soil Fertility Evaluation Using Nutrient Index Approach

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ABSTRACT

A detailed soil fertility status of Krishi Vigyan Kendra (KVK), farm was investigated during 2019 to prepare fertility map and fertilizer recommendations for different crops. Total 37 numbers of geo-referenced (GPS based) composite surface soil samples (0-15cm) were collected from 4 soil unit of KVK farm located at Bharari, Jhansi. Soils were analyzed for pH, EC, organic carbon, available phosphorus, potassium, sulphur and micronutrients *i.e.,* B, Fe, Mn, Cu, Zn. The soil reaction was found slightly acidic to slightly alkaline in nature while EC was found to be in safe range for crop production. About 11 per cent of samples were very low, low (54 %) and medium (35 %)in category of soil organic carbon. The mean available soil P, K and S was found to be 20, 267 kg/ ha and 21ppm, respectively. Soil micronutrient content such as Fe, Mn, Cu, Zn and B were found to be sufficient. The maps indicate the fertility status of KVK farm based on which fertilizer recommendation for crops are made leading to economy of fertilizer and balanced applications and serve as the decision making tool for successful raising of field crops in Bundelkhand region.

Key Words: Nutrient, Soil fertility, Nutrient index, Micro nutrients.

INTRODUCTION

Soil fertility is an inherent property and it can change under the influence of natural and human induced factors. As population of human and animals continue to increase, it disturbs the earth's ecosystem to produce food, fodder and fibre will place greater demand on soils to supply essential nutrients. Continuous cultivation for maximum crop yield removes substantial amount of plant nutrients from soil. Imbalanced and inadequate use of chemical fertilizers, faulty irrigation and various cultural practices also deplete the soil quality rapidly. Soil fertility is an important factor, which determines the growth and yield of plants (Singh *et al,* 2018). However, Soil testing assess the current fertility status and provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields and to maintain the optimum fertility in soil year after year. Therefore, an attempt has been made in present investigation to prepare soil fertility maps for the KVK farm in order to find out the recommendation of organic and inorganic fertilizer to the crops of Bundelkhand region.

MATERIALS AND METHODS

Study area

The study was carried out at Agriculture Research Farm, KVK, Bharari, Jhansi. The district Jhansi comes under Bundelkhand Agro climatic Zone - 06 of Uttar Pradesh and located at latitude of 25.32088^0 N and longitude of 78.034458^0 E. The average annual rainfall of the district is about 885 mm and 90 % of it's received during monsoon season. Droughts and long dry spells occur during rainy season is the common feature in this region which directly affect the *kharif* and *rabi* production. The KVK spreads in an area of 18 ha, out of which 17 ha of area is cultivable land and remaining area is waste land and covered by infrastructure.

Soils of Bundelkhand are characterized by their varying depth, soil texture, colour and topographic

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situations. There are two main soil groups *i.e.,* Red and Black soils classify into four local soils known as Parwa, Rakar, Kabar and Mar. Unfortunately, these all type of soils are found in this study area. The total cultivated area of farm is divided into three blocks namely A, B and C covering 37 small plots. In this farm, Rakar soils cover twelve plots namely 6, 7, 8, 15, 16, 17, 18, 19, 20, 30, 31, 32 and indicate by SU-1, Parwa soil covers seven plots namely 4, 5, 9, 14, 27, 28, 29 and indicate by SU-2, Kabar soil cover fifteen plots 1, 2, 3, 10, 11, 12, 13, 21, 22, 23, 24, 25, 26, 33, 34 and indicate by SU-3, Mar soil cover three plots namely 35, 36, 37 and indicate by SU-4 (Fig:a).

Soil Sampling and Analysis

Altogether 37 numbers of surface soil samples (0-15 cm depth) were collected from KVK, Farm which includes 12, 07, 15 and 03 samples from SU-1, SU-2, SU-3 and SU-4 respectively during May, 2019. The coordination points were recorded by GPS instrument. Quartering technique was used for preparation of soil sample. The samples were air dried and passed through 2 mm sieve and stored in cloth bag. The processed soil samples were analyzed for soil pH with pH meter (1:2 soil water suspension), electrical conductivity by conductivity meter (Jackson, 1973), organic carbon by Walkley and Black method (Walkley and Black, 1934), available phosphorous by spectrophotometer, available potassium using flame photometer, Sulphur by $CaCl_2$ extraction method. Micronutrient analysis was carried out by AAS.

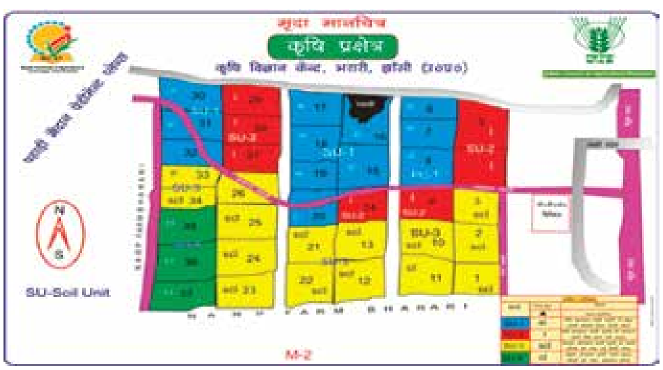

Fig a: Soil map of agriculture research farm, KVK, Bharari, Jhansi

RESULTS AND DISCUSSION

Soil pH

Soil pH (1:2) of surface soil samples of the entire study area was slightly acidic to slightly alkaline in reaction ranged from 6.10 to 8.05pH. The soil pH of SU-1, SU-2, SU-3 and SU-4 varied between 6.10-7.18, 6.45-7.90, 6.28-8.05 and 7.44-7.77 with average value 6.5, 7.2, 7.3 and 7.6 respectively (Table 1). The data showed that a gradual increase in soil pH observed from SU-1 towards SU-3, which could be attributed to the removal of basic cations with runoff water from upland units and medium land units during intensive rainfall and their subsequent deposition in the low land units *i.e.,* SU-3. Similar finding was observed by Priyadarshini *et al* (2017).

Electrical Conductivity

Electrical Conductivity (1:2.5) of surface soil samples were varied from 0.12 to 0.92 dSm^{-1} that is less than 2 dSm^{-1}. Hence, all the soils of the study area are safe for all types of crop production with respect to the soluble salt content (Table 1).

Organic Carbon

Soil organic carbon of surface soil samples ranged between 0.17 to 0.73 %. The organic carbon in SU-1, SU-2, SU-3 and SU-4 varied between 0.17-0.41, 0.22-0.52, 0.21-0.73 and 0.63-0.67 % with mean of 0.20, 0.40, 0.50 and 0.60 % respectively (Table 1, Fig: b). The highest SOC was found in SU-3 (0.73 %) whereas; the minimum organic carbon content was recorded in SU-1 (0.17%). The results clearly showed a gradual increase in average SOC from SU-1 towards SU-3 surface soil samples which could be attributed to higher cropping intensity followed by crop residue incorporation in the low land (Dash *et al,* 2018). The wide variation in organic carbon content in the tested soil might be because of decomposition rate of substrate and different crops to be grown in Agriculture farm (Patil *et al,* 2017).

Available phosphorus

The available phosphorus content in SU-1 and SU-2 varies from 15.14- 19.37 kg/ ha and 12.45-

Table 1. Physico-chemical and macronutrient content in soils of KVK, Bharari.

Sr. No.	Name of soil-unit	No of samples	pH		EC (dSm^{-1})		OC (%)		P ($Kg\ ha^{-1}$)		K ($Kg\ ha^{-1}$)	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	SU-1	12	6.10-7.18	6.5	0.14-0.47	0.3	0.17-0.41	0.2	15.14-19.37	17.3	190-287	233
2	SU-2	7	6.45-7.90	7.2	0.12-0.57	0.3	0.22-0.52	0.4	12.45-22.19	17.9	192-319	234
3	SU-3	15	6.28-8.05	7.3	0.18-0.92	0.5	0.21-0.73	0.5	18.22-27.15	21.7	204-337	288
4	SU-4	3	7.44-7.77	7.6	0.56-0.65	0.6	0.63-0.67	0.6	23.12-24.25	23.7	277-338	315

Table 2. Available secondary and micronutrient content in soils of KVK, Bharari

Sr. No.	Name of soil-unit	No of samples	S (ppm)		Zn (ppm)		Fe (ppm)		Mn (ppm)		Cu (ppm)		B (ppm)	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	SU-1	12	7.98-27.13	16.0	0.80-2.0	1.4	8.10-16.4	12.6	3.0-6.7	4.4	0.3-1.0	0.6	0.6-1.9	1.2
2	SU-2	7	7.98-36.91	20.5	0.4-1.6	1.2	8.10-14.3	11.2	4.0-9.2	6.5	0.4-1.3	0.9	0.6-1.60	1.1
3	SU-3	15	5.90-34.62	17.5	0.6-1.5	1.0	10.2-15.5	12.1	3.9-11.9	6.7	0.6-1.6	0.8	0.5-1.40	0.9
4	SU-4	3	18.62-36.65	29.4	1.1-1.4	1.2	8.1-14.5	10.4	5.1-8.0	6.9	0.6-1.3	1.0	0.6-1.4	1.1

22.19 kg/ha and means value is 17.3 and 17.9 kg/ ha, respectively indicating low available phosphorus content. However, SU-3 (18.22-27.15 kg/ha) and SU-4 (23.12-24.25 kg/ha) soil unit indicating 21.7 and 23.7 kg/ha medium available phosphorus respectively (Table 1, Fig: b). The highest available phosphorus was found in SU-3 (27.15 kg/ha) whereas; the lowest available phosphorus content was recorded in SU-2 (12.45 kg/ha). Low to medium range of phosphorus in soil shows that more fixation of phosphorus with Fe, Al and Ca ions.

Available potassium

The available potassium content in SU-1 and SU-2 unit varies from 190-287 kg/ ha and 192-319 kg/ ha and means value is 233 and 234 kg/ ha, respectively indicating medium available potassium content. However, SU-3 (204-337 kg/ha) and SU-4 (277-338 kg/ha) soil unit indicating 288 and 315 kg/ha high mean value of available potassium (Table 1, Fig: b). This fact may be explained as the soils have been developed from the potash bearing parent materials such as feldspars. Similar results were also observed by Mishra *et al* (2017).

Available Sulphur

The available sulphur content was found in the range of 5.9 to 36.91 ppm (Table 2). In SU-1, SU-2, SU-3 and SU-4 varied between 7.98-27.13, 7.98-36.91, 5.90-34.62 and 18.62-36.65 ppm with average mean of 16.0, 20.5, 17.5 and 29.5 ppm respectively. The maximum value was found in SU-4 (36.65 ppm) whereas; the minimum was recorded in SU-3 (5.90 ppm). A gradual increase in organic carbon, available P and S was observed from SU-1 towards SU-4 soils, which could be attributed to increase in organic matter content in the low land as these nutrients are released from the soil organic matter through mineralization by the activity of micro-organisms (Dash *et al,* 2018).

Micronutrients

The available micronutrient status of agriculture farm, KVK, Bharari was represented in Table 2. Zinc content of surface soil samples was found highest in SU-1 (2.0ppm) and lowest in SU-2 (0.4 ppm). Zinc in SU-1, SU-2, SU-3 and SU-4 varied from 0.80-2.0, 0.4-1.6, 0.6-1.5 and 1.1-1.4 ppm with mean of 1.4, 1.2, 1.0 and 1.2 ppm respectively. The available iron content in SU-1, SU-2, SU-3 and SU-4 unit varies from 8.10-16.4, 8.10-14.3, 10.2-15.5 and 8.10-14.5 ppm means value were 12.6, 11.2, 12.1, and 10.4 ppm, respectively indicating high available iron content. The maximum iron content value was 16.4 in SU-1 and minimum value 8.10 in SU-1, 2 and 4. However, in the entire study area available Fe status was found to be sufficient. Mn content in surface soil samples of the entire study area was found to vary in between 3.0 to 11.9 ppm. The available Mn in SU-1, SU-2, SU-3 and SU-4 ranged from 3.0-6.7, 4.0-9.2, 3.9-11.9 and 5.1-8.0 ppm with mean of 4.4, 6.5, 6.7 and 6.9 ppm, respectively. The maximum available manganese was found in SU-3 (11.9 ppm) whereas; the minimum available manganese content was recorded in SU-1 (3.0 ppm). The available cupper in SU-1, SU-2, SU-3 and SU-4 varied from 0.3-1.0, 0.4-1.3, 0.6-1.6 and 0.6-1.3 ppm with mean of 0.6, 0.9, 0.8 and 1.0 ppm, respectively. The maximum available cupper content was found in SU-3 (1.6 ppm) whereas; the minimum available cupper content was recorded in SU-1 (0.3 ppm). The data showed that, available Mn and Cu contents were increased gradually from SU-1 towards SU-4, which could be attributed to increase in organic carbon content in the low land, as metallic cations form chelates with organic matter. This type of result was in close conformity with results obtained by Mishra (2014) and Pattanayak (2016). The average value of available Boron content in soil of SU-1, SU-2, SU-3 and SU-4 were found 1.2, 1.1, 0.9, 1.1 and 1.0 ppm respectively. The maximum available Boron content was found in SU-1 (1.9 ppm) whereas; the minimum available Boron content was recorded in SU-3 (0.5 ppm).

Delineation of nutrients deficient and sufficient area

In order to compare the levels of soil fertility of

Table 3. Availability of macro nutrients and their nutrient index (NI).

Sr. No.	Soil Unit	Total No of samples	Availability of primary nutrients												Nutrient Index (NI)			
			Organic carbon				Available P				Available				N	P	K	Fertility Code
			VL	L	M	H	VL	L	M	H	VL	L	M	H				
1	SU-1	12	04	08	-	-	-	12	-	-	-	-	10	02	1.66	2.00	3.16	123
2	SU-2	07	-	06	01	-	-	06	01	-	-	-	06	01	2.14	2.14	3.14	223
3	SU-3	15	-	06	09	-	-	03	12	-	-	-	01	14	2.60	2.80	3.93	334
4	SU-4	03	-	-	03	-	-	-	03	-	-	-	-	03	3.00	3.00	4.00	334
Total samples		37	04	20	13	-	-	21	16	-	-	-	17	20	2.35	2.48	3.55	224

Hints: VL-Very low, L-Low, M-Medium, H-High

Table 4. Availability of secondary & micronutrients and their nutrient index (NI)

Sr. No.	Soil Unit	No of Samples	Availability of secondary & micro nutrients																		Nutrient Index (NI)					
			Sulphur			Zn			Fe			Cu			Mn			B			S	Zn	Fe	Cu	Mn	B
			L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H						
1	SU-1	12	04	02	06	-	06	06	-	-	12	-	01	11	-	06	06	-	-	12	2.5	2.5	3.0	2.92	2.5	3.0
2	SU-2	07	-	01	06	-	04	03	-	-	07	-	-	07	-	-	07	-	-	07	2.85	2.42	3.0	3.0	3.0	3.0
3	SU-3	15	05	02	08	01	09	05	-	-	15	-	-	15	-	02	13	-	-	15	2.2	2.26	3.0	3.0	2.86	3.0
4	SU-4	03	-	-	03	-	02	01	-	-	03	-	-	03	-	-	03	-	-	03	3.0	2.33	3.0	3.0	3.0	3.0
Total samples		37	09	05	23	01	21	15	-	-	37	-	01	36	-	08	29		-	37	2.63	2.37	3.0	2.98	2.84	3.0

Hint: L-Low, M-Medium, H-High

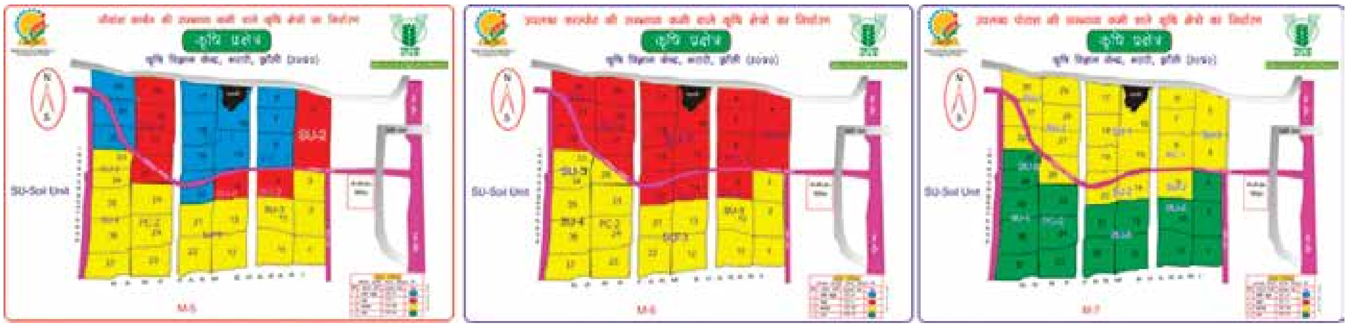

Fig b: Availability of OC, available P, K at M-5, M-6, M-7 respectively in Agriculture Farm, KVK, Bharari, Jhansi

one area with those of another it was necessary to obtain a single value for each nutrient. The whole agriculture field of KVK, Bharari was divided into 04 soil units i.e. SU-1, SU-2, SU-3 and SU-4 on the basis of their soil texture, colour and other physical and chemical parameters. The nutrient deficit or sufficient status of each soil unit is expressed in Table 3. According to soil fertility index, out of 37 soil samples of cultivated field, 11per cent samples in were found in very low content of organic carbon, 54 per cent were low and 35 per cent were medium in category. This distribution of organic carbon represented low nutrient index (2.35). As the organic matter content in the study area was found low in range, the plant available nitrogen content in soils was observed consequently low. Phosphorus exists in soils in both inorganic and organic forms. In reference to available phosphorus, 57 % soil samples was low; while 43% in medium category. Thus, agriculture field showing also low category of nutrient index (2.48). Potassium is one of the three major plant nutrient elements.

The level of available potassium has been found to be medium in 46 per cent and high in 54 per cent of representative area. Because soils of India are rich in potassium so that application of potassic fertilizer should be minimal. Here also the overall nutrient index (NI) of potassium was high (3.55).

The available soil samples and nutrient index for Primary nutrients in Table 3 and for secondary and micro nutrients is depicted in table 4. The number of samples in each of the three classes *i.e.,* low, medium and high is multiplied by 1, 2 and 3, respectively. The sum of the figures thus obtained was divided by total number of samples using following equation:

$$\textbf{Nutrient Index (NI)} \Rightarrow \frac{\text{No. of Samples (Low) X 1 + No of Samples (Medium) X 2 + No. of Samples (High) X 3}}{\text{Total Number of Samples}}$$

Ramamurthy and Bajaj (1969) modified the index classification as low 1.67, medium 1.67 -2.33 and high above 2.33. According to these categories, nutrient index of available S, Zn, Fe, Cu, Mn are 2.63, 2.37, 3.0, 2.98, 2.84, 3.0 respectively and all were found in high categories. On the basis of NI, fertility code for each soil unit has been prepared to recommendation of organic and inorganic fertilizers to different crops (Fig c). The code 1, 2, 3 and 4 indicates very low, low, medium and high category of different nutrients respectively. The overall fertility status of N, P and K is low, low and high (224), respectively.

Fig c: Soil fertility map of agriculture farm based on nutrient index of N, P and K

CONCLUSION

Based on the above study it was concluded that soil fertility status of KVK, Bharari, Jhansi considering the concept of nutrient index value of the soil of investigated area were found in low fertility status for organic carbon, available phosphorus, and high with respect of available potassium, sulphur and micronutrients. The nutrient index value for Nitrogen (N), Phosphorus (P), and Potassium (K), were 2.35, 2.48 and 3.55, respectively while 2.63, 2.37, 3.0, 2.98, 2.84, 3.0 for Sulphur, Zn, Fe, Cu, Mn, respectively. Thus 64.86 percent of soils of KVK, Bharari, Jhansi are likely to respond to nitrogenous and phosphorus fertilization.

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Supplementation of Bypass Fat During Early Lactation in High Yielding Cross Bred Cows Ensures Good Returns

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ABSTRACT

The study was conducted to assess the efficacy of bypass fat supplementation for alleviating energy deficit in high yielding crossbred cows during the early lactation period. Twelve crossbred (Holstein Friesian × Local) cows in early stage of their second and third lactation (10-15 d of calving) with more than 10 l of daily milk production were dewormed and randomly assigned in two groups (Average milk production, 10.15 l and fat percentage 3.3%). The first group of cows (T1) was kept as control and was not supplemented with any energy supplements. The second group of cows (T2) was supplemented with commercial bypass fat at the rate of 10 g/ l of milk produced per day during the initial 90 d of lactation. The final average milk yield of the bypass supplemented cows was 12.32 ± 0.49 which was significantly ($P<0.05$) higher than unsupplemented cows in control group (11.03 ± 0.26). Also, the average milk fat during the study period differed significantly ($P<0.05$) in the bypass supplemented group over the control group. Besides this, supplementation of bypass fat during early lactation ensured good return over feed cost to the farmers.

Key Words: Bypass fat, Milk fat, Milk yield, Return over feed cost.

INTRODUCTION

India has undertaken the crossbreeding policy to increase milk production by increasing the genetic potential of Indian cows for milk yield. The crossbreeding program has certainly resulted in boosting up milk production. However, the milk which is produced possesses less fat percentage due to improper feeding with poor quality roughages. Demand for energy is very high during early stage of lactation but supply does not commensurate with demand, thus affecting the production potential of animal (Sirohi *et al*, 2010). This happens mostly due to lack of proper energy rich diets in the early stage of lactation. The impact of energy is reflected significantly more in lactating and high producing animals, which enter into negative energy balance during early lactation because they cannot consume adequate feed to meet the nutrient requirements for high levels of milk production. Inclusion of unprotected fat in dairy ration is limited to 3 per cent of dry matter (DM) intake, beyond which digestibility of dry mater (DM) and fiber are reduced (NRC, 2001). It has been stated that supplementing ration of lactating animals with bypass fat enhances energy intake in early lactation and reduces the deleterious effect of acute negative energy balance on lactation (Tyagi *et al*, 2010). Supplementation of bypass fat in the diet of dairy animals is very important to alleviate problems of negative energy balance without adversely affecting the dry matter intake and rumen fermentation (Soni *et al*, 2015). Also, its usage during early lactation increases the income of farmers owing to more milk production and fat content. (Rohila *et al*, 2019). The present study was undertaken with the objective of demonstrating the positive effects of bypass fat feeding in early lactating dairy animals.

MATERIALS AND METHODS

The trial was conducted in farmers fields located in Kothamangalam village of Ernakulam district, Kerala for a period of 90 d. Twelve crossbred

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(Holstein Friesian × Local)cows in the early stage of their second and third lactation (10-15 d of calving) with more than 10 l of daily milk production were selected and randomly assigned in two groups. The first group of cows (T1) was kept as control and was not supplemented with any additional energy supplements or bypass fat. The second group of cows (T2) was supplemented with bypass fat at the rate of 10 g / l of milk produced per day during the initial 90 d of lactation. The bypass fat used were rumen inert fats like Ca salts of long-chain fatty acids which resist lipolysis and bio-hydrogenation by rumen microorganisms, but get absorbed from the lower intestine. All the animals were dewormed at the beginning of the trial and ectoparasite infestations were ruled out. Animals were given green fodder (Hybrid napier) @25-30 kg per cow and concentrates mixture with crude protein of 18% and metabolizable energy of 2250 kcal/kg feed to meet their protein and energy requirement for growth as per ICAR standards (Ranjhan, 1998). Concentrate mixture was given according to the level of milk production to meet the maintenance and milk production requirements. Bypass fat was added and mixed in concentrate mixture uniformly and fed. The roughage: concentrate ratio of the diet was kept 60:40. Animals were given ad-lib fresh water throughout the trial. The animals were milked twice a day morning and evening. The concentrate was given at each milking time. Daily milk yield and fat percentage was estimated at fortnightly intervals and average for each group was calculated at the end. The milk was tested with Lactosure milk analyzer at regular intervals and observations recorded. The data obtained in the trial were analyzed statistically by unpaired t test with GraphPad.

RESULTS AND DISCUSSION

Milk Yield

The average milk yield obtained during the 90 d trial was 11.03 l in unsupplemented control (T1) and 12.32 l in bypass fat supplemented group (Table 1). The statistical analysis indicated that the average milk yield of the bypass fat supplemented group (T2) was significantly ($P<0.05$) higher than unsupplemented cows in control (T1) group. This finding was in agreement with the findings of previous workers (Ranaweera *et al*, 2020) who observed that the cows supplemented with bypass fat had recorded significantly higher milk production compared with control during early stages of lactation. Many researchers have reported an increase in milk yield of 5.5-24% during supplementation of bypass fat in feed (Naik *et al*, 2009b; Tyagi *et al*, 2009a; Thakur and Shelke, 2010; Sirohi *et al*, 2010; Parnerkar *et al*, 2011; Wadhwa *et al*, 2012; Gowda *et al*, 2013). The increase in milk yield may be due to the higher energy intake, more efficient use of fat by mammary gland and enhancement of tissue mobilization before peak production (Sklan *et al*, 1991). The addition of fat sources improves the energy status of high-yielding dairy animals and also causes an increase in the energy density of feed. Similar increase in milk yield due to bypass fat supplementation was reported by Garg *et al* (2012) and Mane *et al* (2017). Few researchers have also reported non-significant increase in milk yields due to bypass fat supplementation like Lounglawan *et al* (2008), Soni and Patel (2015) and Veena *et al* (2018) which differs from the finding of the present study.

Milk fat

The average milk fat in the crossbred cows during the trial period was found to be significantly ($P<0.05$) higher in the bypass supplemented group (3.97 %) than the control (3.55 %). Similar increase in milk fat levels were reported by researchers like Garg *et al* (2012) who found an increase of average fat percentage by 0.54 units by supplementing bypass fat @ 100 g/animal. Increase in milk fat percentage was also reported by workers like Soni *et al* (2015), Sharda *et al* (2018), andVeena *et al* (2018). Whereas, few researchers have reported no change in milk fat percentage due to bypass fat supplementation. (Lounglawan *et al*, 2008; Ranaweere *et al*, 2020)

Table 1. Milk yield (l) and milk fat (%) (Mean ± S. E.) measured at fortnightly intervals

Fortnightly intervals of measurement	Milk yield (litre)		Milk fat (%)	
	T1*	T2#	T1*	T2#
At the start of trial	9.92 ± 0.35	10.06 ± 0.27	3.28 ± 0.10	3.32 ± 0.08
2 weeks	10.40 ± 0.33	11.22 ± 0.29	3.46 ± 0.09	3.67 ± 0.10
4 weeks	11.08 ± 0.28	11.97 ± 0.17	3.58 ± 0.09	3.97 ± 0.08
6 weeks	11.71 ± 0.27	13.00 ± 0.14	3.70 ± 0.08	4.22 ± 0.10
8 weeks	11.83 ± 0.31	13.78 ± 0.32	3.66 ± 0.12	4.23 ± 0.10
10 weeks	11.37 ± 0.26	13.25 ± 0.31	3.59 ± 0.11	4.25 ± 0.11
12 weeks	10.92 ± 0.23	12.93 ± 0.30	3.56 ± 0.10	4.12 ± 0.06
Mean	11.03 ± 0.26	12.32 ± 0.49	3.55 ± 0.05	3.97 ± 0.13

*T1 - Control, #T2 - Bypass fat supplemented group

Table 2. Returns over feed cost (in Rs.) due to bypass fat supplementation

Sr. No.	Particular	T1*	T2#
A.	Daily average feeding and maintenance cost (Rs. /cow)		
1.	Cost of green fodder @Rs.2/kg –Total 30 kg	60	60
2.	Cost of concentrate@ 6 kg/cow @ Rs.18/-	108	108
3.	Cost of milking/day (in Rs.)	33	33
4.	Cost of bypass fat supplementation @ 10 g/l of milk-120 g/day (Rs.135/kg)	0	16
	Total (in Rs.)	201	217
B.	Daily Average milk yield (l)	11.03	12.32
C.	Daily average receipt (Rs./cow) @ Rs.34 for Control and Rs.36 for Bypass fat supplemented based on fat in milk	374	443
D.	Daily return over feed cost (Rs./cow) (C-A)	173	226
E.	Daily net return of feed cost over control (Rs.)		53

Economics and return over feed cost

Supplementation of bypass fat during early lactation ensures good return over feed cost to the farmers. Daily net return of feed cost over control per cow showed 31per cent increase in returns in the bypass supplemented group over the control. This was in lines with the returns over feed cost reported by Sharda *et al* (2018) who observed daily net return of feed cost per cow as Rs.28 with increase in returns by 47% in their trial. Similarly, Kumar *et al* (2020) also reported significant increase in income of farmer with bypass fat supplementation during early lactation with a return over feed cost of Rs.33/- over control in bypass fat supplemented group @100 g/animal/day and of Rs.52/- in bypass fat supplemented group @150 g/animal/day.

CONCLUSION

Effective management of energy deficit during early lactation period in high yielding crossbred cows can be done by supplementing bypass fat @10 g/l of milk produced. The significant increase in milk yield and milk fat ensures increased returns to the farmer while alleviating negative energy balance during this period.

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Training need Analysis of Agricultural Officers of Department of Agriculture Development and Farmers' Welfare Kerala

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ABSTRACT

The present study was undertaken in two zones of Kerala viz., Kannur from North Kerala and Thiruvananthapuram from South Kerala. A sample of 90 Agricultural Officers were randomly selected and information was gathered and analyzed. A well-structured interview schedule was used for data collection from the respondents. Training need analysis was conducted in two dimensions namely agricultural practices and extension. The results revealed that majority of the Agricultural Officers belonged to medium training need group. It was observed that job satisfaction, scientific orientation and facilities at training center were having positive and significant relationship with the training need of Agricultural Officers in agricultural practices and extension at 0.01 level of probability. Job experience and mass media contact having negative but significant relationship with training need of Agricultural Officers in agricultural practices and extension at 0.01 level of probability.

Keywords: Agricultural Officers, Kerala, Training need in agricultural practices, Training need in extension, Training Need Index

INTRODUCTION

Training, the foremost vital input for human resource development, is the integral part of the Training and Visit system of Agricultural Extension. Analyzing the situation and realizing what would be the training needs of the future is a vital prerequisite for any training programme to give an effective impact on the trainees. The training need analysis must be carried out before training activities are organized, since it guarantees the success of those activities. It ensures effectiveness, job performance, and strategic organizational development (Potter *et al*, 2003).

Agricultural Officers are the key technical personnel and their efficiency in working depends on their ability and competency backed with technical knowledge, understanding, and skills in agriculture and extension discipline. Due to technical break-through in agriculture, and for implementation of various developmental programmes to keep pace with the recent development, the constant periodical training is mandatory for extension functionaries especially with the introduction of block level Krishi Vigyan Kendras /Agricultural Knowledge Centers (AKC). The agricultural officers should prepare production plan of different crops with the support of Scientists of Agricultural university at block level is envisaged in the AKC concept of Kerala (Sreedaya, 2020). Training imparted to the AOs, is unique to each person, depending upon their basic academic and technical qualifications, besides the service, experience and requirement. Sometimes a particular training may not fulfil the requirements of the whole participants attending it.

To offer a systematic training, as already pointed out one should identify the existent training needs of identified areas. It will help to refresh the training modules which were in progress and

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Table 1. Training need of AOs in agricultural practices and extension.

Sr No	Training Need	Total (N=90)	
		TNI	Rank
Seed manures and fertilizers			
1	Improved varieties of important crops and selection of suitable varieties in field situation	90.00	7
2	Seed production	81.48	17
3	Different types of fertilizers	77.78	22
4	Improving soil fertility status with appropriate doses of manures and fertilizers	88.89	9
5	Seed multiplication methods	76.29	25
6	Compost making	75.18	27
Agronomic practices			
7	Preparatory tillage in important crops	68.51	36
8	Methods of nursery raising in paddy	74.81	28
9	Transplanting	69.62	34
10	Chemical weed control	75.56	26
11	Intercultural operations	70.74	33
12	Maturity indices and identifying correct harvest stage of crops	74.07	29
Soil and water management			
13	Different types of soils and their management	81.48	17
14	Soil and water conservation in field situations	78.51	20
15	Importance and drawing of soil samples	72.96	30
16	Water and its management	77.40	23
17	Soil reclamation	84.81	13
18	Water management in important crops	78.51	20
Plant protection			
19	Identification of pests and their control in important crops	96.29	1
20	Identification of diseases and their control in important crops	94.44	3
21	Preparation of different concentrations of spray solutions	88.89	9
22	Spraying techniques	89.62	8
23	Plant protection equipment and their maintenance	83.33	15
24	Integrated pest control	95.18	2
Post harvest technology			
25	Harvesting threshing and drying the agricultural produce	82.59	16
26	Processing of produce	72.59	31
27	Sorting and grading of agricultural produce	71.11	32

28	Post-harvest technologies of important crops	86.67	12
29	Packaging of agricultural of produce	68.89	35
30	Important food grain storage techniques	80.37	19
General			
31	Understanding and interpretation of meterological data	81.11	18
32	Crop, estimation surveys	77.78	22
33	Use and maintenance of agricultural implements and machinery	77.03	24
34	Orientation on farm planning and contingency planning	84.81	13
35	Diversified farming	84.44	14
36	Agriculture credit and credit institutions	88.51	10
Field extension activities			
37	Selection of farmer groups and contact farmers	83.33	15
38	Procedures to make field visits and extra visits	80.37	19
39	Production recommendations of major crops and their implications	92.96	5
40	Conducting field demonstrations and farm trials, making observations and recording data	90.37	6
Communication and A.V aids			
41	Communication methods and techniques	84.44	14
42	Selection of appropriate communication techniques	78.14	21
43	Planning, preparation, use and evaluation of audio visual aids.	83.33	15
44	Use of extension literature	70.74	33
Management			
45	Basic principles of extension management	72.96	30
46	Effective utilization of available resources	83.33	15
47	Timeliness, feasibility and profitability of production recommendations	84.44	14
48	Time management in field visits	75.56	26
Feedback and follow up			
49	Selecting evaluation criteria	75.18	27
50	Evaluation of field problems	78.14	21
51	Methods of giving feedback about field and operational problems	74.81	28
52	Follow up action to be taken in adoption, partial adoption and non-adoption of recommended practices by farmers	75.92	26
Training activities			
53	Effective participation methodology in fortnightly training sessions	86.67	12
54	Assessing the training needs of farmers	75.92	26
55	Conducting training sessions for farmers	77.78	22

56	Organizing farmers training programmes	90.0	7
Leadership			
57	Identification and making use of opinion leaders and contact farmers in technology dissemination process	87.78	11
58	How to motivate and encourage farmers to adopt recommended practices	93.70	4
59	Human relations	90.37	6
60	Speaking in meetings (public speaking)	84.44	14

to formulate new training modules by the training institutes like KVK, Agricultural Universities, State and Central Agricultural training institutes, NGOs and other training institutes. The identified areas will also implicate the policymakers to fund training programmes on new areas for an effective implementation of technology led extension services by the agriculture department. This is of paramount importance in order to plan strategies for effectively organizing the training programmes in future

MATERIALS AND METHODS

This study was conducted in the two districts of Kerala viz., Kannur from North, Thiruvananthapuram from South Kerala. Totally 90 Agricultural Officers were selected based on random sampling. Ex-post- facto research design was used for the study. A well structured interview schedule was prepared after consultation with the experts in extension and other related fields. Training need analysis of AOs was studied in two dimensions mainly training need in agricultural practices and training need in extension. The scale developed by Prasad (1990) was used for the study. Training need in agricultural practices comprises of 36 statements and training need in extension comprises of 24 statements. Opinions were collected from the respondents for all the 60 training need items, in the different categories of the training needs under agricultural practices and extension. The total score of each respondent on the scale was obtained by adding the score of all items in the scale, the score range was between 60 and 180. Each need item was provided with three response categories namely High need, medium need and low need and the weightage assigned were 3, 2 and 1 respectively and the training categories were formed based on the mean and standard deviation percentage

Training Need Index (TNI) was computed with the help of following formula. Based on the TNI, the need hierarchy rank was assigned for identification of most needed item.

TNI = Total score obtained / Maximum obtainable score ^{x} 100

RESULTS AND DISCUSSION

Table 1 reveals that training needs of Agricultural Officers in agricultural practices and extension in the following order of ranking. Identification of pests and their control in important crops (96.29)-first rank, integrated pest control(95.18)-second rank, identification of diseases and their control in important crops(94.44)-third rank. It is because, the crop continuously gets effected by pests and diseases and farmers need the help of AOs mainly for identification of pests and diseases. Hence, AOs need to get updated on latest methods for effective control measures. Fourth rank was given to how to motivate and encourage farmers to adopt recommended practices (93.70). In most of the times AOs failed to motivate the farmers to adopt the technologies even though they were thorough with the subjects. Unless the farmers were properly motivated, it is not possible to make them adopt the new practices. Fifth rank was assigned to production recommendations of major crops and their implications (92.96). It was observed

Table 2. Distribution of respondents based on their total training needs in agricultural practices and extension.

Sr. No.	Category	Frequency (N= 90)	Percentage
1	Low need	15	16.67
2	Medium need	56	62.22
3	High need	19	21.11
	Total	90	100

Range-108-178, Mean- 146.83, SD-21.15

in most of the places of the study area farmers largely depend on the shopkeeper's advice to use chemicals to control pests and diseases. Some innovative farmers were very enthusiastic to try the new varieties of crops which are yet to be released by the Universities, or which are under trial. Hence AOs are likely to get questions from farmers on these aspects and if they are not trained to answer farmer's doubts, their credibility will be lost.

Sixth rank equally distributed to conducting field demonstrations and farm trials, making observations and recording data(90.37) and Human relations(90.37). It is important to raise farmer awareness about new practices. Those new practices must be carried under local condition in collaboration with the farmers. Hence AOs require training in conducting demonstrations. Improved varieties of important crops and selection of suitable varieties in field situation(90.0) and organizing farmers training programmes(90.0) were assigned with seventh rank. Farmers are desire to seek information about new high yielding varieties of different crops to enable them to reap high yields and to get more income and also AOs should have the knowledge on organising farmers training programmes as they are vital in transferring the knowledge and skills of new practices to the farmers. Eighth rank was given to spraying techniques(89.62). Ninth rank was equally distributed to preparation of different concentrations of spray solutions(88.89) and improving soil fertility status with appropriate doses of manures and fertilizers(88.89) followed by Agriculture credit and credit institutions was ranked tenth(88.51). Remaining training need items were felt less important by AOs and training programmes on these areas can be conducted occasionally to benefit the newly recruited officers. It was observed that AOs need more training in agricultural practices followed by extension.

It also showed that some of the AOs failed to motivate farmers to adopt the recommended practices and disseminate the information of new varieties and other practices. This clearly indicated that, the AOs who were trained in agricultural technologies should also be trained in extension failing which the purpose of Agricultural Extension System (T&V System) cannot be achieved. This findings were in the line with the findings of Mohan *et al* (2020).

The data (Table 2) revealed that majority (62.22%) of the AOs were belonged to medium training need group, whereas 21.11 per cent of the AOs were belonged to high training need group and only 16.67 per cent were belonged to low training need group. This shows that majority of Agricultural Officers require training to the medium extent to update their knowledge. The findings were in line with the findings of Yadav *et al* (2012).

Correlation Analysis

The correlation analysis (Table 3) showed that job satisfaction, scientific orientation and Facilities at the training center were significantly and positively correlated with the training need of AOs in agricultural practices and extension at 0.01 level of probability. Job experience and mass media

Table 3. Relationships of selected characteristics of Agriculture Officers and Training need of AOs in agricultural practices and extension.

Sr. No.	Item	Coefficient of Correlation 'r' Values
1.	Age	0.193 NS
2.	Job experience	-0.387**
3.	Mass media contact	-0.300**
4.	Job satisfaction	0.286**
5.	Scientific orientation	0.375**
6.	Facilities at the training center	0.396**

'**' Significant at 1% level, 'NS' Non-significant

contact were significantly and negatively correlated with the training need of AOs in agricultural practices and extension at 0.01 level of probability. The correlation analysis shows that, If officer satisfy with the job he will be motivated to carry out the given tasks more efficiently and when he likes to expand the activities he may require more training which might be the reason for the positive correlation between job satisfaction and training need in agricultural practices and extension. It is obvious that officers who had high scientific orientation tend to know the emerging techniques and recent advances in agriculture which might be the reason for positive correlation between the scientific orientation and training need in agricultural practices and extension and also the officers who are more satisfied with the facilities at the training centre had accurate idea about the duties and activities than others naturally desire to go for training to have more work effectiveness as an individual extension worker as it provides opportunities for acquisition of knowledge and skill so this might be the reason for positive correlation between facilities at the training centre and training need in agricultural practices and extension.

CONCLUSION

From the study, it can be concluded that majority of the respondents belonged to medium training need category in agricultural practices and extension, which needs a lot of improvement. This clearly indicates that, the AOs who are trained in agricultural technologies should also be trained in extension failing which the purpose of Agricultural Extension System (T&V System) cannot be achieved.

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Training on Oyster Mushroom Cultivation Enhanced Knowledge Levels of Farm Women in North East Hilly Region of Mizoram

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ABSTRACT

Mushrooms are the edible fruit/fruiting bodies of the edible fungi having high nutritive and pharmaceutical values with delicacy. Oyster mushroom cultivation plays an important role to eliminate malnutrition, reduce poverty, additional income generation and generate employment opportunity for farm women in rural area. Mushroom is also efficient means for changing of agricultural waste into valuable protein source. Krishi Vigyan Kendra, Lunglei district conducted vocational training programmes on oyster mushroom cultivation. The study has shown that exposure to the training programme and method demonstration increased the skill and knowledge of rural farm women with regard to techniques of mushroom cultivation. A structured interview schedule was finalized and survey was done in 120 randomly selected rural farm women from two villages- Hnahthial and South Vanlaiphai to assess the social acceptability. The results reflected that the mushroom cultivation training has generated a remarkable attitude among the trained rural farm women and also increased the socio-economic level of beneficiaries who take on as a primary source of livelihood activity. It was also observed that economic viability of oyster mushroom production as mushroom yield varied from 140-150 kg per cycle from 100 blocks/cycle/unit with gross income ranged from Rs. 40000/- - Rs. 45000/- having net profit of Rs. 30000/-- Rs. 32500/- within two months in twice to thrice harvest.

Key Words: Mushroom cultivation, Vocational training, Oyster mushroom, Self-employment.

INTRODUCTION

In India, due to distinct climate, temperature and abundance of agricultural farm waste, different types of temperate, tropical and sub-tropical mushrooms are cultivated throughout the country (Shah *et al,* 2004). Sharma *et al* (2017) reported that the total production of mushrooms in India is 0.13 Mt (approx.) and in total production of mushroom white button shown is 73 per cent, oyster mushroom (16%), paddy straw mushroom (7%) and milky mushroom (3%). Mushrooms grow at temperatures ranging 15^0-23^0C. There are different types of mushrooms. The three majorly grown mushrooms in India are oyster mushroom, button mushrooms and milky mushrooms. Mushrooms are very nutritious products that can be generated from lignocelluloses waste materials; and rich in crude fiber and protein. Mushrooms contain low amount of fat and calories and high vitamins. Mushrooms are nutritional, medicinal and functional food. It is considered as a healthy food as it contains low calories, high protein, dietary fiber, vitamins and minerals (Barros *et al*, 2008). According to Kalac (2013), mushrooms are nutritionally desirable because of their low energy value, fiber content and high antioxidant capacity. Mushroom also contains good source of vitamin B, C and D, including niacin, riboflavin, thiamine, foliate and various minerals including potassium, phosphorus, calcium, magnesium, iron and copper.

Mushroom cultivation can help decrease vulnerability to poverty and strengthens livelihoods through the generation of a fast yielding and nutritious source of food and a reliable source of income (Rachna *et al*, 2013). According to reports of Chadha and Sharma(1995) Mushroom is an indoor crop, grown independently without sunlight and do

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Table 1. Reasons of participation in vocational training programme in mushroom production.

Sr. No	Reason	Number	Percentage
1.	To gain knowledge about mushroom production technology for nutritional and additional source of income generation	89	74.16
2.	How to grow different variety of mushroom	54	45.00
3.	To obtain certificate of training course for loan	5	4.16
4.	To transfer skill to fellow farmers about mushroom cultivation	27	22.50
5.	To establish linkages with KVK	62	51.66
6.	To adopt mushroom cultivation as an enterprise	75	62.50

not require fertile land and can be grown on small scale as it does not involve any significant capital investment. Promotion of mushroom cultivation could mitigate pressure on land, enhance food and nutritional security and raise the status of rural farm women through drawing additional income and in household decision making as far as concerned (Manju *et al*, 2012). India produces about 600 million tones of agricultural waste per annum and a major part of it is left out to decompose naturally or burn *in situ.* The substrate for oyster mushroom cultivation can be prepared from any agricultural waste material and can be produced in temporary clean shelters. Spent mushroom substrate can be converted into organic manure/ vermicompost.

Mushroom cultivation might serve as an important means of generating employment, for rural farm women and school dropout youths which in turn, will uplift their socio-economic condition. Mushroom can be grown in their home yards since it needs a small piece of area for cultivation and is easy, low budget and acceptable technique for rural areas. According to Bhatia (2000) mushroom cultivation will enhance the socio-economic situation of farm families and solve employment problems of both illiterate and literate women. Considering the above mentioned facts, the present study was undertaken by Krishi Vigyan Kendra Lunglei to promote the oyster mushroom cultivation as an income and employment generation activity.

MATERIALS AND METHODS

Training programmes on oyster mushroom production were conducted both on and off campus of KVK. Farm women of village Hnahthial and South Vanlaiphai were actively participated in the training programme. A structural interview schedule was workout and survey was carried out in the two villages to assess the social acceptability. Sixty respondents, especially farm women from each village were selected randomly thus a total of 120 farm women were selected for the investigation. List of 120 respondents was worked out who have acquired vocational training and method demonstration on oyster mushroom cultivation technique from the two villages during the year 2020-21. To evaluate the technical knowledge acquired by trainees and usefulness of vocational training, a pre-test prior to training and post assessment after training was carried out to notice the level of knowledge of participants. In order to evaluate the knowledge of trainees, a compiled set of 11 questions associated to mushroom cultivation, nutritional value, value added byproducts prepared from mushroom, picking, pest and disease, spawn production and storage methods etc. were developed and the valuable suggestions from the trainees were also noted down for further enhancement in the following training programme. Change in perception level of respondents was drawn from the difference of score obtained in pre and post knowledge.

Table 2. Change in perception level of respondents for oyster mushroom cultivation (N=120).

Sr. No	Particular	Pre-test Knowledge before training (%)	Post-test Knowledge after training (%)	Change in perception level (%)
1.	Awareness of mushroom species and identification of edible mushroom	9.00	86.50	77.50
2.	Knowledge of nutritional and medicinal value of mushroom	10.50	92.25	81.75
3.	Materials and methods used for different types of mushroom cultivation	11.75	96.00	84.25
4.	Techniques of compost preparation	1.75	70.50	68.75
5.	Pest and disease infestation on mushroom	8.50	81.50	73.00
6.	Profitability in mushroom production	20.00	98.50	78.50
7.	Harvesting and storage techniques	8.50	92.00	83.50
8.	Mushroom spawn production	0.00	22.50	22.50
9.	Awareness of loans, sub schemes and subsidies provided by public or private sectors for establishment of mushroom production unit	3.50	90.25	86.75
10.	Post harvest handling and value added products of mushroom	10.50	96.25	85.75
11.	Market value chain	8.00	75.75	67.75

RESULTS AND DISCUSSION

A major indicator of the effect of vocational training programme is the magnitude, to which they have adopted the package of practices of mushroom production technology. The factor which influenced the respondents to attain the training programme was given for ranking in order of significance as perceived by them. The result indicated that about 62.50 per cent attained the training programme to adopt mushroom cultivation as an enterprise, 74.16 per cent willing to gain knowledge about mushroom production technique for nutritional and additional income generation, 45.00 per cent wanted to grow different species of mushroom, 51.66 per cent joined the training course to established good linkages with the KVK, 22.50 per cent wanted to transfer skill to fellow farmers and only 4.16 per cent wanted to obtained training certificate course (Table 1). Similar confirmative result was also reported by Kaur (2016).

Changes in perception level of respondents prior to and after training course were indicated in Table 2. The result shows that rural farm women evolve a successful attitude towards mushroom cultivation after completion of vocational training and method demonstration. In pretest to vocational training, the knowledge of respondents about mushroom spawn production was zero per cent, 1.75 per cent on techniques of compost preparation, 3.50 per cent in case of awareness of loan, sub schemes and subsidies provided by public or private sectors for establishment of mushroom production unit, 8.50 per cent in harvesting and storage techniques, 9 per cent regarding knowledge of mushroom species and identification of edible mushroom. The post training score of different practices varied from 22.50 per cent in case of mushroom spawn production to 98.50 per cent in case of profitability in mushroom production. The result indicated that pre-test knowledge result was not much adequate for all the aspects of training programme. Nevertheless, the knowledge score obtained by respondent's later training was more satisfactory in each and every aspect. Satisfactory change in perception level might be due to keen interest of participants and methods followed for technology transfer to the trainees.

CONCLUSION

Mushroom cultivation is the most appropriate job role for the poor farm women in rural areas. It can be grown in the small space at home yard for small scale production. Socio-economic status of the members of rural farm women can be enhanced by various entrepreneurship development programmes like vocational trainings and method demonstration both on and off campus. The perception levels of the respondents about mushroom cultivation and its production after training have changed significantly. The main reason behind the satisfactory change in perception level is due to keen interest of participant and method followed for technology transfer to the trainees. Majority of the participants, especially the farm women were in young age group which gives better opportunity for generating self employment for rural women. Selection of trainees on the basis of their available resources and interest was of major concerne. Due to low budget requirement, short growing period, high value crop, mushroom cultivation can be adopted by small marginal farm women in both rural and semi-urban areas. Constant availability of good quality spawn is the most important intervention that needs to be addressed for mushroom entrepreneurship to grow.

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User Friendly Pick Bag for Pearl Millet Ear Head Collection

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ABSTRACT

Various agricultural processes like pre-sowing, weeding, picking and post-picking require extensive farm work. For farm workers engaged, these tasks are not only time consuming but also drudgery inducing over years. This directs for interventions in terms of improved technologies to relieve women from high energy demands, time spent and associated drudgery. An access to affordable technology reduces drudgery, saves time and increases work efficiency of farm workers. Adoption of such technologies radically changes their lives. Therefore, study was conducted to develop user friendly pick bag for Pearl Millet Ear Head Collection which would reduce the drudgery and increase farmers' efficiency. The study was carried out in the fields at CCSHAU farm, *Arya Nagar* and *Bherian* village of Haryana state with the objective to assess suitability for pearl millet ear head collection during pearl millet harvesting season on various parameters. Developed pick bag for Pearl millet ear head collection was found suitable. It was assessed as a good initiative towards reduction of drudgery and increasing work efficiency of the worker, hence recommended over the existing practice (conventional bag) of Pearl Millet Ear Head Collection.

Key Words: Drudgery, farm workers, Pearl millet ear head collection, suitability.

INTRODUCTION

Agriculture is one of the most labour intensive occupations of unorganized sector. Many farming and allied activities performed by the farm workers involve a lot of physical strain which adversely affects their work efficiency and leads to several types of occupational health hazards like mechanical hazards, chemical hazards, musculoskeletal disorders, environmental hazards, physical hazards, biological hazards *etc.* These health hazards can create serious health problems for the workers in the long run. Incidences of chronic skeletal muscular and postural health problem such as strain/sprain, neck pain, joint pain, back pain, hand and leg pain, shoulder pain, chest pain, accidents like cut/ wounds, scratches, injury and respiratory diseases such as asthma are indicative of work related health disorders (Chaoudhari *et al,* 2009).

Ergonomics is the scientific study of the relationship between man and his working environment that includes ambient conditions, tools and materials, methods of work and organization of the work. The health of farm workers is of utmost importance, adding to the overall development of agriculture. Therefore, drudgery reduction measures need to be initiated to avoid occurrence of health hazards among farm workers. In view of this, it was felt that there was an urgent need to make them aware about latest drudgery reducing technologies and to motivate them to adopt the same. If relevant technologies are made available to the farm workers, it would definitely contribute in reducing their drudgery, increasing their working capability, increasing farm production, resulting in improved quality of life (Sundhesha, 2018).

The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana which account for more than 90% of pearl millet acreage in the country and commonly grown in *kharif* season. Harvesting of pearl millet

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Table 1. Opinion regarding designing features of Pick Bags for Pearl Millet Ear head collection. n=50

Design	Designing Features	WMS
Design # 1	Full body backing with stiff material	1.6
	Back length increased by 3 inches	1.2
Design # 2	Addition of 4 inch wide strip backed with stiff material (tetron) at the bottom and sides	3.0
	Pocket length reduced to 6 inches	2.7
	Straight shape was given at the sides instead of curved	2.7
	Back length increased by 3 inches	1.2
	Provision to insert required material to give raised effect at the main body to provide fullness	3.0
Design # 3	Addition of 4 inch wide strip backed with stiff material (Foam) at the bottom and sides	3.0
	Pocket length reduced to 6 inches	2.7
	Straight shape was given at the sides instead of curved	2.7
	Back length increased by 3 inches	1.2
	Provision to insert stiff material to give raised effect at the main body to provide fullness	3.0
Design # 4	Addition of 4 inch wide strip backed with stiff material (tetron) at the bottom and sides	3.0
	Pocket length reduced to 6 inches	2.7
	Straight shape was given at the sides instead of curved	2.7
	Back length increased by 3 inches	1.2
	Half body was backed with stiff material (tetron) to give stiffness to the main body of the pick bag	2.0
	Provision to insert required material to give raised effect at the main body to provide fullness	1.0
Design # 5	Four inch wide strip added at the bottom and sides with provision for inserting desired stiff material to provide fullness to the pick bag	1.2
	Pocket length reduced to 6 inches	
	Straight shape was given at the sides instead of curved	2.7
	Back length increased by 3 inches	2.7
	Provision to insert required material to give raised effect at the main body to provide fullness	1.2
		1.0

crop in Haryana is done in two ways as i) in rain fed areas women cut the *bajra* cobs with sickle from top using rest of the crop as green fodder for animals, ii) on the contrary, in irrigated areas the crop is harvested from the bottom and bajra cobs are cut after that. This generally requires bending, stooping and adopting unnatural body postures to collect straws & tie the bundles. For doing this task, they have to stretch their hands fully to reach the *bajra* cobs & adopt arduous posture causing undue stress on women. This activity of *bajra* cobs cutting is primarily performed by farm women. This is a tedious activity as reported by farm women. On an average, a woman spends approximately six hr daily in collecting 20-24 Kg of particular crop using '*jholi'* which is a traditional way of making 'conventional bag' out of their own garments and clothing (including *Chunni, Lugdi* and *Chadder*) which is tied in the form of a bag on their shoulders and back (Gandhi *et al,* 2012).It was reported that width of the conventional bag made by them using *Chunni* etc. decreases towards upper side and it becomes difficult to collect pearl millet ear heads after half-length of the conventional bag as the heads start falling on the ground . Also, the length of pearl millet ear heads also act as hindering factors. To overcome these problems faced by the farm workers in the fields, pick bag for Pearl millet ear head collection was designed and developed for farm workers. Pick bag for Pearl millet ear head collection was then tested in the fields and was found better than existing method of collection. It was also found highly acceptable technology for being user friendly. In this direction, the suitability of developed user friendly Pick bag for Pearl millet ear head collection, field testing of bag was assessed on various parameters.

MATERIALS AND METHODS

Designing of Pick bag for Pearl millet ear head collection

Six samples of pick bag for Pearl Millet head collection were designed incorporating additional constructional designing features. Out of these, one design was not found convenient and practically feasible hence was rejected in the first phase of testing itself by the researchers. Five designed and developed pick bags were tested for pearl millet head collection at Chaudhary Charan Singh Haryana Agricultural University farm during the Pearl millet harvesting season along with ergonomics testing team of Family Resource department**.** All the designing features of pick bag were assessed, so that the most accepted designing features could be combined to finalize a pick bag for Pearl millet head collection on three point scale i.e. highly suitable, suitable and somewhat suitable.

Each design was also tested on various suitability parameters (comfort, shape, appeal, convenient to put on, convenient for loading-unloading, functional (fulfill the purpose) and suitability of fabric) on three point scale i.e. highly agree, agree and somewhat agree scoring 3, 2 and 1 using modified schedule developed in the department.

Development of Pick bag for Pearl millet ear head collection

After final selection of the design on the basis of constructional features, the selected Pick bag for Pearl millet ear head collection was finally developed as per the ergonomic assessment. Some of the features of developed pick bag are half body backing with stiff material to give stiffness to the main body of the pick bag, strip backed with stiff material (tetron) at the bottom and sides, pocket length of 8 inches and straight shape at the sides instead of curved.

Suitability assessment of developed Pick bag

Pick bags was tested on various suitability parameters. The measurement of fabric used for developing pick bag was 40x60 inch. On an average, a farm woman collects 8-10 kg pearl millet ear heads in one lot. Suitability was assessed with reference to comfort, appeal, convenient to put on, convenient for loading-unloading, functional (fulfill the purpose), appropriate size and shape, increase efficiency and good replacement over existing

Table 2. Testing of pick bag for Pearl Millet head collection on various suitability parameters.

Sr. no	Suitability parameter	Design 1 WMS	Design 2 WMS	Design 3 WMS	Design 4 WMS	Design 6 WMS
1	Comfortable	2.0	2.0	2.0	2.0	1.4
2	Appealing	2.0	2.0	2.0	2.0	1.2
3	Convenient to put on	1.7	2.6	2.8	2.8	1.3
4	Convenient for loading-unloading	1.3	1.4	2.0	2.4	2.0
5	Functional	1.4	1.6	2.5	2.8	1.0
6	Shape appropriate	1.4	2.2	2.4	2.8	1.1
7	Suitable fabric	2.0	2.0	2.0	2.0	2.0

methods on five point scale i.e. highly suitable, suitable and somewhat suitable, least suitable, unsuitable scoring 5, 4, 3, 2 and 1, respectively.

RESULTS AND DISCUSSION

Testing of designed pick bags for pearl millet ear head collection (Table 1)

In the case of Design # 1, the designing feature full body backing with stiff material was found suitable with WMS 1.6 while back length increased by 3 inches was the least suitable feature with WMS 1.2. whereas, in design # 2 addition of 4 inch wide strip backed with stiff material (tetron) at the bottom & sides was found 'most suitable' (3.0) by the respondents followed by pocket length reduced to 6 inches and straight shape given at the sides instead of curved with WMS 2.7 .

In design # 3, adding 4 inch wide strip backed with stiff material (foam) at the bottom and sides was most suitable feature (3.0) followed by pocket length reduced to 6 inches and straight shape given at the sides instead of curved with WMS 2.7.

In design # 4, adding 4 inch wide strip backed with stiff material (tetron) at the bottom and sides was found most suitable feature (3.0) followed by straight shape given at the sides and pocket length reduced by 6 inch' with WMS 2.7. Half body backed with stiff material (tetron) to give stiffness to the main body of the pick bag was also reported as suitable feature (2.0).

In Design # 5, pocket length reduced by 6 inches and straight shape given at the sides instead of curved was recorded as suitable feature with WMS 2.7 while the main feature i.e. four inch wide strip added at the bottom and sides with provision for inserting desired stiff material to provide fullness to the pick bag was opined as least suitable (1.2) by majority of the respondents because inserting stiff material was found in-convenient in use. Back length increased by 3 inches and provision to insert required material to give raised effect at the main body to provide fullness were found 'least suitable features in all the designs.

It was concluded that the most acceptable constructional designing features were half body backing with stiff material (tetron) to give stiffness to the main body of the pick bag, addition of 4 inch wide strip backed with stiff material (tetron) and foam at the bottom and sides, pocket length reduced to 6 inches and straight shape given at the sides instead of curved.

Testing of designed and developed pick bags on various suitability parameters (Table 2)

Five designed and developed pick bags were tested on various parameters to assess the suitability. For design no. 1, most of the respondents agreed on suitability parameters i.e. comfort, appeal and suitable fabric with WMS 2.0 followed by convenient to put on' with WMS 1.7, functional', appropriate shape (WMS 1.4 each) and convenient for loading and unloading(WMS 1.3).

In design no. 2, respondents were highly agreed for the parameters 'convenient to put on' with WMS 2.6. Most of the respondents were 'agreed' on parameters of 'appropriate shape' (WMS 2.2), 'comfort', 'appeal' and 'suitability of the fabric' with WMS 2.0 followed by 'convenient for loading and unloading' (WMS 1.4) and 'functional' (WMS 1.6).

In design no. 3, respondents were highly agreed for the parameters 'convenient to put on' (WMS 2.8), 'functional' (WMS 2.5) and 'appropriate shape' (WMS 2.4). Most of the respondents were agreed on parameters of 'comfort', 'appeal', 'suitability of the fabric' and 'convenient for loading and unloading' with (WMS 2.0).

In design no. 4, respondents were 'highly agreed' for the parameters 'Convenient to put on', 'appropriate shape' and 'functional' (WMS 2.8). Most of the respondents were agreed on parameters of 'convenient for loading and unloading' followed by 'comfort', 'appeal', 'suitability of the fabric' with WMS 2.0.

In design no. 6, respondents were agreed on 'convenient for loading and unloading' (WMS 2.0) and 'suitability of the fabric' followed by 'comfort' (WMS 1.4), 'convenient to put on' and 'appeal' (WMS 1.2). They were least agreed on 'functional' (WMS 1.0) and 'appropriate shape' (WMS 1.1).

Out of these, five designed and developed pick bags tested for pearl millet head collection, two designs *i.e.,* Design no # 3 & 4 were found comparatively more suitable on different parameters and designing features. Finally, one design *i.e.,* Design no. 4 was finalized after comparative analysis and discussion with ergonomic testing team (Department of FRM) removing the least suitable designing features i.e. 'back length' and 'provision for inserting desired stiff material to provide fullness to the pick bag'.

Suitability assessment of pick bag for pearl millet ear head collection in the fields

Pick bag was designed and developed for farm workers as per their requirements. Field testing of the developed pick bag was done to assess its suitability for pearl millet head collection on farm workers during harvesting season and presented in Figure 1.

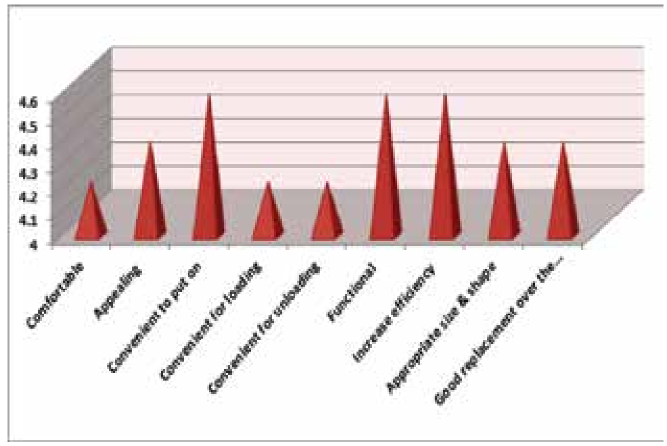

Fig. 1. Suitability Assessment of Pick Bag for Pearl Millet Ear Head Collection.

Pick bag developed for pearl millet head collection was assessed to be highly suitable being functional, convenient to put on and increase efficiency (4.6); good replacement over the existing method (4.4); comfortable and convenient for loading & unloading (4.23). Pick bag was also found to be highly appealing and had appropriate size and shape with WMS 4.4 each.

Pick Bag for Pearl Millet Head Collection

CONCLUSION

Developed Pick bag for Pearl millet ear head collection was found suitable. It seems to be a good initiative towards reduction of drudgery and increasing work efficiency of the worker. Hence, with tireless efforts, it can go a long way in improving quality of life of rural people in general and farm workers in particular.

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Value Addition for Palmyra Palm Tender Fruit Endosperms Through Thermal Processing

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ABSTRACT

The objective of the study was to extend the shelf life of Palmyra palm tender endosperms through canning as there is a constant demand in domestic and international markets. Palmyra palm Tender Fruit Endosperm (PTFE) is a delicacy, highly perishable and seasonal. Canning the tender fruit endosperms of Palmyra palm at 121.1ºC at 15 psi, extended the shelf life period up to 6 months. Canning is one such promising technology that will fetch income to farmers who rely on seasonal earnings and obviously improve their food security. Various physico-chemical parameters such as, viscosity, colour properties, textural properties, moisture content and water activity and sensory studies, microbial analysis were determined throughout the storage period and found all comparable with freshly harvested endosperms. Overall acceptability score in sensory analysis was7.9±0.788 which was a good score in comparison with fresh ones. Microbiological quality was analyzed at different time intervals for commercial sterility. Total viable counts were 0.45±0.02 on 0^{th}d, 0.51±0.02 on 60^{th}d, 0.48±0.02 on 120^{th}d and 0.47±0.02 on 180^{th}d. *Clostridium spp, Staphylococcus, Salmonella* and *coli forms* were absent throughout the study period and therefore fit for consumption.

Key Words: Canning, Palmyra palm, Shelf-life extension, Thermal processing.

INTRODUCTION

A strong and dynamic food processing sector plays a significant role in diversification of agricultural activities, improving value addition opportunities and creating surplus for domestic markets and export of agro-food products. India can harness all the opportunities present in food processing sector only when its labor force is educated and skilled (Bhuyan *et al*, 2019).There always existed a gap between production and processing which was based on skill learning, and technology intervention. Palmyra palm is considered a celestial tree since all of its part is useful for the mankind. Palmyra palm (*Borassus flabellifer* Linn) is distributed in many tropical countries, but reaches its zenith, as a conspicuous feature of the landscape, where it is found in great groves on the coastline from Mumbai to Chennai and Coramandel coast. Palmyra palms have a long history of management for both subsistence and commercial products, many of which are deeply embedded in local cultures and naturalized throughout India, especially Tamil Nadu. Palm neera, palm candy, tender endosperms, palm fruits, haustorium, tuber shoots, even flowers and toddy are consumed by the people. Culturally Palmyra palm is embedded with the marriage and birth rituals and usage of its products in daily life of people of Tamil Nadu and that's why is conferred as the state tree of Tamil Nadu.

Nungu/ Taal, the soft jelly like endosperm obtained from the tender fruit of Palmyra is highly perishable due to its moisture content and seasonal oriented. During the peak season it gets wasted due to fermentation since it is procured at one place

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and marketed at urban areas. During transit of Palmyra palm Tender Fruit Endosperm (PTFE), is getting squandered due to improper storage facility and fermentation. There exists a constant demand for tender endosperm for its health benefits and delicacy throughout the year. To extend the shelf life and to enhance the remunerative income per rupee of investment to the farmer, canning technology was standardized for Palmyra palm Tender Fruit Endosperms as a post farm gate value addition using mini retort designed at College of Food and Dairy Technology, TANUVAS, Chennai.

MATERIALS AND METHODS

Palmyra palm tender fruit samples were collected from Alamathi location, Tiruvallur district, Tamil Nadu throughout the study period to avoid biasedness due to geographical variations. Freshly harvested samples were procured every time, washed and peeled for the white skinny layer and sorted according to weight and processed further.

Three pieces round Open top sanitary (OTS) cans with EOE lids (from Metcan Pack Ltd, Mysuru) of 200 ml capacity chrome coated juice cans were used for canning the PTFE. Pre-sterilized cans were filled with PTFEs and sugar syrup (45º Bx) was standardized based on consumer preference mapping studies) at 2:3 ratio (Mathanghi *et al,* 2020). Sealed using a can double-seamer and arranged those cans in mini retort for heat sterilization at 121.1ºC at 15 psi pressure. Heat penetration studies were also conducted to define the sterility of the product using thermocouple fitted to cans at the cold spot. Sterility was expressed as an F_0-value were determined using improved general method called as trapezoidal integration method given in (Holdsworth and Simpson, 2016), as in

$$F_0 = \int 10^{(T-Tref)/Z}.dt$$

Where, F_0 is the heat required for the commercial sterilization process, which is expressed as the equivalent heating time (in minutes) at a constant temperature of 121.1°C to inactivate *Clostridium botulinum* spores. *T* is the temperature at any given time; *T*ref is a reference processing temperature (121.1°C or 250°F), and *z*-value is 10°C.

Fig.1 Process of canning: a) preparation of PTFE, b) filling and double seaming, c) heat processing of cans, d) after canning and e) finished product at 180th day

Canned PTFE were immediately cooled after heat processing and stored at ambient temperature (approx. 30ºC) for 180d. The standardized, heat processed PTFE were studied for its physicochemical analysis such as moisture content, water activity (using Novasina water activity meter), viscosity of the syrup (Coleparmer viscometer), texture profile using TPA probe compression platen of P/75 (TA.XT*plus C* from Stable Micro Systems Ltd., England, UK), colour analysis **(**Colourflex EZ, Hunter Associates Laboratory, Inc, Reston, VA**)** and microbial analysis (Evancho *et al*, 2009) for its launch as commercially sterile product for 180 d of storage period at various time interval. Sensory analysis was conducted based on 9-pt hedonic scale rating through a set of 20 semi-trained panelists from the institute.

Cost analysis was also performed to clearly understand the remunerative worth of value addition of PTFE through canning. Data obtained were analyzed using IBM SPSS statistical package version XX (Phadke *et al*, 2020) and experimented results were expressed as mean ± standard deviation. Sensory scores differences were calculated based on a non-parametric test.

RESULTS AND DISCUSSION

Thermal processing studies of canned PTFE

Canned PTFE were processed at a suggested temperature for low acid foods (Holdsworth and Simpson, 2016), since the pH of PTFE is 5.2. At this process temperature of F value for canned PTFE was 10.2 min. Heat penetration characteristics of the thermally processed PTFE in cans are given in figures 2. To estimate the processing time for a given food, the rate of heat penetration and its effect on the lethality of microorganisms has to be calibrated (Al-Baali and Farid, 2006). The total process time of 34.5 min was sufficient to reach commercially sterile products in cans. From the graph (figure 2), core temperature values and corresponding retort temperatures can be ascertained. Cook value for the canned PTFE was 141.2°Cto attain the lethality and to increase the shelf life. Whereas the cook value CV represents the extent of cooking of the product at the hot spot, i.e, usually the periphery of the packaging material and it directly relates to nutrient degradation (Holdsworth and Simpson, 2016).

Physicochemical analysis of canned PTFE

Moisture and water activity plays an important role in determining the shelf life of any food (Ergun *et al*, 2010). There was a decreasing trend of moisture content and water activity was observed in canned PTFE over the storage of 180d. At the 0^{th} day of canning, moisture content was 80± 1.19 % and it kept on decreasing to 67±1.23 % at 180^{th}d. The water activity was reduced from 0.893±0.001 (0^{th} day) to 0.85±0.011 (180^{th}d). This phenomenon might be due to osmosis from fruit endosperm to sugar medium. This was explained by the viscosity values. Viscosity plays an important part in any industrial sector where liquid media are involved. 0^{th} day viscosity value of the sugar syrup was 38.18±2.31centipoises and on the 180^{th}d it was reduced to 34.75± 0.99 centipoises. It has direct relationship with the quality of food product and influences the appearance and the consistency of a product (Calderón-Alvarado *et al*, 2016). Free water present in the fruit endosperm got into sugar syrup and the flavour of Palmyra palm got infused into the sugar syrup.

Colour and texture analysis of fresh and canned PTFE

Colour parameters such as L-value, a*, b* were determined (Pathare *et al*, 2013). The degree of lightness (L*), degree of redness (+ve a*) or greenness (-ve a*), degree of yellowness (+ve b*) or blueness (-ve b*) values were obtained from the equipment and the average value was taken, the comparison was made with freshly harvested sample and different time interval of storage. There was a distinct change of colour from fresh ones to processed ones but in the acceptable range only. Over the time of storage the lightness property of the PTFE got reduced and so the hue angle got increased. Also over the time redness value and yellowness value got increased and it may be due to reduction of lightness property and hue angle. From the table it was evident that there is no much difference from 90^{th}d sample and 180^{th}d sample. Instrumental colour analysis showed similar results with that of subjective sensory evaluation.

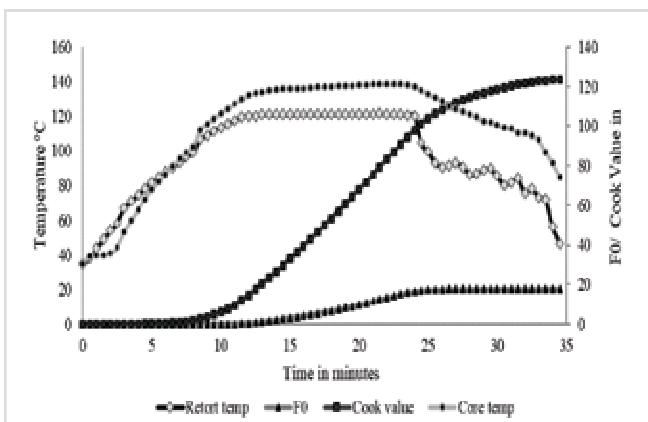

Figure 2. Heat penetration characteristics, cook value, and F0 value of Canned PTFE

Table. 1 Instrumental colour and texture analysis of fresh and canned PTFE.

Colour parameters	Fresh PTFE	Canned PTFE			
		0^{th} day	90^{th} day	180^{th} day	F-value
L-value	44.58±0.04	32.91±0.38	30.51±0.94	29.92± 1.55	13.0622*
Hue angle	-36.77±8.6	27.39±2.46	34.03±9.84	34.47±2.73	3.039^{NS}
Chroma	2.50±0.25	2.19±0.26	3.81±0.63	4.04±0.46	23.966*
Colour coordinate (a/b)	-1.4±0.08	1.94±0.20	1.60±0.59	1.46±0.14	3.3617^{NS}
Textural Parameters					
Hardness kgf	3.46±0.05	2.16±0.02	2.016±0.23	1.87±0.01	519.211**
Springiness mm	0.45±0.01	0.74±0.01	0.792±0.02	0.832±0.02	33.328*
Cohesiveness	0.29±0.01	0.6±0.01	0.68±0.1	0.71±0.01	145.35*
Gumminess kgf.mm	0.21±0.0	1.29±0.02	1.15±0.03	1.04±0.01	190.84*
Chewiness kgf.mm	1.28±0.04	0.95±0.03	0.94±0.02	0.92±0.02	1.635^{NS}
Resilience %	0.28±0.01	0.275±0.01	0.23±0.01	0.21±0.01	714.11*

Data are mean ± SD (n=6) * p-value<0.05; ** p-value <0.01

Instrumental testing of texture provide time-series data of product deformation thereby allowing a wide range of texture attributes to be calculated from force–time or force–displacement data (Chen and Opara, 2013). Texture profile results depicted the reduction in hardness over the storage whereas springiness and cohesiveness increased from 0^{th} day to 180^{th} day (Table 1). On the other hand secondary texture parameters such as gumminess and chewiness got reduced that was reflected in resilience percentage value where it showed a decreasing trend. But there was no much of the difference obtained in terms of cohesiveness. All the data showed statistically significant values at p-value <0.5.

Sensory analysis of fresh and stored canned PTFE

Organoleptic evaluation of the fresh ones and canned PTFE at different time intervals was carried out. The colour and appearance got a score of 7.95 ± 0.88 0^{th} day of canning and scored 7.5± 0.68 at end of storage. The whiteness value got slightly reduced and that was similar with the instrumental colour analysis. Sweetness score of the product was increasing from 7.65 ± 0.98 at 0^{th} d to 7.85±0.58 at 180^{th} d. Succulence was a measure of infusion of syrup into PTFE which was also increased over the storage. Similarly, the toughness score of PTFE was also increased from 7.8±0.77 to 7.95± 0.76. Comparable results with that of instrumental texture analysis were obtained. Even on the 180^{th} d of storage all the sensory score was not got beyond 6 that showed the product was liked by the most of people in the semi-trained sensory panel.

Cost analysis of canned PTFE

The cost analysis of the canned product was done based on capacity and functional ability of equipment's, total variable and total fixed cost involved. Fixed cost includes depreciation, of the equipment, interest on average investment including interest rate and salvage value, insurance and tax. Variable costs included were input cost, repair and maintenance, energy cost and labor cost. It was found that the cost of production per can of PTFE was Rs. 14.5 per 200 g.

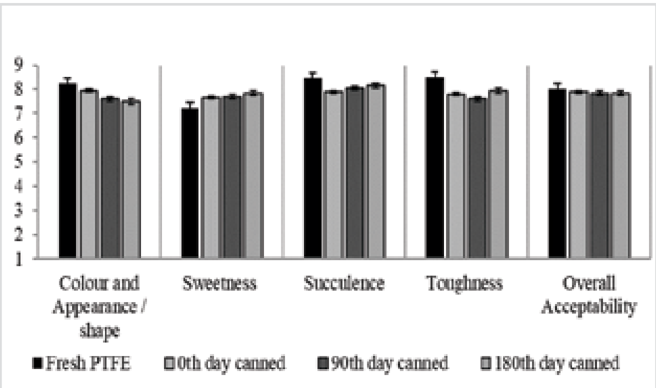

Figure 3.Sensory analysis of stored canned PTFE

Microbial analysis

There is always a chance that microorganisms may survive if the heat treatment is not proper thereby leading to spoilage of food. Hence the commercial sterility tests (Reddy *et al*, 2006) were performed for flat sour spoilage, Thermophilic anaerobic (TA) spoilage and putrefaction. It showed negative for *clostridium perfringens, staphylococcus and salmonella spp* throughout 180d of study. And the Total Viable Counts was 0.45 ± 0.02 cfu on 0^{th} day, 0.51 ± 0.02 cfu on 60^{th} d; 0.48 ± 0.02 cfu on 120^{th} d and on 180th d it was 0.47 ± 0.02 cfu. These results confirmed the safety of canned PTFE for consumption.

CONCLUSION

Canned PTFE were stored for 180d in room temperature without any physical damage and microbial contamination. It has passed the commercial sterility test also. This canning process has enhanced the shelf life of the produce and seemingly gives an appealing sense to the consumers who always think of quality and safety. Processed Nungu (PTFE) gives an enhanced value to the product and adds a craft explicit preferences for it among the consumers and it will undeniably promotes the farmers to remain in Palmyra palm tree business. Small scale preparation of canned PTFE (Nungu) will cost about Rs.72.5/Kg (pertaining on the availability of raw material during the season). At global markets value added PTFE are priced Rs.800 Rs.1000/Kg. Canning is a simple adoptable technology with a minimum investment and maximum return on investment can be achieved by processing PTFE.

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Vermicompost and Integrated Nutrient Management Approach for Yield Enhancement of Capsicum (*Capsicum annuum* L.) under Hill Agro Ecosystem of Meghalaya, North East India

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ABSTRACT

The present study was carried out at farmers' field of Ri-Bhoi district of Meghalaya to test the effect of integrated nutrient management with vermi-compost for yield improvement of capsicum (*Capsicum annuum* L.) and its effect on soil nutrient status. The experiment was conducted by using 3 treatments: T1: Vermicompost @ 1.0 t/ha + 50% RDF (RDF: N: P_2O_5: K_2O::120: 80: 60 kg/ha), T2: Vermicompost@ 2.0 t /ha + Lime @ 500kg/ha + 2% urea spray at branching & pod initiation stage, T3: Farmers' practice (imbalance fertilizer with N: P_2O_5: K_2O:: 40:25:15 kg/ha) with 5 replications following randomized block design during 2016 and 2017. From the results it was revealed that Vermicompost @ 1.0 t/ha + 50% RDF showed significant increase in fruit yield *i.e.*, 132 q/ ha and B.C ratio of 2.98 followed by Vermicompost@ 2.0 t /ha + Lime @ 500kg/ha + 2% urea spray at branching and pod initiation stage (108 q/ha yield, B.C ratio 2.25) and farmers' practice (86 q/ha yield, B.C ratio 2.10). Moreover, improved soil nutrient status was achieved in T1 followed by T2 and T3. There was an increase of 123.16 % in organic carbon, 123.76 % nitrogen, 131 % available phosphorus and 169.07 % potassium recorded in the soil after the harvest of the crop as compared to initial stage of soil before the implementation of Treatment 1.

Key Words: On Farm Testing, Vermi-compost, INM, Capsicum.

INTRODUCTION

North East India is the region of amazing natural beauty with wonderful hills and valleys and the integration of different culture and tradition. Meghalaya is one of the Hilly State of North East India. It receives heavy rainfall almost all round the year and its suitable agro-climatic conditions prevailing in the area makes Meghalaya favourable for the cultivation of vegetables throughout the year (Bordoloi, 2021a). The cultivation of capsicum crop is gradually rising in the hilly areas of North Eastern region. The cultivation of capsicum is being commercialized and it is spread to almost all the parts of the Meghalaya because of its good price achieved from the neighbouring states too. The productivity of capsicum crop is less in this area due to improper soil nutrient management as well as other intercultural operations. Furthermore, farmers of this hilly region use the chemical fertilizer and pesticides in very low quantity and prefers to grow the crop by putting the locally available manure only due to unawareness of modern technology (Bujarbaruah, 2004, Sanjay-Swami, 2020). The farmers get lower yield of crop due to improper soil fertility management in Meghalaya (Bordoloi, 2021b, Sanjay-Swami, 2019).

The productivity of crops and soil nutrient status can be increased through integrated use of inorganic fertilizers and organic manure in the hill agro ecosystem of Meghalaya (Bordoloi and Islam, 2020, Sanjay-Swami and Singh, 2020). The organic carbon, available nitrogen, phosphorus and potassium status of soil can be increased through integrated application of inorganic fertilizers and organic manure (Baishya *et al*, 2015). Due to the occurrence of heavy rainfall in this area, the high

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soil acidity is experiencing in this region which also affects the crop productivity (Bordoloi, 2020; Bordoloi, 2021c; Sanjay-Swami *et al*, 2020). Vermicompost can be utilized successfully to improve the soil physical and chemical properties and for productivity enhancement of crops (Kumar *et al,* 2020; Rajkhowa and Kumar, 2013; Rajkhowa *et al*, 2019; Bordoloi, 2021d). Moreover, capsicum crop requires a high amount of nutrients and therefore integrated nutrient management approach is very much effective for improvement of soil health and productivity of capsicum. So, considering the above in view the present study was carried out during 2016 and 2017 at five different farmers' field of Ri-Bhoi district of Meghalaya to test the effect of integrated nutrient management with vermi-compost in yield improvement and economics of capsicum (*Capsicum annuum* L.) along with soil nutrient status.

MATERIALS AND METHODS

The Ri-Bhoi district lies between the North Latitudes 25.15/ and 26.15/ and East Longitudes 91.45/ and 92.15/. The total area of Ri-Bhoi district is 2378 sq. km with a total population of 2, 58,840 (Anonymous, 2011). The area falls under humid subtropical with an average rainfall of 1000mm to 2500 mm. The study area covers three villages namely Khweng, Kdonghulu and Kyrdem and falls between the altitudes of 823 to 898 amsl. The total area covers for the on farm testing was 0.5 ha. The soil of the experimental site was found to be sandy loam and acidic in reaction. The variety taken for the experiment was California wonder. The experiment was conducted by following 3 treatments like T1: Vermicompost @ 1.0 t/ha + 50% RDF (RDF: N: P_2O_5: K_2O::120: 80: 60 kg/ha), T2: Vermicompost@ 2.0 t /ha + Lime @ 500kg/ha + 2% urea spray at branching & pod initiation stage, T3: Farmers practice (imbalance fertilizer with N: P_2O_5: K_2O:: 40:25:15 kg/ha) with 5 replications following randomized block design. The chemical properties of vermi-compost used in the experiment are presented in the **Table 1**. The farmers were trained in vermi-composting technology, capsicum cultivation and about soil fertility management. The data related to yield parameters and soil fertility status were collected from all the plots before and after the implementation of the programme. The economics of the experiment was also analyzed for proper conclusion of the experiment.

Table 1. Chemical properties of vermi-compost used in the present investigation

Property	**Value (%)**
Organic Carbon	10.3
Nitrogen	2.75
Phosphorus	1.88
Potassium	1.98
Calcium	1.29
Sulphur	0.35
Magnesium	0.38

Table 1. Yield of Capsicum and Economics under the Agro-ecosystem of Meghalaya.

Treatment	**Av. Yield (q/ha)**	Per cent	**Avg. Gross cost (Rs/ha)**	**Avg. Gross return (Rs/ha)**	**Avg. Net income (Rs/ha)**	**BCR**
T 1	132	153.49	88444	264000	175556	2.98
T 2	108	125.58	96086	216,000	119914	2.25
T 3	86	FP	82000	172,000	90000	2.10
CD (pd" 0.05)	7.13					
%= % increase in yield over control						

RESULTS AND DISCUSSION

Crop Yield and Economics Analysis

It was revealed that the application of vermicompost @ 1.0 t/ha + 50% RDF (RDF: N: P_2O_5: K_2O:120: 80: 60 kg/ha gave significantly higher yield (at 5% level of significance) of capsicum followed by vermicompost@ 2.0 t /ha + Lime @ 500kg/ha + 2% urea spray at branching and pod initiation stage and farmers' practice. There was a 153.49 per cent yield improvement in T1 compared to T3 and 125.58 per cent yield improvement in T1 compared to T3 i.e., farmers' practice where they used imbalanced Fertilizers. Similar results of yield improvement on rabi onion by application INM were achieved by Dhillon and Singh (2019).

The input and output cost of products exist during the period of demonstrations were taken for calculating the cost of cultivation, net return and benefit cost ration show in Table 2. The highest B.C ratio was recorded in the T1 i.e. Vermicompost @ 1.0 t/ha + 50% RDF (RDF: N: P_2O_5: K_2O::120: 80: 60 kg/ha (2.98) followed by T 2 i.e. Vermicompost@ 2.0 t /ha + Lime @ 500kg/ha + 2% urea spray at branching & pod initiation stage (2.25) and T3 i.e. farmers' practice (imbalance fertilizer with N: P_2O_5: K_2O:: 40:25:15 kg/ha) (2.10). The average net income (Rs/ha) was recorded Rs. 175556/- in T1 which is higher as compare to T2 (Rs. 119914/-) and T3 (Rs. 90000/-). The recorded results were obtained may be due to higher yield obtained under the experimental plot compare to farmers' practice. Similar results of improvement of BC ratio and net income of capsicum by the application INM was also recorded by Shabir *et al* (2017). The suitable BC ratio reveals the economic viability of the OFT and convinced the farmers to adopt the Technology.

Soil Fertility Status

Soil sample were collected before the implementation of the treatments to the farmers field and after the harvesting of the crop. The soil fertility status was significantly increased with the application of organic and inorganic combination of fertilizer from initial to final stage of the crop during both the years of experimentation. It revealed that the soil was acidic in nature with high organic carbon content. The soil pH, organic carbon, available nitrogen, available phosphorus and available potassium status of soil after harvest of the crop significantly increased (at 5% level of significance) due to application of the treatment. From the results of the experiment it is seen that application of T1 (Vermicompost @ 1.0 t/ha + 50% RDF (RDF: N: P_2O_5: K_2O::120: 80: 60 kg/ha) significantly increased the nutrient content followed by T2 (Vermicompost@ 2.0 t /ha + Lime @ 500kg/ha + 2% urea spray at branching and pod initiation stage) and T3 i.e. farmers' practice. A total of 123.16 % increased in organic carbon, 123.76 % nitrogen, 131 % increased available phosphorus and 169.07 % increased in potassium were recorded in the soil after the harvest of the crop as compare to initial stage of soil. The increased amount of NPK in soil by application of INM in rice in Meghalaya was recorded by Bordoloi and Islam (2020). So, the integrated use of vermicompost along with reduced rate of NPK fertilizer can be effectively used for increase the productivity of capsicum crop and for sustaining the soil nutrient status for increase the farmers' income. It indicates that applications of organic sources with inorganic sources were found more effective in building up soil fertility status as compared to farmers' practice and can successfully use for maintain and improve the soil fertility.

CONCLUSION

Vermicompost is a suitable method to recycle of crop waste available in the Ri-Bhoi district and it is an appropriate organic fertilizer for yield improvement of crop as well as for improving the soil nutrient status. The technology used for the experiments were to make less productive soils into productive and profitable for income generation on a long-term sustainable basis. So, it is needed to popularize the technology locally for adoption by the farmers and spread the technology to

Table 2. Effect of Vermi-Compost Based INM on Soil Nutrient Status.

Treatment	pH		Organic C (kg/ha)		%	Available N (kg/ha)		%	Available P (kg/ha)		%	Available K (kg/ha)		%
T 1	5.84	5.34	0.95	1.17	123.16	311.56	385.6	123.76	49.21	64.35	131.00	41.96	70.94	169.07
T 2	5.86	5.14	0.93	1.09	117.2	314.76	365.4	116.09	46.43	59.35	127.83	44.42	68.14	153.40
T 3	5.96	5.94	0.93	1.02	1.10	309.43	315.8	1.02	48.67	54.35	1.12	42.43	57.22	134.86
CD (pd" 0.05)		0.06		0.09			8.86			2.45			1.43	

%= % increase

different part of the region for profit maximization and for management of soil health in commercial cultivation of capsicum crop. As the farmers of this region prefer the organic cultivation of crop, so, further research is required for more reduction of chemical fertilizers for increase the productivity of capsicum crop and reducing the cost of cultivation as well as for environmental sustainability.

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Yield and Morphological Characters as Affected by Chlormequat Chloride Application in Grape Cultivar Punjab MACS Purple

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ABSTRACT

The present investigation was carried out to evaluate the effect of growth retardant Chlormequat chloride (CCC) on morphological characters of grape cultivar Punjab MACS Purple. The foliar application of Chlormequat chloride (250, 500, 750 and 1000 ppm) was done at five leaf stage while the control vines were sprayed with water only. Observations on vegetative growth were recorded at different growth stages. Maximum dose of Chlormequat chloride was found to be most effective in reducing cane length and internodal length while the same dose resulted in maximum cane diameter. There was reduction in leaf area as well as size while the effect on time of anthesis and trunk girth was less significant. It has been reported that yield and bunch weight was maximum with the application of 1000 ppm Chlormequat chloride followed by 700 ppm Chlormequat chloride.

Key words: Grapes, Chlormequat Chloride, Vegetative Growth, Flowering, Yield.

INTRODUCTION

Grape cultivation is considered to be an economic venture for the farmers due to its high monetary returns. Grape belongs to the family Vitaceae which consists of 12 genera and 600 species. Among these, *Vitis vinifera* produces the highest quantity of grapes either as pure *vinifera* or in the form of hybrids. Grape cultivation occupies an area of 140 thousand hectares with the production of 3,125 thousand MT (Anonymous, 2020a).). In Punjab, area under grapes is 320 hectare with per annum production of 5,680 MT and productivity of 17,749 kg/ hectare. The recommended varieties of grapes by Punjab Agricultural University include Punjab Macs Purple, Superior Seedless, Flame Seedless, Beauty Seedless and Perlette (Anonymous, 2020b).

Under North Indian conditions, one of the reasons of barrenness of the vines is excessive vegetative growth of the vines. Moreover, presence of excessive shoot vigour is detrimental to the plant growth because plant metabolites are used for vegetative growth which results in reduction in yield. So, it is important to decrease the vigour of vegetative growth without reduction in the shoot number. The vigour of vines can be controlled with either judicious pruning of canes or with use of growth retardants or both. Plant growth regulators are now considered to be new generation agrochemicals after pesticides, fertilizers and herbicides as these improve the source sink relationship thereby enhancing the translocation of photo assimilates and helping in better fruit set (Anayat *et al* 2020). In horticulture, plant growth retardants are used for the reduction of unwanted shoot length without affecting the productivity of the plants. Use of growth retardants is also a good practice in viticulture for the improvement of quality and productivity in grapes (Kumber *et al* 2017). Out of all the growth retardants used, the application of quaternary ammonium salt– chlormequat chloride is most common (Polyvanyi *et al* 2020). Since excessive vegetative growth hampers the fruit production, fruiting and flowering is successfully enhanced by the use of growth retardants. Cycocel can be used on vines as it is non-toxic, as well as it reduces the internodal length without causing change in leaf number and emergence of lateral shoots (Chougule *et al* 2008). Plant growth retardant

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Chlormequat Chloride was discovered in 1950s. It was first described in Michigan State University at East Lansing in USA by N E Tolbert for the reduction of shoot length in many plant species (Rademacher 2016). Use of Chlormequat Chloride was done firstly in wheat crop for the production of shorter plants with thick stems. Chlormequat Chloride belongs to the onium compounds which blocks ent-kaurene synthase and copalyl-diphosphate synthase which are involved in the synthesis of Gibberellins (Koutroubas and Damalas 2016). In many fruit crops, Gibberellic Acid (GA) leads to inhibition of flower formation. Under such conditions use of growth retardants such as cycocel, paclobutrazol and SADH can be done to inhibit the biosynthesis of GA thus promoting flowering (Kumari *et al* 2018). Chlormequat chloride (CCC) is an inhibitor of biosynthesis of gibberellins and it is used to inhibit cell elongation and vegetative growth (Kulkarni *et al* 2018). Chlormequat chloride (CCC) is available commercially under the trade name of Cycocel. Its application on the foliage or fruit clusters one or three weeks before flowering leads to increased fruit set. The spray of chlormequat chloride (CCC) on the shoots also result in shortened internodes, dark green leaves, retarded tendrils and more number of inflorescence. Unlike daminozide, chlormequat chloride leads to inhibition of biosynthesis of Gibberellins early in the process. Chlormequat chloride has activity when application is done on leaves as well as roots. Usually, it is applied as foliar spray as more concentration is needed for its application as drench.

MATERIALS AND METHODS

The experimental trial was conducted in year 2021 at Punjab Agricultural University, Ludhiana. The experimental plot is located at 30° 40′ N and 75°48′ E with an altitude of 247 m above the mean sea level. The present investigation was carried out on own rooted grape vines of Punjab MACS Purple at the spacing of 5x5 feet and trained on bower system of training. All the vines were provided with uniform cultural practices, manure and fertilizers during the research.

Foliar application of Chlormequat chloride was done in morning hours using knap sack sprayer when vines reach 5 leaf stage after sprouting. At the same time, untreated grape vine were sprayed with water. There were five treatments (T_1: Chlormequat Chloride @ 250 ppm, T_2: Chlormequat Chloride @ 500 ppm, T_3: Chlormequat Chloride @ 750 ppm, T_4: Chlormequat Chloride @ 1000 ppm, T_5: Control). The experiment was conducted in Randomized Block Design (RBD) and the data was analyzed using statistical software CPCS1.

The length of the cane was measured from the base to the tip with the help of a measuring tape and was expressed in centimetres. The diameter of the mature cane was measured at the middle of the first internode with the help of vernier caliper and was expressed in centimetres. For internodal length, measurement of third internode (between second and third node) was done using measuring tape.

Leaf area of ten leaves per treatment was measured, with the help of Leaf Area meter (Delta-T digital image Analysis System). Trunk girth was measured at 15 cm from ground level with the help of measuring tape. Time of anthesis was considered when more than 90% of the flowers on a panicle were opened. From the harvest data, the yield per vine from each treatment was calculated. It was expressed as kg/vine by multiplying the number of bunches per vine with average bunch weight.

RESULTS AND DISCUSSION

Cane Length (cm)

Application of chlormequat chloride had a clear effect on reduction of cane length. The perusal of the data in Fig. 1 reveals that the cane length was higher in control in comparison to other treatments. The length of canes reduced drastically with increase in dose of chlormequat chloride. Towards the end of growth period (at 69 days interval), the maximum cane length was recorded in T_1 (94.2 cm) which was closely followed by T_5 (92.8 cm). It is clear from the data that the treatments had shown remarkable effect in inhibiting the vegetative growth in terms of cane length as it was found to be lowest in T_3 and T_4 (84.2 cm each).

Chlormequat chloride, a growth retardant has been used traditionally for reduction in vegetative growth of the plants. The decrease in cane length as recorded in the present study results due to inhibition of gibberellins biosynthesis. The role of gibberellic acid in cell elongation thereby decreasing the vegetative growth is well known. Chlormequat chloride decreases the same by acting as an anti-gibberellin compound. Reduced concentration of gibberellic acid in the cells affects the movement of solutes between the cells as plasticity and cell wall relaxation is decreased while the stiffness of the cell wall increases. This increase in stiffness results in reduced cell elongation and replication (Abdel-Mohsen 2015).The results of the current study are in accordance with Bahar *et al* (2009) who observed that there was reduction in cane length in grape cultivars Sauvignon Blanc and Semillon with the application of chlormequat chloride. Similarly, Taili *et al* (2011) found that in grape cultivar Kyoho the growth of new shoots was inhibited after 3 weeks of treatment with chlormequat chloride with more pronounced effect at the 4th week after treatment. Also, the branch length in Kyoho cultivar of grapes was reduced due to the application of 300, 500 and 750 ppm cycocel (HongYan *et al* 2013). The decrease in cane length in grape cultivar Thompson Seedless was also observed by Kulkarni *et al* (2018). In this study the length of shoots was reduced significantly by the application of chlormequat chloride @ 1000ppm at 5 leaf stage, 1500 ppm at 7 leaf and 2000 ppm at 12 leaf stage.

Cane Diameter (cm)

As presented in Fig. 2, the cane diameter was maximum (0.51 cm) in the vines with the highest dose of cycocel. The cane diameter in all other treatments was nearly same with the least value in T_2 (0.45 cm). After 60 days, the cane diameter in T_3 increased substantially and was the highest (0.61 cm) among all the treatments. This was followed by both T_1 and T_2 (0.59 cm each). The lowest cane diameter was recorded under controlled conditions (0.57 cm).

Structurally, cycocel is closely related to Choline which takes part in methylation reaction and lipid methabolism. Both these processes result in thicker and shorter shoots (Tolbert 1960). Kulkarni *et al* (2018) found that in grape cultivar Thompson Seedless, the use of chlormequat chloride at various concentrations lead to increased cane diameter. In the past studies, it has been revealed that chlormequat chloride reduces the internodal length by its inhibitory effect on the growth promoting hormones. The impact of growth retardants in the plant takes place in the sub-apical region of the tip of the shoot. At sub-apical region of the shoot, cell division as well as elongation is inhibited. Therefore the internodes of the treated plants are shorter because of lesser number of cells. Chlormequat chloride application at 5 leaf stage has been proved to be more effective than other treatments in reduction of internodal length between 5th and 6th; 10th and 11th and 15th and 16th internode in grapes (Wani *et al* 2020). Coombe (1967) observed the decrease in internodal length with the application of 1000 ppm cycocel. Similar findings were obtained by Umar and Sharma (2008) who concluded that the application of chlormequat chloride at 5 leaf stage resulted in reduced internodal length. In grape cv. Ciliegiolo application of 500 and 1000 ppm of chlormequat chloride resulted in minimum internodal growth among all the treatments (Loreti 1974).

Internodal Length (cm)

The effect of spray on reducing the internodal length was significant in open conditions. The internodal length was highest in control at all the intervals (Fig 3). At 15 days interval, the length of internodes was maximum (8.50 cm) in control and minimum in T_4 (7.16 cm). At 75 days interval, the internodal length was maximum in T_5 (11.34 cm)

Table 1: Effect of chlormequat chloride application on leaf characteristics in grape cv. Punjab Purple

Treatment	Leaf Length (cm)	Leaf Breadth (cm)	Leaf Area (cm^2)
T_1 Chlormequat Chloride @ 250 ppm	11.98	14.26	183.95
T_2 Chlormequat Chloride @ 500 ppm	12.45	13.39	151.82
T_3 Chlormequat Chloride @ 750 ppm	11.71	13.43	143.74
T_4 Chlormequat Chloride @ 1000 ppm	11.3	12.38	112.08
T_5 Control	14.41	15.84	221.72
CD (5%)	0.66	0.30	1.33

and least in T_4 (10.48 cm) which was at par with T_2 (10.74 cm) and T_3 (10.58 cm).

In the past studies, it has been revealed that chlormequat chloride reduces the internodal length by its inhibitory effect on the growth promoting hormones. The impact of growth retardants in the plant takes place in the sub-apical region of the tip of the shoot. At sub-apical region of the shoot, cell division as well as elongation is inhibited. Therefore the internodes of the treated plants are shorter because of lesser number of cells.

Trunk Girth (cm)

The data pertaining to effect of chlormequat chloride on trunk girth of grape cv. Punjab Purple shows that trunk girth did not vary significantly among the treatments. As depicted in Fig. 4, the trunk girth under open field conditions was at par in all the treatments.

Leaf Characters (cm and cm^2)

Data presented in Table 1 shows the effect of cycocel application on leaf characters of Punjab Purple cv. of grapes. It was observed that the spray had significant influence on all three characteristics with the maximum values being obtained in control under both environmental conditions. Under open field conditions, leaf length, breadth and area decreased substantially in the higher doses of chlormequat chloride with the least values being recorded in T_4 which were 11.3 cm, 12.38 cm and 112.08 cm^2 for leaf length, breadth and area, respectively. The leaf length (14.41 cm), breadth (15.84 cm) and area (221.72cm^2) was maximum in untreated vines.

Gibberellic Acid stimulates leaf expansion, stem and root elongation in the plants (Hedden and Sponsel 2015). Expansion of the leaves is inhibited due to cycocel due to inhibition of biosynthesis of gibberellins in the epidermal cells of leaves (Li *et al* 2011). Cycocel application results in reduction of cane length and leaf area along with increasing fruit set and improving the quality of bunches (Kumar *et al* 1998). In grape cv. Thompson Seedless there was decrease in leaf area from , 177.27 cm^2, 184.50 cm^2, 190.76 cm^2 in control to 166.00 cm^2, 132.20 cm^2, 177.86 cm^2, 182.00 cm^2 by the application of chlormequat chloride (CCC) @ 1500 mg/l at 5 leaf, 2000 mg/l at 7 leaf and 2500 mg/l at 12 leaf stage (Kulkarni *et al* 2018). Similarly, in grape cv. Thompson Seedless, the leaves in the vines with the treatment of growth retardant paclobutrazol were thicker, darker and smaller in comparison to untreated vines (Sable 2016). In strawberry, the application of GA resulted in maximum number of leaves per plant while the number of leaves were decreased significantly with the application of 700 and 500 ppm of chlormequat chloride (Kumar *et al* 2012).

Time of anthesis

In grape cv., Punjab Purple (Table 4.2), earliest anthesis was observed in T_2 and T_3 (04

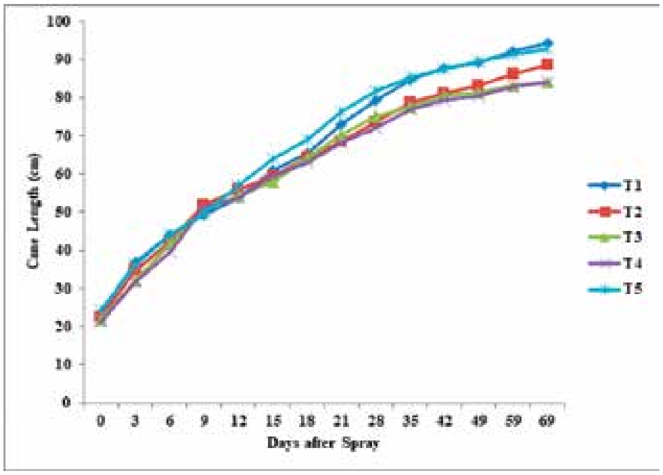

Fig. 1: Effect of chlormequat chloride application on cane length (cm) in grape cv. Punjab Purple

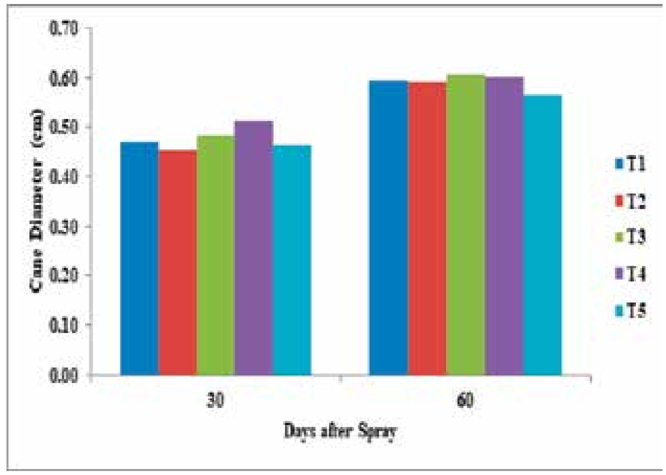

Fig. 2: Effect of chlormequat chloride application on cane diameter (cm) in grape cv. Punjab Purple

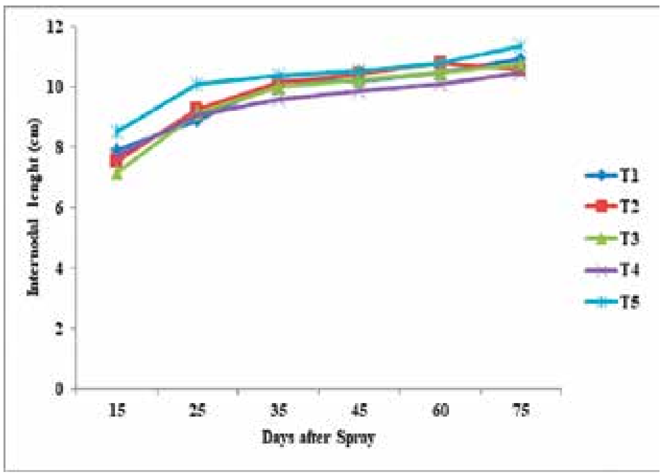

Fig. 3: Effect of chlormequat chloride application on internodal length (cm) in grape cv. Punjab MACS Purple under open field conditions

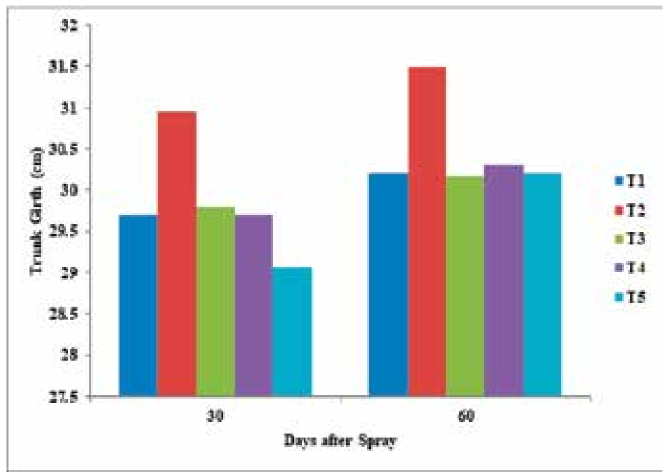

Fig. 4: Effect of chlormequat chloride application on trunk girth (cm) in grape cv. Punjab Purple

April) followed by T_5 (05 April) and T_1 (07 April). However, the time of flower opening in T_4 was late among all treatments (14 April).

In cycocel treated plants, the earlier flowering may be attributed to ita inhibitory effect on the vegetative growth of the vines resulting in favourable C: N ratio in the terminal buds for the floral initiation to occur at the earliest (Akshay 2020). Higher levels of gibberellic acids inhibit the flowering in plants as the more levels of GA_3 are antagonistic to the formation of flower primordia. The lower levels of endogenous Gibberellic Acid due to application of Chlormequat Chloride must have resulted in the earlier and profuse flowering in treated vines.

Number of bunches

Application of Chlormequat chloride resulted in increase in the bunch number with the maximum being obtained in T_4 (107.33) while minimum number of bunches (96.33) were recorded in the vines sprayed with lowest dose of Chlormequat chloride (Table 2).

In vines with the treatment of cycocel, number of bunches increases due to increased fruitfulness of the vines. Also, the increase in number of bunches

Table 2: Effect of chlormequat chloride application on time of anthesis, number of bunches and yield in grape cv. Punjab Purple

Treatment	Date of anthesis	Number of Bunches	Yield (kg/ vine)
T_1 Chlormequat Chloride @ 250 ppm	07 April	96.33	17.39
T_2 Chlormequat Chloride @ 500 ppm	04 April	97.33	19.35
T_3 Chlormequat Chloride @ 750 ppm	04 April	105.66	20.82
T_4 Chlormequat Chloride @ 1000 ppm	04 April	107.33	21.38
T_5 Control	05 April	101.00	18.86
CD (5%)	-	2.44	0.56

per tree might be due to the fact that chlormequat chloride reduces the vegetative growth of the plants and thus leads to decrease in abortion of fruitlets, therefore increasing the fruit set and consequently the number of fruits.

Yield

As indicated in Table 2, yield recorded was maximum in T_4 (21.38 kg/vine) followed by T_4 (20.82 kg/vine) while minimum yield was recorded in T_1 (17.39 kg/vine).

When treated with chlormequat chloride, the plants carry 20 times more cytokinins concentration in comparison to control treatments. Therefore, the increase in fruit set in the plants treated with cycocel may be due to increased cytokinins production in the plants (Skene 1969). Albuquerque *et al* (2000) reported that with the application of cycocel @ 500 ppm at 5 leaf stage, cane density of 35/ vine and leaf density of 16/ cane, highest yield per vine (15.96 kg) and highest per hectare yield (35.44 MT) was recorded in grape vines. Similarly, Sherawat *et al* (1998) observed that the application of 1500 ppm cycocel lead to increase in yield and bunch size in grapes. Also, yield per vine was increased by the use of chlormequat chloride @ 1500 ppm at 15 leaf stage in grapes due to more number of clusters per vine (Shikhamany and Reddy, 1989). Likewise, Shikhamany and Reddy (1989) reported the maximum yield with the treatment of chlormequat chloride@ 3000ppm at 15 leaf stage. Higher number of fertile buds in grapes due to cycocel application was also reported by Motoike *et al* (1996).

CONCLUSION

From present investigations, it is concluded that Chlormequat Chloride (CCC) @ 1000ppm followed by 750 ppm proved to be most effective in reduction of vegetative growth of vines in terms of shoot length, internodal length and leaf area and size. Also the application of chlormequat chloride @ 1000ppm resulted in significant improvement in the yield and number of bunches.

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Short Communication

Analysis of Yield Gaps and Profitability in Blackgram (*Vigno mungo* L.) in Mandsaur District of Madhya Pradesh

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INTRODUCTION

Pulse crops play an important role in agricultural economy. In India, pulses are grown in 29.99 mha area with a total production of 25.23 mt and productivity of 841 kg/ha out of which 7.48 mha area with a production of 8.11 mt and productivity of 1084 kg/ha is under Madhya Pradesh with first rank (Anonymous, 2018). In Madhya Pradesh, most of the *kharif* pulse crops are grown in rainfed or semi irrigated situation. In India, yield gap is very high as compared to other countries yield in different pulse crops. On the other hand, due to increasing population in India, per capita consumption of pulses has falling constantly due to stagnant production and productivity. This has been due to presence of a number of impediments in pulse production in India, such as higher yield gaps, abrupt climatic changes, attack of pest and diseases, lack of quality seeds, low adoption rates etc.

The productivity of kharif pulses can be increased by adopting improved technology of pulse production. Under front line demonstrations (FLD), the improved technologies are first time demonstrated at farmer's field by the scientist themselves before being fed into the main extension system of the State Department of Agriculture. Thus, front line demonstration is the most powerful tool of extension because farmers, in general, are driven by the perception that is "Seeing is Believing'. The basic objective of cluster front line demonstration is speedy spread of new technology and its management practices in the farmer's field under different agro-climatic zone and farming situation of different crops in the district. While, demonstrating the technologies at farmer's field, the scientists are required to study the factor constraints of production of any crop. Considering the prevailing scenario of pulse, study of yield gaps in major pulse crops was taken through front line demonstrations to know the, status of yield gaps and factors that contributes to yield gaps to develop suitable extension interventions for the benefit of pulse growers in agro-climatic situation of Mandsaur district of Madhya Pradesh.

MATERIALS AND METHODS

Cluster front line demonstrations (CFLD) on blackgram crop were conducted by RVSKVV – Krishi Vigyan Kendra, Mandsaur during kharif seasons of 2016 to 2019. In this programme, total 397 demonstrations having 158.8 ha area were conducted in cluster approach. In cluster front line demonstrations (CFLD) plot, full package of practice was adopted with critical input provided by KVK and the adjoining farmer's field was served / treated as control plot or farmer practice. These two treatments *i.e.,* farmer's practice and recommended practice for demonstration plot were tested in Randomized black design technique using total number of farmers as replications each year. The detail of technology adopted in Cluster front line demonstrations (CFLD) and farmer's plot are given in Table 1.

The economics of treatments were calculated on the basis of prevailing market price of produce. The data related to yield and economics of crops

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Table 1: Demonstration's package and farmer's practice under CFLD on pulses in Mandsaur district of Madhya Pradesh

Component	Demonstration	Farmer's practice
Variety	IPU 94-1, PU-31, Pratap Urd -1	Local mixture (T-9)
Seed rate	20 kg/ha	30 kg/ha
Fertilizer dose	20:50:20 Kg NPK/ha	9:23 Kg NP/ha
Seed treatment	Carbendazim @ 2.5 g/kg seed	No seed treatment
Plant protection	Quinalphos @1 l/ha and Dimethoate @1 l/ha	Indiscriminate use

were collected from the beneficiary farmers through personnel interview. The incremental benefit cost ratio (IBCR) was calculated through increase in cost and benefit in between treatments. The estimation of technology gap, extension gap and technology index were calculated using following formulae suggested by Kadian *et al* (1997) and Samui *et al.* (2000).

1. Technology Gap = Potential yield – Average Demo Yield
2. Extension Gap = Average Demo Yield – Average Farmer's Practice Yield
3. Technology Index = {(Potential yield – Average Demo Yield) X 100}/ Potential yield

RESULTS AND DISCUSSION

Grain Yield

It was evident (Table 2) that the grain yield of blackgram crop was 66.40, 36.58, 26.47 and 35.16 per cent higher under demonstration plots as compared to the grain yield of farmer's plot during 2016, 2017, 2018 and 2019, respectively. While, on the basis of average of data, there was 41.80 per cent higher under demonstration plots as compared to the grain yield of farmer's plot. This indicates that with adoption of improved technology in blackgram crops can be raised by 41.89 percent over farmer's plots. The yield advantages have also been reported by Kumar *et al* (2015) and Singh *et al* (2019).

Yield Gaps

The technological yield gap and extension yield gap were calculated under present study. The results revealed that technological yield gap was maximum in blackgram crop variety Pratap Urd 1 (1078 kg/ha) during *kharif,* 2019 followed by variety IPU 94-1 during kharif 2017 (262 kg/ ha) while the lowest technological yield gap was observed in blackgram crop variety IPU 94-1 (27 kg/ha) during *kharif* 2016. The technological yield gaps appear when any demonstration is laid out at farmer's field even if the demonstration is conducted under the supervision of scientist. During *kharif,* 2019 the technological yield gap was maximum because of heavy rainfall (2151.6 mm) during the growing period of blackgram crop while average rainfall of district is only 826.5 mm. Further, this technological yield gaps may be attributed due to lack of facility, variation soil fertility and local specific management problems to attaining the potential and demonstration yield of crops. These results are in close conformity with the Kumbhare *et al* (2014) and Gireesh *et al* (2019).

Table 2: Yield and economic analysis of blackgram under frontline demonstration on pulses

Treatment	Yield (kg/ha)					Cost of cultivation (Rs/ha)				
	2016	2017	2018	2019	Mean	2016	2017	2018	2019	Mean
Demonstration	1273	1038	1075	222	909	20100	20100	22500	21000	20938
Farmers' Practice	765	760	850	170	641	19600	19600	21050	20000	20063
F Test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG

Table 3: Economic analysis of blackgram under frontline demonstration on pulses

Treatment	Gross Return (Rs/ha)					Net Return (Rs/ha)				
	2016	2017	2018	2019	Mean	2016	2017	2018	2019	Mean
Demonstration	70015	53976	61417	12632	49884	49915	33876	38867	-8368	28946
Farmer Practice	42075	39520	48800	9690	35286	22475	19920	27750	-10310	15223
F Test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG

The maximum extension yield gap of 508 kg/ha was observed in blackgram crop variety IPU 94-1 during kharif, 2016. The lowest extension yield gap of 52 kg/ha was observed in in blackgram crop variety IPU 94-1 during *kharif*, 2019. The higher extension yield gap indicates that there is a strong need to motivate the farmers for adoption of improved technology over their local practices (farmer's practice). The extension yield gaps in cluster front line demonstrations on pulses have been reported by many extension workers which observed that extension gap was maximum due to lack of awareness in adoption of improved and recommended package of practice in pulses crop production. The present study is in close conformity with the findings of Choudhary (2013) and Thakur and Bhushan (2016).

Technology Index

The data presented in Table 2 revealed that technology index varied from 2.08 to 82.92 per cent in the blackgram crop during the kharif, 2016 to 2019. The lowest technology index 2.08 was recorded in blackgram variety IPU 94-1 during kharif 2016 followed by 17.31per cent in blackgram variety PU 31 during kharif 2018. Further, highest technology index value was observed with blackgram variety Pratap Urd 1 (82.92%) during *kharif,* 2019. The technology index indicates the feasibility of evolved technology in the farmer's field. If the value of technology index is lower, there is higher the feasibility of improved technology. During *kharif,* 2019 the technological index was maximum because of heavy rainfall (2151.6 mm) during the growing period of blackgram crop while average rainfall of district is only 826.5 mm. Thus, this indicates that blackgram crop variety IPU 94-1 is more popular among the farmers of Mandsaur district in comparison to other varieties demonstrated at farmer's field during 2016 to 2019. The present study was in close conformity with the findings of Dwivedi *et al* (2014).

Economic

It was evident that highest gross and net return was with blackgram crop variety IPU 94-1 during *kharif,* 2016 followed by blackgram variety PU 31 crop during *kharif,* 2018 under demonstration plots. The lowest gross and net return were recorded during *kharif,* 2019 in blackgram crop at farmer's

Table 4: Technology gap, extension gap and technology index of FLD on blackgram in Mandsaur district of Madhya Pradesh

Season / Year	Area (ha)	No. of farmers	Yield (kg/ha)			Technology Gap (kg/ha)	Extension Gap (q/ha)	Technology Index (%)	Additional Cost (Rs/ha)	Additional Return (Rs/ha)	IBCR
			Potential Yield	Demonstration Yield	Farmers Practice						
Kharif, 2016	38.8	97	1300	1273	765	27	508	2.08	500	27440	54.88
Kharif, 2017	40.0	100	1300	1038	760	262	278	20.15	500	13956	27.91
Kharif, 2018	40.0	100	1300	1075	850	225	225	17.31	1500	11117	7.41
Kharif, 2019	40.0	100	1300	222	170	1078	52	82.92	1000	-1942	-1.94
Mean	--	--	1300	909	641	391	268	30.07	875	13723	15.68

plot. The average additional cost and additional net return of Rs 875/- and 13723/- were recorded from 2016 to 2019.

CONCLUSION

It was concluded from the present study that there is a wide technology yield gap (391 kg/ha) and extension yield gap (298 kg/ha) in blackgram crops which reflect in demonstration yield (909 kg/ha) of different varieties of blackgram demonstrated in study at Mandsaur district of Madhya Pradesh. The profitability and productivity of blackgram crop can be improved by adopting improved production technology under agro-climatic conditions of Mandsaur district of Madhya Pradesh.

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Short Communication

Efficacy of MASTIGUARD and Treatment of Subclinical Mastitis in Dairy Cattle

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ABSTRACT

A study was conducted to assess the efficacy of TANUVAS MASTIGUARD (Teat protect spray with TANUCHEK SCC kit) in dairy cattle during 2018-19 and 2020-21. Animals in mid lactation were screened with somatic cell count (SCC) test kit and animals having SCC of more than 2.0 lakh were selected for the study. One group of 10 animals was kept as control and the other group of 10 animals were sprayed with teat protect for 6 wk. The observations recorded at weekly intervals and economics and BCR were also studied. At the end of 6th week, reduction in SCC of milk was recorded in animals of treatment group (1.5 lakh cells / ml) whereas the SCC remains same in control group (2.7 lakh cells/ml). The net returns from treatment group increased owing to increase in milk production and reduction in cost incurred towards treatment. Hence, use of MASTIGUARD was found to be effective in prevention and treatment of subclinical mastitis in dairy cows.

Key Words: Subclinical mastitis, Mastiguard, Teat spray, TANUCHEK kit.

INTRODUCTION

Mastitis is the one of the economically important diseses of dairy cattle which continues to be the major disease that affects milk production especially of the high yielding crossbred cattle. Mastitis is having significant impact on milk production, milk quality and herd health. The cost towards treatment of mastitis is high and the recovery of udder health is also questionable when it is diagnosed at a later stage. Clinical mastitis can be diagnosed based on clinical signs like udder swelling or redness of udder and changes in milk quality that are visible to naked eye. In subclinical mastitis, there won't be any visible changes in milk quality which makes it difficult to detect and also subclinical mastitis contributes to reduction in milk quantity significantly and there are every chance for the animals with subclinical mastitis to become clinical mastitis. By diagnosing subclinical mastitis, it would become easier for the farmers to adopt prophylactic and treatment measures at the earliest to prevent subsequent losses. The economic loss due to subclinical mastitis in terms of monetary loss per lactation is huge owing to reduction in milk yield and veterinary expenses. Higher losses were observed in crossbred cows as their high production potential is affected during mastitis period (Sinha *et al*, 2014).

Use of various teat dips and sprays found to be effective in prevention and treatment of subclinical mastitis, and teat protect sprays were found to be more effective than potassium permanganate teat dips (Sukumar *et al*, 2019). Somatic cell count (SCC) is the most widely used single reliable indicator of udder health and SCC can be successfully used in field for diagnosis of subclinical cases of mastitis (Yadav *et al*, 2018; Sharma *et al*, 2010).

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Sr. No.	Particulars	2018-19		2020 -21	
		Treatment	Control	Treatment	Control
1.	No. of cows in each group	10	10	10	10
2.	Milk yield (Litres/day)	8.04	7.20	8.6	7.4
3.	Somatic cell count before treatment (lakh cells/ml)	2.7	2.7	3.0	3.0
4.	Somatic cell count after treatment (lakh cells/ml)	1.5	2.7	2.0	3.0
5.	Gross cost (Rs.)	26954	29754	22316	24725
6.	Gross return (Rs.)	68628	63154	61896	50248
7.	Net return (Rs.)	41674	33400	39580	25523
8.	BCR	2.55	2.12	2.78	2.03

In view of the above, the present study was conducted during 2018-19 and 2020-21to assess the efficacy of MASTIGUARD (contains Teat protect spray and TANUCHEK SCC Kit) a product from TRPVB, TANUVAS, Chennai, 2016.

MATERIALS AND METHODS

In this study, TANUCHEK SCC kit and teat protect sprays were used in crossbred animals in mid lactation. TANUCHEK SCC Kit is an on – farm test kit for quick determination of the somatic cell counts which increase in milk samples upon infection of the udder. The specific substrate used changes to blue colour by the membrane bound enzymes from the cells. Accordingly, a drop of milk sample was added to the tube having reagent and 3 drops of enhancer solution was added, mixed well and kept 30 minutes for colour development. The colour development in the test samples was compared with standard colour chart to estimate the SCC count. TANUCHEK SCC kit detects SCC of milk in cases of subclinical mastitis and SCC of milk of animals which recovered from clinical mastitis could also be detected.

Teat protect is an unique germicidal teat protective spray for mastitis. This gel works by preventing mastitis causing bacteria from entering the teat canal and provides extended antimicrobial protection. It is having good antibacterial activity against common bovine mastitis pathogens (*Staphylococcus aureus, Escherchia coli).* It promotes healing of minor cuts and abrasions in teat, udder hygiene and health.

The study was conducted in 2 phases. In each year, crossbred dairy cattle in mid lactation were screened for subclinical mastitis using TANUCHEK SCC Kit and 20 animals with somatic cell count of more than 2,00,00 cells /ml were selected for the study. One group of animals with 10 numbers was kept as control and other 10 animals from second group were sprayed with Teat protect spray on all the four teats and udder after each milking for 6 wk. SCC of milk was recorded at weekly intervals. Gross cost, gross returns, net returns and BCR were calculated and the results were interpreted.

RESULTS AND DISCUSSION

From the study, it was observed that increase in milk yield of 11.67 and 16.21 per cent was recorded in the treatment group over the control group in the first and second phases, respectively. Use of teat protect spray was effective in reducing the somatic cell count in treatment group to 1.5 lakh cells/ml and 2.0 lakh cells/ml in the study conducted during 2018-19 and 2020-21, respectively. In the first phase, net return and BCR of treatment and control groups were Rs. 41674/-, 2.54 and Rs. 33400/-, 2.12, respectively. In the second phase net return and BCR of treatment and control groups were Rs. 39600/-, 2.78 and Rs. 25550/-, 2.03 respectively. These results were in resemblance with the findings of Thangadurai *et al* (2019) who recorded a somatic cell count of 1.6 lakh cells/ml in teat protect spray treated group in comparison to control group 2.75 lakh cells/ml. TANUVAS teat protect was found to be effective in reducing SCC of milk in subclinical mastitis cases that indicated udder health.

CONCLUSION

It was concluded that, Teat protect spray was effective in treatment of subclinical mastitis and along with TANUCHEK – SCC counter and easier for the veterinary professionals and farmers to detect SCC at field level. By detection of subclinical mastitis, treatment could be initiated at the earliest to prevent further losses by preventing the condition to become a clinical mastitis. The net return from dairy farming increased owing to increase in milk yield and reduction in treatment cost.

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Short Communication

Evaluation of Tomato Hybrids in Salem District of Tamil Nadu

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ABSTRACT

Tomato is cultivated in an area of 3177 ha in Salem district of Tamil Nadu. The major villages cultivating tomato are Panamarathupatti, Kammalapatti, Thumbalpatti, Mallur and Nalikkalpatti. Most of the farmers are cultivating private tomato hybrids with lesser productivity and more yield loss (up to 30 %) due to diseases like leaf curl, early and late blight and bacterial wilt. Hence, it was proposed to conduct an on farm trial to assess the *per se* performance of tomato hybrids with high yield and multiple disease resistance like TNAU Tomato Hybrid CO4 and Arka Vishesh. A field experiment was conducted at five different locations of Panamarathupatti block of Salem district during *Kharif* 2019 using hybrids IIHR hybrid Arka Vishesh and TNAU Tomato Hybrid CO 4 with Sivam hybrid as control. TNAU Tomato Hybrid CO 4 recorded an average yield of 95 t/ha and Arka Vishesh around 87 t/ha. The private hybrid Sivam recorded a yield of only 62 t/ha. TNAU Tomato Hybrid CO 4 recorded more average number of fruits per cluster (5.5) and higher fruit yield per plant (2.5 kg) as compared to Arka Vishesh with average number of fruits per cluster (4.5) and higher fruit yield per plant (2.25 kg). The seed cost of the private variety grown by the farmer was higher and the hybrids such as TNAU CO4 and IIHR hybrid Arka Vishesh performed better with regard to higher cost benefit ratio (BCR for TNAU Tomato Hybrid CO 4 is 1:3.81 and for Arka Vishesh 1:3.41).The market preference for TNAU Tomato Hybrid CO 4 was comparatively higher due to the large sized fruits with more acidity (0.7%) which enhances the consumer preference in the market.

Key Words: Tomato, Hybrids, TNAU Tomato Hybrid CO 4, Arka Vishesh, Performance.

INTRODUCTION

Tomato (*Solanum Lycopersicon* L.) has acquired the status of world's most popular vegetable crop due to its wider adaptability to various agro climatic conditions (Gupta *et al,* 2015). In Tamil Nadu, tomato is cultivated in an area of 29,000 ha with a production of around one million tonnes and productivity of 30.51 t/ha. Tomato is considered as protective food crop because of having rich in mineral, vitamins and organic acids. It is an important source of lycopene, ascorbic acid and carotene valued for their colour, flavour and antioxidant properties. The increasing consumption of tomato makes it, a high value crop for generating income to the farmers. It is an important crop both for production and industry point of view, there is a necessity to improve the productivity per unit area to achieve the increased production from a limited land. Generally diverse parents are expected to give high hybrid vigour and it is also often possible to combine desired alleles in regular fashion without waiting for longer term (Shankar *et al,* 2015). Hence, usually hybrids show better fitness and breeding value than their parents. Higher yield and better fruit quality are universally desired (Triveni *et al,* 2017; Vilas *et al,* 2015).

In Salem district, the area under horticultural crops is 39765 ha and area under tomato cultivation was around 3177 ha in the year 2019-20. The major villages cultivating tomato are Panamarathupatti,

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Kammalapatti, Thumbalpatti, Mallur and Nalikkalpatti. Private hybrids are ruling the market. Cost of the seeds of private hybrids is too high but the farmers are forced to get it for cultivation due to the easy availability. Most of the farmers are cultivating private tomato hybrids with lesser productivity. Yield loss due to diseases like leaf curl, early and late blight and bacterial wilt was up to 30 per cent. Hence, an investigation is needed to assess the performance of high yielding tomato hybrids in Salem district.

MATERIALS AND METHODS

The experimental material consisted of three different hybrids of tomato namely, TNAU Tomato hybrid CO 4 (COTH 4), Arka Vishesh and Sivam hybrid. COTH 4 is released from Horticultural College and Research Insititute, Tamil Nadu Agricultural University, Coimbatore and the special characteristics of COTH 4 is a F1 hybrid of LE 1226 X LE 1249, in which fruits are flat round with thick pericarp (5.84 mm), and the fruits have green shoulder at breaker stage which turns to red colour at ripening. Fruits are borne in clusters of 5-6, with an average fruit weight of 75.3 g. The hybrid has long harvesting period with 20-22 harvests in 150 days with a yield of 2.94 kg/plant. It is having a capacity of yielding 92.3 t/ha (27.31 % increase over TNAU tomato hybrid CO3 and 40.91% over Lakshmi) with ascorbic acid content: 26.13 mg/100 g and TSS: 6.1o brix and titrable acidity: 0.70 per cent.

Arka Vishesh is a F1 hybrid released from Indian Institute of Horticultural Research, Bengaluru and its yield potential is 75-80 t/ha. It is suitable for processing into puree, paste, ketchup, sauce, tomato crush. TSS: 4- 4.6^{0} **Brix, c**olour value of crushed tomato juice (a/b, Hunter Lab scale): 1.98-2.12, average fruit weight: 70-75gm, acidity of crushed tomato juice: 0.32-0.36, pH: 4.21-4.41, lycopene content: 8.5-10.5 mg/100g, lycopene content in tomato paste: 14.14 mg/100g, firmness: 4.09-5.41 kg/cm^2, seed content 0.4 to 0.5 and peel content: 5.96.

Sivam is a private semi determinate hybrid from the Hyveg Company and it is tall determinate to semi determinate plants with good foliage cover and vigour. Days to first harvest are 62-67 days. Flat round fruits with green with very firm structure and acidic taste. Colour of the fruit is deep red with a average weight of 100-120g and have intermediate resistance to tomato leaf curl virus. Shoulder of the fruit is green, mild ribbing with deep oblate shape and it sets fruits up to 38^{0}C.

A field experiment was conducted at different locations of Panamarathupatti block in Salem district during *Kharif* 2020 using hybrids TNAU Tomato Hybrid CO 4 and Arka Vishesh and with Sivam Hybrid as check hybrid. The experiment was laid out in a randomized block design with seven replications. The mean performance of different traits such as plant height, days to first flowering, days to first harvest, number of fruits per cluster, fruit yield per plant, yield per hectare, net returns per hectare and benefit cost ratio have been recorded and data were subjected to statistical analysis (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

The data (Table 1.) showed that TNAU Tomato Hybrid CO 4 recorded an average high yield of 95 t/ha and Arka Vishesh around 87 t/ha. The private hybrid Sivam recorded less yield of 62 t/ha. TNAU Tomato Hybrid CO 4 recorded more average number of fruits per cluster (5.5) and higher fruit yield per plant (2.5kg) as compared to Arka Vishesh with an average number of fruits per cluster (4.5) and higher fruit yield per plant (2.25 kg). The size of the fruit was also better in TNAU Tomato Hybrid CO 4 (73.5g of average fruit weight). With regard to precocity in flowering and fruit setting, TNAU Tomato Hybrid CO 4 took around 32 days for first flowering and 36 days for 50 per cent flowering. These results were in resemblance with the findings of Shankar *et al* (2015) and Triveni *et al (* 2017).

The seed cost of the private variety grown by the farmer was higher and the hybrids such as

Table 1. ***Per se*** **performance of TNAU Tomato Hybrid CO 4 and Arka Vishesh, IIHR hybrid of tomato in Salem District.**

Treatment	Plant height (cm)	Days to first flowering	Days to 50% flowering	Number of fruits per cluster	Av. fruit wt (g)	Yield per plant (kg)	Yield (t/ha)	Net Returns (lakh/ha)	B:C ratio
TNAU Tomato Hybrid CO4	90	32	36	5.5	73.5	2.50	95	3.8	3.81
Arka Vishesh	92	33	37	4.5	70.5	2.25	87	3.26	3.41
Sivam hybrid	96	35	40	4.5	62.5	2.15	62	2.17	2.55
Mean	93.14	33.3	37.6	5.02	68.88	2.29	81.3		
CD5%	1.77	1.03	0.95	0.37	0.46	0.11	1.26		
CD1%	2.49	1.44	1.33	0.51	0.65	0.16	1.76		
SEd	0.81	0.47	0.43	0.17	0.21	0.05	0.58		
CV(%)	1.6	2.65	2.16	6.26	0.58	4.28	1.3		

TNAU Tomato Hybrid CO 4

Arka Vishesh

Sivam Hybrid Tomato

Field view of the Experiment in farmers field

TNAU Tomato Hybrid CO 4 and IIHR hybrid Arka Vishesh performed better with regard to higher cost benefit ratio (BCR for TNAU Tomato Hybrid CO 4 is 1:3.81 and for Arka Vishesh 1:3.41). But the market preference for COTH4 was comparatively higher due to the large sized fruits with green shoulder at breaker stage with more acidity (0.7%) which enhances the consumer preference in the market.

In general, it was observed that apart from higher yield in TNAU tomato hybrid CO 4, the consumers preference was more than Arka Vishesh hybrid and hence marketability was also comparatively easier and better in TNAU Tomato Hybrid CO 4 than Arka Vishesh and Sivam Hybrid.

CONCLUSION

In Salem District of Tamil Nadu the TNAU Tomato Hybrid CO 4 recorded higher fruit yield of 95 t/ha with higher benefit cost ratio (3.81) whereas the Arka Vishesh recorded an yield of 87 t/ha with a benefit cost ratio (3.41). Hence, TNAU Tomato Hybrid CO 4 hybrid is found be more suitable for Salem tomato growing farmers to get higher yield in tomato as well as higher net income and benefit cost ratio.

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Short communication

Validation of Bio-intensive modules towards the Management of Viral and Phytoplasma Diseases of Brinjal, *Solanum melongena* L.

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ABSTRACT

Development of bio-intensive module was carried out at Agricultural Research Station (ARS), Virinjipuram for a period of two years during 2017-19 in *kharif* and *rabi* against viral and phytoplasma diseases of brinjal. The module thus developed was tested in two locations *viz*., ARS farm, Virinjipuram and at farmers' field to assess the performance of Bio-intensive Integrated Disease Management (BIDM) module against the mosaic, little leaf disease and whitefly during *Kharif* 2020. The results revealed that the BIDM was found superior in minimising the mosaic incidence in both locations tested and recorded 5.16 and 6.12 per cent also with lowest little leaf incidence. The lowest whitefly population was also recorded in bio-intensive module adopted plots when compared to farmers' practice at all stages of crop growth. At 30 days after transplanting (DAT), the whitefly population of 4.45 and 3.77 number per plant was recorded at ARS, Virinjipuram and at farmers' field. With respect to fruit yield, an adoption of bio-intensive module registered a significantly higher yield both at ARS farm (34.02 t/ha) and at farmers' field (30.36 t/ha) coupled with higher benefit cost ratio of 5.84 and 5.18 where as in farmers' practice the lowest fruit yield of 31.71 t/ha with BC ratio of 5.57 at ARS farm and 25.68 t/ha of fruit yield with CB ratio of 1:4.43 in farmers' field were recorded.

Key Words: BIDM module, Validation, Brinjal, mosaic disease, Vector population.

INTRODUCTION

Brinjal (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics. In India, it is one of the most common, popular and principal vegetable crops grown throughout the country except higher altitudes. It is highly preferred crop upon fruit colour, size and shape. The brinjal little leaf disease was first described by Thomas and Krishnaswami (1939) in India with 100% yield loss in epidemics Rao and Kumar (2017). Several approaches were suggested for the management of virus and phytoplasma diseases and their insect vectors but still management could not be done successfully. Hence, an integrated approach might be the most viable and sustainable option with an integration of cultural, physical, biological, resistance and chemical applications. However, an indiscriminate use of chemical leads to number of problems like development of resistance, contamination of food, soil, groundwater and also causes toxic effect on non-target and other organisms. One of the biggest challenges of developing and implementing integrated disease management (IDM) module is to successfully balance the goals of reducing pesticide use while maintaining the crop quality demanded by the producer as well as the consumer. Keeping this

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Table 1. Components of BIDM module and farmers' practice.

Bio-intensive module	Farmers' practice
Seed treatment with *Trichoderma viride* @ 4 g /kg or *Bacillus subtilis* @ 10 g / kg nursery application of neem cake @ 1.0 kg sq.m^{-1} Growing of maize as border crop Roguing out of early diseased plants Installation of yellow sticky traps @ 12 /ha Foliar spraying of neem oil formulation @ 3 ml/ litre or NSKE 5 % One application of spiromesifen 240 SC @ 1.0 ml and thiacloprid 240 SC @ 1.0 ml per litre of water	Two application of imidacloprid 17.8 SL @ 5ml per litre of water at 30 & 45 DAT. One application of acephate 75 SP @ 1.5 g per litre of water at 60 DAT

$$\text{Mosaic and little leaf disease (\%)} = \frac{\text{Number of affected plant in a plot}}{\text{Total number of plants in a plot}} \times 100$$

in mind, the bio-intensive module thus developed was validated at farmers' field for its performance and economic impact.

MATERIALS AND METHODS

Bio-intensive integrated disease management module was developed at Agricultural Research Station (ARS), Virinjipuram after two consecutive years (2017-2019) of study in *kharif* and *rabi*. In order to assess the performance to validate the findings, two field experiments were conducted simultaneously at different locations one at Agricultural Research Station, Virinjipuram, Vellore District, Tamil Nadu and second at farmers' holding field at K. V. Kuppam block of Vellore district to assess the performance of Bio-intensive Integrated Disease Management (BIDM) module against the mosaic, little leaf disease and whitefly, *Bemisia tabaci* Gennadius during *Kharif* 2020 with two components of management *viz*., Bio-intensive Integrated disease management (BIDM) and Farmers' practice (Table 1). Brinjal (Variety: VRM 1) seedlings (25d old) were transplanted in an area of 25 cents with a spacing of 60x45 cm (RxP) under each management modules. The recommended agronomic package of practices was followed to raise a good crop. The need-based spray and insecticides were sprayed with the help of a knapsack sprayer using 500 L of spray per hectare. Observations on the disease incidence of mosaic and little leaf were taken using the given formula in each module. Likewise, the whitefly population counts were also taken at 30, 60 and 90 days after transplanting (DAT) from three leaves, one each at the top, middle and bottom of the each plant also recorded and expressed as population per plant. The disease incidence was worked out using the formula given below. The fruit yield, thus obtained per plot has been converted in terms of fruit yield per hectare and Cost: Benefit ratio was also worked out for different management modules. Thus, the data obtained on the population, mosaic disease incidence and fruit yield in different treatments were analyzed statistically using AGRES (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results (Tables 2 and 3) revealed that there was a remarkable decrease in the disease incidence and whitefly population. Observations

Table 2. Bio-intensive management of viral and phytoplasma diseases of brinjal.

Treatment	Whitefly population (No/ plant)				Disease incidence (%)		Fruit yield (t/ha)	C:B
	30 DAT	60 DAT	90 DAT	120 DAT	Mosaic	Little leaf		
Bio-intensive module	4.45 (2.11)[a]	3.11 (1.76)[a]	0.71 (0.84)[a]	0.89 (0.94)[a]	5.16 (13.09)	2.59 (9.17)	34.02	1: 5.84
Farmers' practice	5.98 (2.44)[b]	4.32 (2.08)[b]	1.95 (1.40)[b]	1.79 (1.34)[b]	11.46 (19.74)	5.90 (13.96)	31.72	1: 5.57
S. Ed.	0.02	0.01	0.01	0.02	0.68	0.65	0.50	
C. D (p=0.05)	0.05	0.03	0.03	0.05	1.49	1.42	1.08	

on disease incidence and vector population were recorded at regular intervals at ARS farm and also in farmers' holding. Among the three treatments, the bio-intensive management was found superior in minimising the mosaic (5.16%) and little leaf diseases (2.59%) and whitefly population (0.89 No./plant) with increased fruit yield (34.02 t/ha) and higher Cost: Benefit (1:5.84).The untreated check recorded the highest incidence of mosaic (18.50%) and little leaf (8.24%) and whitefly population coupled with lowest fruit yield (27.58 t/ha) and C:B (1:4.07).

Adoption of bio-intensive management module by the farmer also resulted in minimising the mosaic (6.12%) and little leaf diseases (3.06%) and whitefly population (1.62 Nos/plant) with increased fruit yield (30.36 t/ha) and higher C:B (1:5.18).The untreated check recorded the highest incidence of mosaic (12.54%) and little leaf (7.31%) diseases and whitefly population (6.32 Nos/plant) coupled with lowest fruit yield (25.68 t/ha) and Cost: Benefit (1:4.43). The present finding on the use of integrated pest management package over conventional methods was also studied by Sandeep *et al* (2017). They found that seedling root treatment for 3 hr with imidacloprid (1ml/l) + Soil application of *Trichoderma* + installation of pheromone traps @ 35 /ha + Mechanical removal of infected shoots and fruits + spraying of NSKE 4 % recorded the lowest shoot and fruit infestation and wilt incidence. In case of Chillies, IDM was found effective to check the powdery mildew, anthracnose and die back diseases and increase fruit yields. Yadav *et al* (2017) also reported that the per cent disease incidence of powdery mildew, anthracnose on leaves, fruit infection and plant mortality in chillies were recorded 3.6, 17.7, 23.0

Table 3. Bio-intensive management of viral and phytoplasma diseases of brinjal.

Treatment	Whitefly population (Nos/plant)				Disease incidence (%)		Fruit yield (t/ha)	C:B
	30 DAT	60 DAT	90 DAT	120 DAT	Mosaic	Little leaf		
Bio-intensive module	3.77 (1.94)[a]	5.91 (2.43)[a]	4.74 (2.18)[a]	1.62 (1.27)[a]	6.12 (14.32)	3.06 (9.98)	30.36	1: 5.18
Farmers' practice	6.17 (2.48)[b]	11.67 (3.42)[b]	10.86 (3.30)[b]	6.32 (2.51)[b]	12.54 (20.67)	7.31 (15.59)	25.68	1: 4.43
S. Ed.	0.01	0.04	0.01	0.06	1.28	1.34	1.25	
C. D (p=0.05)	0.02	0.09	0.02	0.13	2.79	3.12	2.71	

and 5.6 in IDM fields and 7.8, 33.6, 37.7 and 17.1 in without IDM fields.

CONCLUSION

The findings clearly indicated that with an adoption of bio-intensive IDM module *viz*., Seed treatment with *Trichoderma viride* @ 4 g /kg or *Bacillus subtilis* @ 10 g / kg nursery application of neem cake @ 1.0 kg sq.m^{-1} , growing of maize as border crop, rogueing out of early diseased plants, Installation of yellow sticky traps @ 12 /ha, Foliar spraying of neem oil formulation @ 3 ml/ litre or NSKE 5 % and need based applications of spiromesifen 240 SC @ 1.0 ml and thiacloprid 240 SC @ 1.0 ml per litre of water reduced the mosaic and little leaf diseases and also whitefly population besides increasing the fruit yield and cost benefit ratio.

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