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ENHANCEMENT OF SOURCE-SINK RELATIONSHIP IN BLACKGRAM (*Vigna mungo* (L.) Hepper) THROUGH FOLIAR APPLICATION OF SALICYLIC ACID AND BORON

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ABSTRACT

A field experiment was conducted during *rabi*, 2019 at dry land farm of S.V. Agricultural College, Tirupati to study the effects of foliar application of salicylic acid and boron in enhancing the source-sink relationship in blackgram (*Vigna mungo* (L.) Hepper) with ten treatments. Among the various treatments imposed T_2 (Recommended dose of fertilizer (RDF) + foliar spray of salicylic acid @ 100 ppm at 25 (DAS) days after sowing) recorded highest dry matter partitioning efficiency of 31.76 per cent and 46.49 per cent in pods at 60 DAS and harvest respectively. Similarly, treatment T_2 recorded highest SPAD chlorophyll meter readings at 30 DAS (48.2) and 60 DAS (48.69), number of pods plant^{-1} (24.32), number of seeds pods^{-1} (8.03), test weight (54.40 g) and seed yield (801.66 kg ha^{-1}). Whereas, T_7 (RDF + foliar spray of boron 100 ppm at 25 and 45 DAS) recorded lowest values for dry matter partitioning (27.23%) at 60 DAS, SPAD (37.29), number of pods plant^{-1} (10.46), test weight (41.26 g) and seed yield (500 kg ha^{-1}).

KEYWORDS: Boron, Blackgram, Salicylic acid, SPAD

INTRODUCTION

Pulses are commonly known as food legumes, belongs to family Fabaceae and have an unique ability of biological nitrogen fixation, mobilization of insoluble soil nutrients with their deep root system hence, popularly known as wonderful gift of nature. Pulses are rich source of proteins compared to cereals hence they possess great importance in Indian Agriculture (Prajapati *et al.,* 2017). World health organization recommends per capita consumption of pulses as 80 g day^{-1}.

Blackgram occupies fourth position in terms of area, production and productivity in India, it is cultivated in an area of about 4.48 m ha with production of 2.8 mt and productivity of 632 kg ha^{-1}. In Andhra Pradesh it is cultivated in an area of 5 m ha with production of 3.29 m t and productivity of 658 kg ha^{-1} (Anonymous, 2017). Blackgram is one of the utmost important pulse crop with high price and cultivated in almost all parts of India. It has perfect combination of all nutrients, which includes carbohydrates (60%), proteins (26%), fat (1.5%),calcium (154 mg), minerals (3.2%), phosphorous (385 mg), fiber (0.9%), 9.1 mg of iron and vitamin B-complex (Jadhav *et al*., 2019).

Potential of blackgram in terms of yield is poor as it is mainly grown in rainfed condition with meager management practices and also due to several physiological and biochemical processes hampering the crop growth. Physiological problem like flower drop and premature shedding of reproductive structure diminishes number of potential sinks which seems to be associated with nutrient deficiency and hormonal imbalance and results in reduced translocation of dry matter to reproductive parts. Further, the reduction of blackgram yield is due to inadequate partitioning of assimilates, poor pod formation and lack of nutrients availability during critical stages of crop growth which may be improved through foliar application of growth hormones coupled with micronutrients play a major role in improving the source sink relationship through increased capacity of source and increased translocation of assimilates to sink. (Kumar *et al.,* 2018).

Salicylic acid plays an important role in controlling plant growth and development and also plays a main role in response to environmental stresses. Boron is an essential element which is vital for plant growth and development. It is especially required in meristematic cells and essential for actively growing areas of plants such as newly forming leaves, root tips and bud development (Ahmad *et al*., 2009).

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However, collective result of salicylic acid and boron on physiological behaviour of plant growth, metabolism and development is scanty and is of a research priority. Therefore, the present study was formulated to study the influence of salicylic acid and boron on source-sink relationship of blackgram.

MATERIAL AND METHODS

The experiment trial was carried out during *rabi*, 2019, at S.V. Agricultural College farm, Tirupati. The experiment was laid out in randomized block design with 10 treatments replicated thrice. The treatmental details composed of T_1 : Control(RDF- 20 kg N and 50 kg P_2O_5 as basal), T_2 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 days after sowing,T_3 : RDF + Foliar spray of Salicylic acid 100 ppm at 45 days after sowing,T_4 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 and 45 days after sowing, T_5 : RDF +Foliar spray of boron100 ppm at 25 days after sowing, T_6 : RDF + Foliar spray of Boron 100 ppm at 45 days after sowing, T_7 : RDF + Foliar spray of Boron 100 ppm at 25 and 45 days after sowing, T_8 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 days after sowing, T_9 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 45 days after sowing,T_{10} : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 and 45 days after sowing. The concentrations used in the experiment were salicylic acid @ 100 ppm and boron @ 100 ppm. The seed variety used in the experiment was TBG-104.

The concentrations used in the experiment were salicylic acid @ 100 ppm and boron @ 100 ppm. Three irrigations were given to the crop *i.e*., at the time of sowing, 20 DAS and at flowering stage.

SPAD chlorophyll meter reading (SCMR)

SPAD chlorophyll meter readings (SCMR) were taken by following the method of Turner and Jund (1991) and the data was recorded on 5th or 6th leaf from top of each representative plant, between 8.00 a.m. and 9.00 a.m. at 30, 60 DAS and harvest.

Dry matter partitioning efficiency

Total dry matter partitioning efficiency was estimated in five plants by randomly pulled out with root system intact from each treatment in three replications and separated into roots, stems, leaves and pods. The plant parts were dried to a constant weight in hot air oven at 80°C for 48 hours and the dry weights were recorded and expressed in g plant^{-1}.

Yield and yield components

Number of pods plant^{-1}, number of seeds per pod was counted for the five tagged plants and the mean value was calculated.

For test weight thousand seeds were drawn at random from each treatment in three replications and then weighed. It is expressed as the average value of test weight. Seed yield was calculated as seed from each plot was weighed and expressed as gram plant^{-1}. Seed yield also calculated for a net plot area and it was computed to hectare and expressed as kg ha^{-1}.

The experimental data were analyzed statistically by following standard procedure outlined by Panse and Sukhatme (1985). Significance was tested by comparing 'F' value at 5 per cent level of probability. Further the data was analyzed by OPSTAT (Operational statistics) software.

RESULTS AND DISCUSSION

Parameters such as SPAD chlorophyll meter reading, dry matter partitioning efficiency (%) and yield attributes *viz*., number of pods plant^{-1}, number of seeds pod^{-1}, test weight and seed yield kg ha^{-1} were significantly influenced by treatments are presented in the Tables.

Among the treatments at 60 DAS significantly high SCMR (48.69) was recorded in T_2 (RDF + Foliar spray of Salicylic acid 100 ppm at 25 days after sowing) which was on par with T_6 (48.33) followed by T_4 (46.71). Whereas T_7 (39.96) recorded significantly low SCMR which was on par with T_8 (41.22) followed by T_1 (43.06) (Table 1). Similar trend was observed at harvest. Our results were supported by Bhattacharya *et al*. (2004) who reported a similar increase in chlorophyll content in blackgram with the application of boron.

Among the treatments at 60 DAS T_5 (26.09 %) recorded highest partitioning in leaf, T_8 (36.89%) in stem, T_7 (12.15%) in root and T_2 (31.76 %) translocated more amount of assimilates to pods. Whereas at harvest, maximum dry matter partitioning were obtained in T_2 (18.67%), T_8 (31.11%), T_3 (8.64%) and T_2 (46.49%) in leaf, stem, roots and pods respectively. Decreasing leaf and stem dry weight might be due to remobilization of assimilates towards grain at maturity. At harvest maximum

Table 1. Effect of salicylic acid and boron on SPAD Readings at different growth stages of blackgram

S. No.	Treatments	SPAD Chlorophyll Meter Readings		
		30 DAS	60 DAS	At Harvest
1	T_1 : Control	38.77	43.06	38.40
2	T_2 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 days after sowing	48.29	48.69	44.30
3	T_3 : RDF + Foliar spray of Salicylic acid 100 ppm at 45 days after sowing	39.86	43.69	39.64
4	T_4 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 and 45 days after sowing	41.58	46.71	42.71
5	T_5 : RDF + Foliar spray of Boron 100 ppm at 25 days after sowing	44.50	44.45	41.66
6	T_6 : RDF + Foliar spray of Boron 100 ppm at 45 days after sowing	43.23	48.33	43.48
7	T_7 : RDF + Foliar spray of Boron 100 ppm at 25 and 45 days after sowing	37.29	39.96	35.23
8	T_8 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 days after sowing	38.04	41.22	36.11
9	T_9 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 45 days after sowing	40.44	44.07	41.22
10	T_{10} : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 and 45 days after sowing	46.62	45.07	42.07
	Mean	41.86	44.53	40.48
	CD (p=0.05%)	1.46	1.45	1.69
	SEm±	0.492	0.490	0.57

Table 2. Effect of salicylic acid and boron on dry matter partitioning efficiency (%) at different growth stages of blackgram

S. No.	Treatments	60 DAS				Harvest			
		Leaf	Stem	Root	Pods	Leaf	Stem	Root	Pods
1	T_1 : Control	24.06	35.69	11.87	28.39	16.17	30.27	8.23	44.98
2	T_2 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 days after sowing	25.00	32.70	10.55	31.76	18.67	27.34	7.59	46.49
3	T_3 : RDF + Foliar spray of Salicylic acid 100 ppm at 45 days after sowing	24.27	35.09	11.47	29.17	16.42	29.38	8.64	45.56
4	T_4 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 and 45 days after sowing	24.89	33.32	11.17	30.62	18.07	28.72	8.16	45.05
5	T_5 : RDF + Foliar spray of Boron 100 ppm at 25 days after sowing	26.09	35.02	10.66	28.23	17.75	29.85	7.83	44.57
6	T_6 : RDF + Foliar spray of Boron 100 ppm at 45 days after sowing	24.52	33.79	10.69	30.99	17.76	27.93	7.89	46.41
7	T_7 : RDF + Foliar spray of Boron 100 ppm at 25 and 45 days after sowing	24.15	36.46	12.15	27.23	15.29	29.71	8.51	46.40
8	T_8 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 days after sowing	23.74	36.89	11.59	27.79	15.54	31.11	8.27	45.08
9	T_9 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 45 days after sowing	25.65	34.91	11.11	28.33	17.80	28.94	8.29	45.33
10	T_{10} : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 and 45 days after sowing	25.39	34.49	11.25	28.87	18.34	28.29	8.37	45.01
	Mean	24.78	34.84	11.25	29.14	17.18	29.15	8.18	45.49
	CD (p = 0.05%)	NS	NS	NS	NS	NS	NS	NS	NS
	SEm±	1.34	1.04	0.65	1.69	0.79	1.35	0.85	1.90

Table 3. Effect of salicylic acid and boron on yield and yield components of blackgram

S. No.	Treatments	Yield and yield components			
		No. of pods plant^{-1}	No. of seeds pod^{-1}	Test weight (g)	Seed yield (kg ha^{-1})
1	T_1 : Control	9.34	5.53	40.96	475.80
2	T_2 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 days after sowing	24.32	8.03	54.40	801.66
3	T_3 : RDF + Foliar spray of Salicylic acid 100 ppm at 45 days after sowing	11.85	6.56	42.50	619.80
4	T_4 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 and 45 days after sowing	16.15	7.63	50.83	740.40
5	T_5 : RDF + Foliar spray of Boron 100 ppm at 25 days after sowing	13.28	7.13	44.45	675.10
6	T_6 : RDF + Foliar spray of Boron 100 ppm at 45 days after sowing	21.13	7.96	45.74	765.40
7	T_7 : RDF + Foliar spray of Boron 100 ppm at 25 and 45 days after sowing	10.46	5.77	41.26	500.46
8	T_8 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 days after sowing	10.98	6.25	42.29	572.62
9	T_9 : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 45 days after sowing	12.56	6.86	42.62	658.20
10	T_{10} : RDF + Foliar spray of Salicylic acid 100 ppm + Boron 100 ppm at 25 and 45 days after sowing	14.77	7.31	52.07	718.00
	Mean	14.49	6.90	45.71	652.75
	CD (p=0.05%)	1.50	0.18	6.71	202.71
	SEm±	0.50	0.06	2.26	68.22

dry matter partitioning was obtained in T_2 (18.67%), T_8 (31.11%), T_3 (8.64%) and T_2 (46.49%) in leaf, stem, roots and pods respectively (Table. 2). Similar trend was observed by Kulsum *et al*. (2007) in blackgram. In dry matter partitioning, most of the treatments conferred more than 40% assimilates to the pods at maturity. Due to foliar application of nutrients and hormones leaf area and assimilation of photosynthates in leaf increased and ultimately higher assimilates partitioned to pod than control.

Yield components *viz*., number of pods plant^{-1}, number of seeds pod^{-1}, test weight and seed yield kg ha^{-1} were recorded highest with T_2 : RDF + Foliar spray of Salicylic acid 100 ppm at 25 days after sowing (Table 3). Our results are supported by Ram *et al*. (2017) and Rawat *et al*. (2019) where number of pods plant^{-1} recorded highest with the application of boron and salicylic acid. Kaisher *et al*. (2010) reported that application of sulphur and boron increased number of seeds pod^{-1} in mungbean.

It is due to fact that boron plays a role in cell division, sugar and starch formation, carbohydrate metabolism, which further increases the size and weight of grain (Kaisher *et al*., 2010). Ali and Mahmoud (2013) confirmed that application of salicylic acid recorded the highest 1000 seed weight in blackgram.

Higher seed yield in black gram (Darade *et al*., 2019) is due to better partitioning of assimilates from sources to sink. Manjri *et al*. (2018) found that highest seed yield in blackgram obtained with foliar spray of salicylic acid.

CONCLUSION

With the application of nutrients and growth regulators enhanced pods to flower ratio being increased availability of nutrients and subsequently better translocation of assimilates from source to sink by preventing flower abortion and increased pod setting, number of pods plant^{-1}, seeds pod^{-1}, test weight and seed yield kg ha^{-1}.

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STUDY ON COSTS, RETURNS AND CONSTRAINTS IN PRODUCTION OF *RABI* JOWAR IN KURNOOL DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The study was carried out during the year 2018-19. The purpose of selecting Kurnool district in Andhra Pradesh for the study was, because of its highest area and production under *Rabi* jowar when compared to other districts. Probability proportionate sampling was employed to select the number of farmers from the selected villages and the total sample constitutes to 120. Human labour is the most influencing component among various factors involved in the production process. The total cost of cultivation of *Rabi* jowar per hectare was calculated as ₹ 53,657.14. Among the total costs 75.42 per cent was occupied by variable costs and remaining 24.57 per cent was occupied by fixed costs. Cultivation cost of *Rabi* jowar according to cost concepts were calculated and they were, cost A_1 ₹ 35066.94, cost B_1 ₹ 35919.14, cost B_2 ₹ 47169.14, cost C_1 ₹ 42404.14, cost C_2 ₹ 53654.14 and finally cost C_3 ₹ 59019.55. Gross returns from per hectare of *Rabi* jowar was ₹ 78,000 and net return was ₹ 24,342.86. Farm income measures were worked out per hectare of *Rabi* jowar. The farm business income was worked out as ₹ 42933.06. Family labour income and farm investment income were ₹ 30830.86 and ₹ 31082.65 respectively. When Returns per rupee of expenditure were worked out they stood at 0.41. Major constraint faced by farmer's during cultivation of *Rabi* jowar was inadequate and untimely rainfall during the period of harvesting.

KEY WORDS: Cost concepts, Farm income measures, Net return, *Rabi* jowar.

INTRODUCTION

Agriculture is the major occupation in India, nearly 70 percent of country's population depends on agriculture either directly or indirectly for their livelihood. Production of food grains has increased from 51 million tonnes during 1950-51 to 285.2 million tonnes during 2018-19 (FAO, 2019). Millets are generally cultivated in low-fertile land, tribal and rain-fed areas. These areas include Andhra Pradesh, Gujarat, Chhattisgarh, Haryana, Rajasthan, Maharashtra, Madhya Pradesh, Karnataka, Tamil Nadu, Uttar Pradesh and Telangana. Millets are often referred as coarse cereals and also nutri-cereals because of nutrient richness of grains. India is the leading producer of millets followed by Africa. Major millets grown in India are jowar, bajra, ragi, banyard millet, proso millet, foaxtail millet and kodo millet. Jowar is called as great millet due to its grain size among the millets. The major jowar producing states are Maharashtra, Karnataka, Gujarat, Madhya Pradesh and Andhra Pradesh. Area of jowar in Kurnool district was about 742 and 63673 hectares in *kharif* and *Rabi* respectively and with total production of 60252 tonnes and the productivity was 935 kg per hectare in the year 2018-19 (Anonymous, 2019).

Objectives of investigation

1. To estimate the costs and returns of *Rabi* jowar cultivation.
2. To recognize constraints faced by the farmers in cultivation of *Rabi* jowar.

MATERIAL AND METHODS

The list of all 54 mandals of kurnool district, was prepared and three mandals *viz*., Banaganapalli, Koilakuntla and Allagadda were purposively selected for the present study based on the maximum area under *Rabi* jowar. All the villages in selected mandals were listed out and four villages from each selected mandals were purposively selected based on the criterion of maximum area under *Rabi* jowar thus making the total sample villages to twelve. All the farmers in the selected villages were listed out and probability proportionate sampling was employed to get the sample from each village. The total sample size constitutes to 120. After getting the sample the farmers were selected randomly. The primary data required for the study were collected through personal interview with the help of a pre-tested schedule.

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Tools of Analysis

Cost concepts

Cost concepts defined by Commission for Agricultural Costs and Prices (CACP) were followed to estimate the cost of cultivation and derive the measures of efficiency *viz.,* farm business income, family labour income, net income and farm investment income . The cost concepts *viz.,* cost A_1, cost A_2, cost B_1, cost B_2 and cost C_1, cost C_2, cost C_3 were used in the present study and they are derived as follows.

Cost A_1

This cost includes values of hired human labour, owned and hired cattle labour, owned and hired tractor services, seeds, fertilizers, farm yard manures, plant protection chemicals, depreciation, repairs, land revenue and interest on working capital.

Cost A_2 = Cost A_1 + rent paid for leased in land.

Cost B_1 = Cost A_2 + Interest on value of owned fixed capital assets (excluding land) **Cost B_2** = Cost B_1 + Rental value of owned land and rent paid for leased-in land **Cost C_1** = Cost B1 + Imputed value of family labour.

Cost C_2 = Cost B_2 + Imputed value of family labour.

Cost C_3 = Cost C_2 + 10 per cent of cost C_2 as management cost. (On account of managerial functions performed by farmers).

Farm efficiency measures

Farm business income = Gross income – Cost A_1 Family labour income = Gross income – Cost B_2 Net income = Gross income – Cost C_2.

Farm investment income = (Gross income – Cost C_3) + (Cost B_2 – Cost A_1) Returns per rupee of expenditure = Net income / Cost C_3.

GARRETT'S RANKING TECHNIQUE

Garrett's ranking technique was employed to prioritize or rank the problems posed by the farmers in production and marketing of *Rabi* jowar.

Garratt's Formulae for converting rank into per cent is given by:

Per cent position=100*(Rij-0.5)/N_j Where,

R_{ij} = Rank given for i^{th} factor (constraint) by j^{th} individual, N_j = Number of factors (constrains) ranked by j^{th} individual.

RESULTS AND DISCUSSION

Costs and Returns of *Rabi* Jowar

Any enterprise to gain profitability depends on its cost structure, output and price received by entrepreneur.

Cost structure depends on expenditure made on inputs and services utilized in the process of production.

Human Labour utilization on sample farms

Human labour is the most influencing component among various factors involved in the production process. The reason behind this is that successful completion of operations in the farm heavily depends on the human resources involved. So, an effort had been made to analyze the labour utilization pattern in the sample of jowar farms considered. The result is presented (Table 1).

A keen observation of Table 1 revealed that the total man days employed in the production of per hectare *Rabi* jowar was 38.78. Cultural operations performed in *Rabi* jowar are land preparation, sowing, spraying of fertilizers and plant protection chemicals, irrigation, weeding, inter cultivation, harvesting and threshing. Among the total man days 12.97 and 25.81 are owned and hired man days respectively. Highest number of man days are observed in harvesting, they are 13.76 (35.48%). Least number of man days are seen in inter cultivation and they are 0.68 (1.75%). Land preparation is the first and foremost cultural operation in cultivation of jowar and the total number of man days required for land preparation are 5.02 (12.94%). Next important operation is sowing and totally 3.04 (7.84%) man days are required. The man days required for spraying of fertilizers and plant protection chemicals are 3.24 (8.35%) and 2.79 (7.19%) respectively. Weeding is the further most important operation which requires 3.50 (9.02) man days. Threshing is the last operation done by farmer on the threshing floor with 5.66 (14.59%) man days.

Cattle and machine labour utilization in sample farms

Cattle labour is only used in inter cultivation in *Rabi* jowar. Generally, cattle labour is calculated as cattle pair days. *Rabi* jowar inter cultivation was done only once. The total cattle pair days per hectare were 1.0. Out of the

Table 1. Human labour utilisation – operation wise in *rabi* jowar cultivation

(In man days per hectare)

S. No.	Particulars	Owned	Hired	Total
1	Land preparation	2.10 (16.19)	2.92 (11.31)	5.02 (12.94)
2	Sowing	1.26 (9.71)	1.78 (6.89)	3.04 (7.84)
3	Fertilizers	1.18 (9.09)	2.06 (7.98)	3.24 (8.35)
4	Plant protection	1.24 (9.56)	1.55 (6.00)	2.79 (7.19)
5	Irrigation	0.45 (3.47)	0.65 (2.52)	1.00 (2.58)
6	Weeding	1.98 (15.27)	1.52 (5.89)	3.50 (9.02)
7	Intercultivation	-	0.68 (2.63)	0.68 (1.75)
8	Harvesting	2.5 (19.27)	11.25 (43.58)	13.76 (35.48)
9	Threshing	2.26 (17.42)	3.40 (13.17)	5.66 (14.59)
10	Total	12.97 (100)	25.81 (100)	38.78 (100)

Figures in parenthesis indicate percentages

Table 2. Cattle and machine labour utilization in *Rabi* jowar cultivation

S. No.	Particulars	Owned	Hired	Total
	Cattle labour (In cattle pair days per hectare)			
1	Intercultivation	0.16 (16.00)	0.84 (84.00)	1.00 (100)
	Machine labour (Hours per hectare)			
1	Land preparation	1.75 (53.84)	2.00 (44.74)	3.75 (48.57)
2	Sowing	1.50 (46.15)	2.47 (55.25)	3.97 (51.42)
3	Total	3.25 (100)	4.47 (100)	7.72 (100)

Figures in parenthesis indicate percentages

total cattle pair days 0.16 was done with owned cattle and remaining 0.84 was done with hired cattle.

In *Rabi* jowar machinery was used in two operations called land preparation and sowing. The total number of working hours of machinery per hectare was calculated as 7.72. Total working hours for land preparation are 3.75 (48.57%), out of this 1.75 and 2.00 hours of work is done with owned and hired machinery respectively. The working hours for sowing are 3.97 (51.42%) and out of the total working hours of sowing 1.50 and 2.47 hours of work is done with owned and hired machinery respectively. The results of cattle and machinery use were presented (Table 2).

Material inputs utilized in cultivation of *Rabi* jowar in sample farms

In cultivation of *Rabi* jowar material inputs used were seeds, fertilizers and plant protection chemicals. All these material inputs were calculated for one hectare of land. On an average seed used to sow in one hectare was 14.5 kg. The seed rate of *Rabi* jowar was observed to be excessive than recommended in the study area. The fertilizers mainly used are urea and Diammonium phosphate (DAP). The quantities of fertilizers applied to the crop were 150 and 125 kg of urea and DAP respectively. The plant protection chemicals used were corogen and dimethoate. On an average 2.5 lit of plant protection chemicals were sprayed for one hectare of standing crop. The quantities of inputs used were presented (Table 3).

Cost structure of *Rabi* jowar

Economic costs include both explicit and implicit costs. To arrive at the profitability of any project these costs should be covered by gross income. Usually farmers feel satisfied only when gross income exceeds explicit costs. More specifically, the total costs were divided in to operational and fixed costs. Hence the above costs were worked out for per hectare of *Rabi* jowar crop and mentioned (Table 4).

Table 3. Material inputs used in cultivation of *Rabi* jowar

(Per hectare)

S. No.	Particulars	Units	Farms
1.	Seeds	Kilograms	14.5
2.	Fertilizers		
	Urea	Kilograms	150
	DAP	Kilograms	125
4.	Plant protection chemicals	Liters	2.5

Total cost of cultivation of *Rabi* jowar per hectare was calculated as ₹ 53,657.14. Out of this ₹ 40,472.94 and ₹ 13,184.20 are operational costs and fixed costs respectively. The operational costs include costs on human labour, bullock labour, tractor power, seeds, fertilizers, plant protection chemicals and interest on working capital. Among the operational costs the major portion was constituted by human labour which amounted to ₹ 19,342. Human labour is the major contributing factor to the total cost of cultivation accounting to 36.04 percent of total cost in the study area. Labour cost has major contribution in total cost (Zalkuwi *et al*., 2015).

The next highest amount was spent on tractor power *i.e.* ₹ 11,580. The cost on fertilizers and pesticides was ₹ 3250 and ₹ 3836 respectively. The cost on bullock labour was ₹ 750. The cost on seeds was worked out as ₹ 725. Seed cost was least among the operational costs and same result was reported (Tandel *et al.,* 2018).

The interest on working capital was calculated based on interest given to crop loans by commercial banks in Kurnool district which was 12 per cent and it was calculated as ₹ 989.94. The fixed costs include land revenue, depreciation on machinery and Rental value of owned land. The land revenue was ₹ 100 and Rental value of owned land was ₹ 11,250. Among the fixed costs rental value was observed as highest with a share of 20.97 per cent of total cost, Similar result was reported (Kusuma *et al.,* 2013).

Depreciation was calculated for machinery used by the farmer in the farm business and it was worked out as ₹ 982. Interest on fixed capital was calculated based on interest fixed by commercial banks on long term loans which was 8 per cent and it was worked out as 852.2.

Cost concepts of *Rabi* jowar

The cost concepts generally employed in the farm management studies are used in the current study. Hence, Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3 were utilized in the present study. Cost C_2 is the ample one because it includes both fixed and variable

Table 4. Cost of cultivation of *Rabi* jowar according to component wise

(In rupees per hectare)

S. No.	Particulars	Farms	Percentage
I	**Operational costs**		
1.	Human labour	19342	36.04
a.	Owned	6485	12.08
b.	Hired	12857	23.96
2.	Bullock labour	750	1.39
3.	Tractor use	11580	21.58
a.	Owned	4875	9.08
b.	Hired	6705	12.49
4.	Seed	725	1.35
5.	Fertilizers	3250	6.05
6.	Plant protection chemicals	3836	7.14
7.	Interest on working capital	989.94	1.84
8.	Total operational costs	40472.94	75.42
II	**Fixed costs**		
9.	Land revenue	100	0.18
10.	Depreciation	982	1.83
11.	Rental value of owned land	11250	20.97
12.	Interest on fixed capital	852.2	1.58
13.	Total fixed costs	13184.20	24.57
III	**Total costs**	**53657.14**	**100.00**

costs and therefore provides basis to compare different types of operational holdings. Cultivation cost of *Rabi* jowar according to cost concepts were calculated and mentioned (Table 5).

The numbers in the (Table 5) indicate the values of cost A_1 as ₹ 35066.94, cost B_1 as ₹ 35919.14, cost B_2 as ₹ 47169.14, cost C_1 as ₹ 42404.14, cost C_2 as ₹ 53654.14 and finally cost C_3 as ₹ 59019.55.

Output and returns per hectare of *Rabi* jowar

The material output and income from per hectare *Rabi* jowar were presented (Table 6).

From the close perusal of (Table 6) the main product and by product yields can be known as 37.5 quintals and 60 quintals respectively. The price of one quintal jowar grains was ₹ 2000 and the total value of 37.5 quintals was ₹ 75,000. The total value of by product per hectare was ₹ 3,000. Therefore, gross returns from per hectare of *Rabi* jowar was ₹ 78,000.

Table 5. Costs concepts- *Rabi* jowar production

(Per hectare)

S. No.	Particulars	Farms
1.	Cost A_1/A_2	35066.94
2.	Cost B_1	35919.14
3.	Cost B_2	47169.14
4.	Cost C_1	42404.14
5.	Cost C_2	53654.14
6.	Cost C_3	59019.55

Table 6. Output and returns per hectare of *Rabi* jowar

(Per hectare)

S. No.	Particulars	Units	Farms
1.	Yield in physical units		
a.	Main product	Qtls	37.50
b.	By product	Qtls	60.00
2.	Yield in monetary terms		
a.	Main product	₹	75000.00
b.	By product	₹	3000.00
3.	Gross returns	₹	78000.00
4.	Cost of cultivation	₹	53657.14
5.	Net returns	₹	24342.86

Table 7. Measures of farm income- *Rabi* jowar production

(Per hectare)

S. No.	Particulars	Farms
1.	Gross income	78000.00
2.	Net income	24342.86
3.	Farm business income	42933.06
4.	Family labour income	30830.86
5.	Farm- investment income	31082.65
6.	Returns per rupee of expenditure	0.41

Gross income alone does not notify success of any farm business even though it is best measure to estimate farms production and efficiency. For this reason net income was calculated. Relation between net income and success of farm business is directly proportional. Net income per hectare *Rabi* jowar was ₹ 24,342.86.

Measures of farm income

Any business enterprise has two elements and they are costs and returns. Costs indicate the worth of inputs utilized in the production process and returns indicate the value of output achieved. Success of any farm business depends on comparative magnitude of costs and returns. A vital element in farm business is the way of allocation of resources. A measuring tool is required to provide guidelines and standards for evaluating the use of resources. Therefore, to achieve this farm efficiency measures were computed *viz*., farm business income, family labour income, farm investment income and net income. Returns per rupee of investment were computed in addition to farm efficiency measures and the results were presented (Table 7).

Farm income measures were calculated out per hectare of *Rabi* jowar. The farm business income was worked out as ₹ 42933.06. Family labour income and farm investment income were ₹ 30830.86 and ₹ 31082.65 respectively. When Returns per rupee of expenditure were worked out they stood at 0.41. Farmers were capable to get net income of 0.41 per rupee spent on *Rabi* jowar cultivation.

Constraints faced by the farmers in cultivation of *Rabi* jowar

The mean scores presented (Table 8), clearly indicate that the major constraint faced by the farmer's during cultivation of *Rabi* jowar was inadequate and untimely rainfall during the period of harvesting (76.33), which reduced the grain quality and was the main reason for the reduction in yield quality of *Rabi* jowar. The second constraint was high wage rate (66.32), farmer's felt that it was the main reason for increase in cultivation cost. The third constraint faced by the farmer's was high rate of fertilizers and plant protection chemicals (55.72), because many of the farmer's were unable to meet the high costs of fertilizers and pesticides. The fourth constraint faced by the farmer's was high rate of ploughing by tractor (51.75), many of the famer's were hiring the tractors for ploughing and they felt that hiring charges were too high. The fifth constraint was high prevalence of pests and diseases (39.73) like stem borer. Few farmers felt that labour shortage in farm (38.05) and non-availability of loan in time (22.63) were the constraints in cultivation of *Rabi* jowar. Hile *et al.* (2013) studied problems faced by farmers in cultivation of *rabi* jowar in western Maharastra and reported that high wage rate was a major problem.

CONCLUSION

Among the operational costs the major portion was constituted by human labour and the least amount was spent on seeds. Major constraint faced by farmer's during cultivation of *Rabi* jowar was inadequate and untimely

Table 8. Farmers perception on constraints in cultivation of *Rabi* jowar

(n = 120)

S. No.	Particulars	Mean score	Ranking
1	High wage rate	66.32	2
2	Labour shortage	38.05	6
3	Inadequate and untimely rainfall	76.33	1
4	High rate of fertilizers and pesticides	55.72	3
5	High prevalence of pest and diseases	39.73	5
6	High rate of ploughing by tractor	51.75	4
7	Non- availability of loan in time	22.63	7

rainfall during the period of harvesting, which reduced the grain quality and was the main reason for the reduction in yield quality of *Rabi* jowar.

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SOIL FERTILITY STATUS OF GUDIPALAMANDAL OF CHITTOOR DISTRICT, ANDHRA PRADESH FOR SITE SPECIFIC RECOMMENDATIONS

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ABSTRACT

Two hundred fifty representative soil samples from seventy three villages of Gudipala mandal in Chittoor district of Andhra Pradesh were collected at 250 m grid interval leaving hills and water bodies and assessed for their fertility parameters. Fertility data was interpreted and statistical parameters *viz.,* range, mean, standard deviation and coefficient of variation were calculated. Soils were moderately to highly alkaline, non-saline and soil organic carbon was low to very high. The available nitrogen (57.0-305.0 kg ha^{-1}) was low to medium, available phosphorus (20.0-85.0 kg ha^{-1}) and potassium (201.0-416.0) was low to high and available sulphur (8.00-50.0 ppm) as deficient to sufficient. DTPA extractable micronutrients zinc (Zn), iron (Fe) and manganese (Mn) were deficient to sufficient range and whereas, available copper (Cu) was sufficient range in the study area. The fertility status of soils revealed that, the available N, S, Zn, Fe and Mn major soil fertility constraints.

KEY WORDS: alkaline soils, micro nutrients, soil fertility

INTRODUCTION

Soil – a nature's marvel is one among the vital natural resources of the earth, whose health decides the survival of all living organisms depending on it. The soil must be in harmony with its inherent properties and productivity to maintain sustainable soil health. In India, crop productivity has been driven by increased use of fertilizers during the past four decades for meeting growing demand for food. Hence, proper management of the vital natural resource soil is a paramount significance for sustenance. Nutrient imbalance in soil could be due to the increased demand from high yielding varieties (HYV), intensive cropping, continued expansion of cropping on to marginal lands with low micronutrients application (Richard and Bernie, 2006), increased use of fertilizers, poor recycling of crop residues and little use of animal wastes (Setia and Sharma, 2004). Hence, soil fertility problems are predominant in recent times and hindering optimum crop productivity. Soil fertility limitations being assessed by scientific soil samples collection from farmer's fields and evaluation of available major and micro nutrients.

The Gudipala mandal of Chittoor district is affected by drought frequently, which is pre-dominantly under rainfed farming with erratic rainfall distribution associated with low crop productivity and which further needs site-specific information in terms of soil characteristics, their productivity potentials and limitations for soil resource development and management. Hence, the present investigation was planned and executed with the objective of identifying available nutrient constraints in soils of Gudipala mandal in Chittoor district of Andhra Pradesh.

MATERIAL AND METHODS

The study area geographically located between 13° 06′ to 14° 00′ N latitudes and 79°12′ to 79°25′ E longitudes with a cultivated area of 2500 ha. The climate was semi-arid monsoonic with distinct summer, winter and rainy seasons. The decennial mean annual rainfall was 952.5 mm. The mean annual minimum and maximum temperatures were ranged from 21.1°C to 37.7°C.

The composite soil samples at 0-15 cm depth were collected by using a handheld GPS on grid points of 250 m interval in the study area. A total of 250 samples were collected from the Gudipala mandal. The soil samples were airdried, grounded (< 2 mm) and analyzed for physico-chemical and fertility parameters. The pH (1:2.5) and electrical conductivity (EC) (1:2.5) of soils were measured using standard procedures as described by Jackson (1973). Organic carbon (OC) was determined using the Walkley-Black method (Nelson and Sommers 1996). Available nitrogen (N) was estimated by alkaline

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permanganate method (Subbiah and Asija 1956). Available phosphorus (Olsen P) was measured using sodium bicarbonate ($NaHCO_3$) as an extractant (Olsen and Sommers 1982). Available potassium (K) was determined using the ammonium acetate method (Jackson, 1973). Available sulphur (S) was measured using 0.15 percent calcium chloride ($CaCl_2.2H_2O$) as an extractant (Williams and Steinbergs, 1959). Micronutrients (Fe, Zn, Cu and Mn) were extracted by DTPA using the procedure outlined by Lindsay and Norvell (1978). Soil fertility variability was assessed using mean standard deviation and coefficient of variation for each set of data. Availability of N, P and K in soils are interpreted as low, medium and high and that of available sulphur (S), zinc (Zn), iron (Fe), copper (Cu) and manganese (Mn) interpreted as deficient and sufficient range by following the criteria given in Table 1.

RESULTS AND DISCUSSION

Soil reaction and electrical conductivity

The soil pH in the study area varied from 6.10 to 8.40 with a mean, standard deviation and CV of 7.51, 0.50 and 6.67 per cent, respectively Soil reaction of Gudipala mandal range indicates that soils are moderately acidic to highly alkaline. The lowest value of pH under cultivated soils might be due to depletion of basic cations bycrop harvest and drainage to streams in run-off by accelerated erosion (Foth and Ellis (1997). The higher pH of soils could be attributed to low intensity of leaching and accumulation of bases. These results were in agreement with findings of Patil *et al.* (2016). Electrical conductivity of the soils in study area ranged from 0.09 to 0.96 d Sm^{-1} and the soils are non-saline, with a mean ,standard deviation and CV of0.35, 0.17 and 49.05 per cent, respectively non salinity of the study area attributed to good drainage condition and favours the leaching of salts to lower horizons, which is highly favorable to crop growth (Sharma and Sanjeev, 2008 and Satish *et al*., 2018).

Organic carbon

The organic carbon content of Gudipala mandal was low to very high and ranged from 0.22 to 1.41 per cent with mean, standard deviation and CV of 0.52, 0.15and28.16 per cent, respectively. The organic carbon content indicated that, soils of Gudipala mandal showed wide variations spatially. Rice and sugarcane are the major crops in the study area and crop residue of these crops left in soil after harvest and their subsequent degradation is the reason for low organic carbon content in these soils. Similar results were also reported by Prabhavati *et al.* (2015) and Nalina *et al.* (2016).

Available major nutrients

The available nitrogen content varied from 57.0 to 305.0 kg ha^{-1}, with a mean value of 178.02 kg ha^{-1} and standard deviation of 53.53 with CV of 30.07 per cent. It is quite obvious that the use efficiency of applied nitrogen was very low due loses by various mechanisms like volatilization, nitrification, denitrification, chemical and microbial fixation leaching and runoff. However, the reason for medium status in available nitrogen which was observed in the surface horizons could be attributed to the addition of higher quantities of N at regular interval especially to the rice crop during crop cultivation.

The available phosphorus status was under low to high range from 20 to 85 kg ha^{-1}, with mean value of 34.22 kg ha^{-1} and standard deviation of 7.71 with CV of 22.54 per cent. In majority soils of the Gudipala mandal were low to high in available phosphorus content. The lower phosphorus content could be attributed to the fixation of released phosphorus by clay minerals and oxides of iron and aluminium. The high P_2O_5 in some of these soils was ascribed to buildup of P_2O_5 due toindiscriminate use of DAP and other complex fertilizers (Sashikala *et al*., 2019).

Available potassium

The available potassium ranged between 201 to 416 kg ha^{-1}, with mean of 335.88 kg ha^{-1}, standard deviation of 36.47 and CV of 10.86 per cent. The slower rate of weathering of mica minerals and fixation of applied potassium might have resulted in low available potassium status. The higher potassium in some of the soils could be attributed to more intense weathering, release of liable K from micacious minerals, application of K fertilizers. Similar results were reported by Vedadri and Naidu (2018) in soils of Chillakur mandal of SPSR Nellore district in Andhra Pradesh. Present results are in accordance with Patil *et al*., 2016.

Available calcium content varied from 8 to 22 cmol (p+) kg^{-1} with a mean value of 14.52 Cmol (p+) kg^{-1} with standard deviation of 3.23 cmol (p+) kg^{-1} and C.V of 22.20 per cent and results are in accordance with Sashikala *et al*., 2019.

Table 1. Physico-chemical properties and available major nutrients status in Gudipala mandal at 0-15 cm depth

	pH	EC (dS m^{-1})	Organic carbon (%)	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
Range	6.10 – 8.40	0.09 – 0.96	0.22 – 1.41	57.0 – 305.0	20.0 – 85.0	201.0 – 416.0
Mean	7.51	0.354	0.52	178.0	34.2	335.8
SD	0.50	0.17	0.15	53.5	7.7	36.5
CV (%)	6.67	49.1	28.2	30.1	22.5	10.9

Table 2. Summary of ground truth analysis data of secondary and available micronutrients of Gudipala mandal at 0-15 cm depth

	Exchangeable Ca (cmol (p^+) kg^{-1})	Exchangeable Mg (cmol (p^+) kg^{-1})	Available Sulphur (mg kg^{-1})	DTPA extractable Zn (mg kg^{-1})	DTPA extractable Cu (mg kg^{-1})	DTPA extractable Mn (mg kg^{-1})	DTPA extractable Fe (mg kg^{-1})
Range	8.00 – 22.00	0.46 – 0.95	8.00 – 50.0	0.08 – 1.58	0.22 – 3.48	2.0 – 10.0	2.0 – 10.0
Mean	14.52	0.54	24.42	0.69	0.71	5.46	4.37
Std. Dev	3.23	0.07	8.42	0.22	0.44	1.39	1.93
CV (%)	22.22	12.56	34.46	31.53	61.65	25.4	44.1

Exchangeable magnesium

Available magnesium content varied between 0.46 to 0.95 cmol (p+) kg^{-1} with a mean value of 0.54 cmol (p+) kg^{-1} with standard deviation of 0.07 cmol (p+) kg^{-1} and C.V of 12.56 per cent and results are in accordance with Sathish *et al*., 2018 in Ramanagar district of Karnataka.

Available sulphur

Available sulphur content in soils varied from 8.00 to 50 mg kg^{-1} with mean value of 24.42 mg kg^{-1} with standard deviation of 8.42 mg kg^{-1} and C.V of 34.46 per cent. According to Tandon (1991) the sufficiency level of sulphur in Indian soils was above 10 mg kg^{-1} soil. Based on this, status of sulphur in the nearly 50 per cent of soil samples were found to be deficient and remaining 50 per cent were sufficient.

DTPA extractable micronutrients

Available iron

The available iron content in soils ranged from 2.0 to 10.0 mg kg^{-1} with an mean of 5.46 mg kg^{-1}, standard deviation of 1.39 and CV of 25.41 per cent. The low iron content might be due to iron fixation by clay which decreased its availability. Similar results were also observed by Ravikumar *et al.* (2017) and Patil *et al.* (2016).

Available copper

The available copper content in soils ranged between 0.22 to 3.48 mg kg^{-1} with a mean value of 0.71 mg kg^{-1},

standard deviation of 0.44 and CV of 61.65 per cent. All the soil samples recorded sufficient copper content of more than 0.3 mg kg^{-1}. The higher concentration of copper in the surface horizons might be due to the chelating of organic compounds, released during the decomposition of organic matter left after harvesting of crop. Similar findings were made by Reddy and Naidu (2016) in soils of Chennur mandal of Kadapa district in Andhra Pradesh.

Available zinc

The available zinc content in soils ranged from 0.08 to 1.58 mg kg^{-1} with a mean value of 0.69 mg kg^{-1}, standard deviation of 0.22 and CV of 31.53 per cent. The low DTPA extractable zinc was possibly due to high soil pH values which might have resulted in the formation of insoluble compounds of zinc or insoluble calcium zincate (Prasad *et al.,* 2009). Zinc deficiency was wide spread in soils with high pH, low organic matter and calcareousness.

Available manganese

The available manganese content of soils ranged from 2.00 to 10.00 mg kg-1 with a mean value of 4.37 mg kg^{-1}, standard deviation of 1.93 and CV of 44.10 per cent. All the soils of study area were recorded sufficient manganese content and results are in accordance with Sathish *et al.,* 2018 in soils of Ramanagara district of Karnataka.

The data of micronutrient status in the Gudipala mandal have shown that DTPA extractable iron, copper and manganese content were sufficient range in the soils with exception of zinc, which was deficient in majority area.

CONCLUSION

The soils of Gudipala mandal of Chittoor district, Andhra Pradesh were moderately alkaline to highly alkaline and non-saline in nature. Soil organic carbon was low to very high. Available N was low to medium, available P and K_2O were low to high, available S was deficient to sufficient range. The available micro nutrients *viz.,* Zn, Mn and Fe were deficient to sufficient range, whereas Cu was sufficient in majority of the soils. The fertility status of study area revealed that, available N, S, Zn and Fe are important soil fertility constraints which indicate immediate attention for harnessing sustained crop production.

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PERFORMANCE OF FARMER PRODUCER ORGANIZATIONS IN KURNOOL DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The primary objective of this study is to assess the business performance of a selected Farmer Producer Organizations (FPOs) in Kurnool district of Andhra Pradesh. For this purpose, Two FPOs under Andhra Pradesh Rural Inclusive Growth Project (APRIGP) were selected and financial ratio analysis has been done on parameters such as liquidity, solvency, efficiency and profitability of the firm for the financial years 2017-18 to 2018-19. The study concluded that the Farmer Producer Organizations overall business performance is average. The performance scores of FPOs under APRIGP authority were falling in the yellow zone indicated an overall average performance. The FPOs had an average liquidity, solvency and efficiency performance while profitability also showed average performance. Hence, the study concluded that the overall FPOs performance under APRIGP was in the yellow zone i.e. average performance and the score was 215.5.

KEYWORDS: Farmer producer organizations, liquidity, ratio analysis, solvency and profitability.

INTRODUCTION

Indian agriculture is dominated by large number of fragmented land holdings. Small and marginal farmers own about 85% of the land holdings. Being unorganized, these small and marginal farmers are unable to reap high value for their produce and these issues can be mitigated by organizing them into Farmer Producer Organizations (FPOs) that allow farmers to reap the advantages of economies of scale by buying inputs, processing and marketing their products**.**

Farmer Producer Organisations (FPOs) are essential institutions for the empowerment, poverty alleviation and advancement of farmers and the rural poor. Politically, FPOs strengthens the political power of farmers, by increasing the likelihood that their needs and opinions are heard by policy makers and the public. Economically, FPOs can help to farmers gain skills, access inputs, form enterprises, process and market their products more effectively to generate higher incomes. In Andhra Pradesh, FPOs have linkages for marketing of produce, procurement and distribution of agricultural inputs. Knowledge linkages help farmers to access and adopt better agricultural practices through advisory and training services at different levels. Financial linkage with banks and other financial institutions helps access credit for working capital and other operational purposes. FPOs are helping make small holder farming viable and sustainable. FPOs are providing right input at right time at lower price to farmers (Garg, 2012) . In the year 2015, the government of Andhra Pradesh implemented APRIGP (Andhra Pradesh Rural Inclusive Growth Project) which is undertaken by SERP (Society for Elimination of Rural Poverty) in 150 most backward mandals representing all politico-agro-climatic regions of the state. In this project, 169 FPOs were setup in 13 districts.

The primary objective of this paper is to evaluate and analyse the business performance of Farmer Producer Organizations. In this study, an attempt has been made to evaluate the Farmer Producer Organizations under the authority of Andhra Pradesh Rural Inclusive Growth Project (APRIGP) in Kurnool district of Andhra Pradesh on the basis of liquidity, solvency, efficiency and profitability status from 2017-18 to 2018-19 *i.e.,* two years.

Under the authority of APRIGP, there are 169 FPOs working in various districts of Andhra Pradesh. Among

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13 districts, Kurnool district has 19 FPOs under APRIGP, these FPOs deal with input sales, procurement, marketing of major crops like paddy, redgram, bengalgram, groundnut, maize, cotton and sorghum. Some FPOs deal with vegetables and horticultural products. The scope of this study is limited to examine the financial performance of selected Two FPOs under APRIGP. The results cannot be generalized to all FPOs.

MATERIALS AND METHODS

The study is based on secondary data. The data regarding audited annual financial statements like income statement, balance sheet from selected FPOs over a two year period from 2017-18 to 2018-19 was obtained. And also the data regarding the agro-economic aspects of the study area were collected from the District Chief Planning Officer, Kurnool district. The financial ratios were computed by establishing the relationship between the items of balance sheet and profit and loss account. Table 1 shows the list of Two FPOs under APRIGP taken up for study.

RESULTS AND DISCUSSION

The financial ratios and formulae used presented in Table 2. The financial ratios and performance scores of 2 sample FPOs were calculated and discussed. A performance scorecard was prepared to evaluate Farmer Producer Organisationson the basis of their financial performance by scoring them against it. Performance score is given for each of the financial performance variable *i.e.,* liquidity, solvency, efficiency and profitability and financial ratios under it to each of the FPOs**.** Deepali and Ship (2013) developed similar financial performance variables.

Five different performance clusters are classified based on the performance benchmark for each financial ratio i.e. 5, 4, 3, 2 and 1. Performance score 5 is the best score which is given when the financial ratio is in most optimum range and 1 being the worst. These performance scores will help us to assess whether the Farmer Producer Organisations financial performance is good, average or poor. Good FPOs are kept in green zone, average FPOs in yellow zone and poor FPOs in red zone. The performance score is based on the efficiency and effectiveness of the financial ratios derived from the Farmer Producer Organisations financial statements. Since, neither a low nor a high ratio shows the optimum level of performance as shown in Table 3.

Criteria for performance score is presented in Table 4. Under criteria for performance score for FPOs performance variables (liquidity, solvency, activity and profitability) it was 11.5 and above for green (good), 11.5 to 7.5 for yellow (average) and below 7.5 for red (poor). Under criteria for performance score for individual FPOs performance, it was 46 and above for green (good), 46 to 30 for yellow (average) and below 30 for red (poor) as shown in Table 5. Similar performance score for FPOs was developed by Shivam and Arup (2017).

Financial performance of Kothapalli agriculture and allied producers company

Information regarding financial particulars from 2017-18 to 2018-19 were obtained from balance sheet and profit loss account of Kothapalli agriculture & allied producers company. The financial ratios were computed and presented in Table 7.

Table 7 indicated that current ratios from 2017-18 to 2018-19 were 1.99 and 2.57 respectively. This indicated that an increasing trend was observed in current ratios from 2017-18 to 2018-19. The quick ratios from 2017-18 to 2018-19 were 1.68 and 1.56 respectively indicating a decreasing trend from 2017-18 to 2018-19. The absolute cash ratios from 2018 to 2019 were 0.79 and 0.68 respectively. This inferred that a decreasing trend was observed in absolute cash ratios from 2017-18 to 2018-19. The average performance score of the FPO for liquidity position was 12 falling in green zone and considered to be good. Similar results were also recorded by Vishwanath (1994).

The debt equity ratios of the FPO from 2017-18 to 2018-19 were 2.54 and 2.4 respectively which showed that the FPO's dependency on outside lenders was declining. The total assets to debt ratios of the FPO from 2017-18 to 2018-19 were 8.01 and 6.09 respectively. This inferred that a decreasing trend from 2017-18 to 2018-19 revealing that their creditors are covered by their assets and they can be paid off as and when needed by realising their assets. Proprietary ratios of the FPO from 2017-18 to 2018-19 were 47 per cent and 42 per cent respectively. This indicated that the FPO depended on the equity capital to finance their assets. The average performance score of the FPO for solvency position was 11.5 falling in green zone and considered to be good.

Capital turnover ratios of the FPO from 2017-18 to 2018-19 were 16.09 and 18.02 respectively. The

Table 1. List of FPOs under APRIGP

S. No.	FPO Name
1.	Kothapalli agriculture and allied producers company (KAAPC)
2.	Alur agriculture and allied producers company (AAAPC)

Table 2. Financial ratios and formulae

Ratios	Formula
Liquidity ratios	
Current Ratio	Current Assets/ Current Liabilities
Quick Ratio	Quick assets/ Current Liabilities
Absolute cash ratio	(Cash + Bank Balance+ marketable securities)/ Current liabilities
Solvency ratios	
Debt equity ratio	Debt/Equity
Total Assets to Debt ratio	Total assets/ Debt
Proprietary ratio	Proprietors fund/Total assets
Activity ratios	
Capital turnover ratio	Sales/Capital employed
Fixed Assets Turnover ratio	Net sales/Average fixed assets
Working Capital Turnover ratio	Net sales/(Total assets - Total liabilities)
Profitability ratios	
Net Profit ratio	Net profit after tax/Net sales
Return on Investment	Net Income/Cost of investment
Earnings per share	(Net Income-preferred dividends)/weighted average shares outstanding

increasing trend for two years indicated that on an average 16 and 18 times in two years where capital was being converted into sales. The fixed assets turnover ratios of the FPO from 2017-18 to 2018-19 were 48 and 51.07 respectively. This inferred that an increasing trend was observed in fixed assets turnover ratios from 2017-18 to 2018-19 which indicated that the FPO was utilising its fixed assets more effectively. Working capital turnover ratios of the FPO from 2017-18 to 2018-19 were 46.12 and 53.55 respectively. The increasing trend for two years indicated that high ability to generate sales per rupee of working capital by the FPO. The average performance score of the FPO for efficiency was 9 falling in yellow zone and considered to be average. This was in conformity with Garg (2012).

Net profit ratios of the FPO from 2017-18 to 2018-19 were 5.45 per cent and 9 per cent respectively. This indicated that an increasing trend was observed in net profit ratios from 2017-18 to 2018-19. Return on investment of the FPO from 2017-18 to 2018-19 were 18.9 and 24.5 respectively. This indicated an increasing

Table 3. Performance score for the financial ratio outputs

Particulars	5 (Very good)	4 (Good)	3 (Average)	2 (Bad)	1 (Worst)
Current Ratio	2.5:1 to 2:1 and Above	2:1 to 1.5:1	1.5:1 to 1:1	1:1 to 0.5:1	Below 0.5:1
Quick Ratio	1.5:1 to 1:1 and Above	1:1 to 0.75:1	0.75:1 to 0.5:1	0.5:1 to 0.25:1	Below 0.25:1
Absolute Cash Ratio	0.6:1 to 0.4:1 and Above	0.4:1 to 0.3:1	0.3:1 to 0.2:1	0.2:1 to 0.1:1	Below 0.1:1
Debt-Equity Ratio	2.5:1 to 2:1 and Above	2:1 to 1.5:1	1.5:1 to 1:1	1:1 to 0.5:1	Below 0.5:1
Total Assets to Debt Ratio	5:1 to 2:1 and Above	2:1 to 1.5:1	1.5:1 to 1:1	1:1 to 0.5:1	Below 0.5:1
Proprietary Ratio (%)	40% to 25% and Above	25% to 20%	20% to 15%	15% to 10%	Below 10%
Capital Turnover Ratio (Times)	12 to 10 and Above	10 to 8	8 to 6	6 to 4	Below 4
Fixed Assets Turnover ratio (Times)	40 to 16 and Above	Above 40 to 44 and Below 16 to 12	Above 44 to 48 and Below 12 to 8	Above 48 to 52 and Below 8 to 4	Above 52 and Below 4
Working Capital Turnover ratio (Times)	40 to 20 and Above	20 to 15	15 to 10	10 to 5	Below 5

Table 4. Criteria for performance score (Performance variable)

Performance Zones	Performance score
Green (Good)	11.5 and above
Yellow (Average)	11.5 to 7.5
Red (Poor)	Below 7.5

Table 5. Criteria for performance score (Individual FPOs)

Performance Zones	Performance score
Green (Good)	46 and above
Yellow (Average)	46 to 30
Red (Poor)	Below 30

Table 6. Criteria for performance Score (Overall performance of APRIGP)

Performance Zones	Performance Score
Green (Good)	92 and above
Yellow (Average)	Below 92 to 60
Red (Poor)	Below 60

trend in return on investment from 2017-18 to 2018-19 thus indicating a higher ability to generate profits from per rupee of capital employed. Earnings per share of the FPO from 2017-18 to 2018-19 were 23 and 35 respectively. This indicated an increasing trend in earnings per share from 2017-18 to 2018-19 The average performance score of the FPO for profitability was 10 falling in yellow zone and considered to be average. Overall score of FPO was 42.5 falling in yellow zone and to be average. The finding were in line with Adrian and Green (2001).

Financial performance of Alur agriculture and allied producers company

Information regarding financial particulars from 2017-18 to 2018-19 were obtained from balance sheet and profit loss account of Alur agriculture & allied producers company. The financial ratios were computed and presented in Table 8.

A perusal of Table 8 shows that current ratios from 2017-18 to 2018-19 were 1.89 and 2.23 respectively. This indicated that an increasing trend was observed in current ratios from 2017-18 to 2018-19. The quick ratios from 2017-18 to 2018-19 were 1.67 and 1.53 respectively indicating that a decreasing trend from 2017-18 to 2018-19. The absolute cash ratios from 2017-18 to 2018-19 were 0.77 and 0.56 respectively. This inferred that a decreasing trend was observed in absolute cash ratios from 2017-18 to 2018-19. The average performance score of the FPO for liquidity position was 12.5 falling in green zone and considered to be good. Similar results were reported by Vishwanath (1994).

The debt equity ratios of the FPO from 2017-18 to 2018-19 were 3.67 and 3.11 respectively which indicated that the FPO's dependency on outside lenders was decreasing. The total assets to debt ratios of the FPO from 2017-18 to 2018-19 were 8.58 and 6.12 respectively. This inferred that a decreasing trend from 2017-18 to 2018-19 indicated that their creditors are covered by their assets and they could be paid off as and when needed by realising their assets. Proprietary ratios of the FPO from 2017-18 to 2018-19 were 45 per cent and 36 per cent respectively. This indicated that the FPO depended on the equity capital to finance their assets. The average performance score of the FPO for solvency position was 10.5 falling in yellow zone and considered to be average.

Capital turnover ratios of the FPO from 2017-18 to 2018-19 were 15.77 and 17.0 respectively. The increasing trend for two years indicated that on an average 16 and 17 times in two years where capital was being converted into sales. The fixed assets turnover ratios of the FPO from 2017-18 to 2018-19 were 48 and 50.21 respectively. This inferred that an increasing trend was observed in fixed assets turnover ratios from 2017-18 to 2018-19 which revealed that the FPO was using its fixed assets more effectively. Working capital turnover ratios of the FPO from 2017-18 to 2018-19 were 46.88 and 50.02 respectively. The increasing trend for two years indicated that high ability to generate sales per rupee of working capital by the FPO. The average performance score of the FPO for efficiency was 11 falling in yellow zone and considered to be average. These results were in line with the findings of Garg (2012).

Net profit ratios of the FPO from 2017-18 to 2018-19 were 6.4 per cent and 12 per cent respectively. This indicated that an increasing trend in net profit ratios from

Table 7. Financial performance and performance scores of Kothapalli agriculture and allied producers company

Years	Liquidity Ratios			Solvency Ratios			Activity Ratios			Profitability Ratios		
	Current ratio	Quick ratio	Absolute cash ratio	Debt-equity ratio	Total assets to debt ratio	Proprietary ratio (%)	Capital turnover ratio	Fixed assets turnover ratio	Working capital turnover ratio	Net profit ratio (%)	Return on investment	Earnings per share
2017-18	1.99	1.68	0.79	2.54	8.01	47	16.09	48	46.12	5.45	18.9	23
2018-19	2.57	1.56	0.68	2.40	6.09	42	18.02	51.07	53.55	9.00	24.5	35
Performance Scores												
2017-18	4	4	3	4	3	3	2	3	3	3	3	3
2018-19	5	4	4	5	4	4	3	3	4	3	4	4
Total score		24			23			18			20	
Average score		12			11.5			9			10	
Performance Zones		Green			Green			Yellow			Yellow	
Overall score of FPO						42.5						
Performance Zones for FPO						Yellow						

Table 8. Financial performance and performance scores of Alur agriculture and allied producers company

Years	Liquidy Ratios			Solvency Ratios			Activity Ratios			Profitability Ratios		
	Current ratio	Quick ratio	Absolute cash ratio	Debt equity ratio	Total assets to debt ratio	Proprietary ratio (%)	Capital turnover ratio	Fixed assets turnover ratio	Working capital turnover ratio	Net Profit ratio (%)	Return on investment	Earnings per share
2017-18	1.89	1.67	0.77	3.67	8.58	45	15.77	48	46.88	6.4	18.5	16
2018-19	2.23	1.53	0.56	3.11	6.12	36	17.0	50.21	50.02	12	23	22
Performance Scores												
2017-18	4	4	3	2	3	4	3	3	3	3	3	2
2018-19	5	4	5	3	4	5	4	4	5	4	4	3
Total score		25			21			22			19	
Average score		12.5			10.5			11			9.5	
Performance Zones		Green			Yellow			Yellow			Yellow	
Overall score of FPO						43.5						
Performance Zones for FPO						Yellow						

Table 9. Overall financial performance of the Two FPOs

Authority	Liquidity	Solvency	Efficiency	Profitability	Total	Remark
APRIGP	24.5	22	20	19.5	86	Yellow

2017-18 to 2018-19 Return on investment of the FPO from 2017-18 to 2018-19 were 18.5 and 23 respectively. This indicated an increasing trend was observed in return on investment from 2017-18 to 2018-19 that indicating a higher ability to generate profits from per rupee of capital employed. Earnings per share of the FPO from 2017-18 to 2018-19 were 16 and 22 respectively. This indicated an increasing trend in earnings per share from 2017-18 to 2018-19. The average performance score of the FPO for profitability was 9.5 falling in yellow zone and considered to be average. Overall score of FPO was 43.5 falling in yellow zone and to be average.

Overall financial performance of the two FPOs

The study concluded that the Farmer Producer Organizations overall business performance was average. The performance scores of FPOs under APRIGP authority were falling in the yellow zone indicated an overall average performance. The FPOs had an average liquidity, solvency and efficiency performance while profitability also showed average performance with the respective score of 24.5, 22, 20 and 19.5. Hence, the study concluded that the overall FPOs performance under APRIGP was in the yellow zone i.e. average performance and the score was 86 (Table 9).

CONCLUSION

The business performance of Kothapalli Agriculture and Allied Producers Company and Alur Agriculture and Allied Producers Company was found average. The overall FPO's business performance under APRIGP was in the yellow zone i.e. average. The two FPOs need to focus all the financial parameters such as liquidity, solvency, efficiency, profitability to improve their performance from average to good category. And especially for their overall performance FPOs need to focus on efficiency and profitability parameters.

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AMAZING PLANT GROWTH-PROMOTING ACTINOBACTERIA FROM HERBAL VERMICOMPOST

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ABSTRACT

Biological degradation and conversion of agricultural or herbal wastes by earthworms and microorganisms, called vermicomposting, is becoming a favored method of recycling biodegradable wastes. Application of vermicompost prepared from the herbals not only benefits crop plants, as it contains beneficial microorganisms, that help the plants to mobilize and acquire nutrients, but also promotes plant growth and inhibits phytopathogens. The use of plant growth-promoting (PGP) microorganisms for sustainable agriculture has increased tremendously in many parts of the world as it is widely reported to enhance the plant growth and yield of agriculturally important crops. PGP microorganisms facilitate the plant growth either by direct means (such as nitrogen fixation, phosphate solubilization, iron chelation and phytohormones production) or by indirect means such as inhibition of phytopathogens. Actinobacteria are gram positive filamentous bacteria that are known to produce antibiotics effective against fungal plant pathogens and possess PGP traits. This article gives an outline of how actinobacteria isolated from such herbal vermicompost at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) were exploited for crop production and crop protection.

KEYWORDS: Actinobacteria, PGP microorganisms, vermicompost

INTRODUCTION

Vermicomposting, a decomposition process of organic material through the use of earthworms and microbes, got more attraction in sustainable agriculture due to low cost technology, utilization of wide range of initial substrate and eco-friendly process (Prabha, 2009). Vermicompost has substantial quantities of macro- and micro-elements and growth-promoting substances with desirable soil physical properties (Aira *et al*., 2007). Use of vermicompost as total/partial substitute for chemical fertilizers in potting media or as soil amendments under field conditions demonstrated to produce lush growth on variety of crops including cereals, fruits, vegetables and horticultural crops (Hameeda *et al*., 2006; Perner *et al*., 2006; Nath and Singh, 2009). All these beneficial actions of vermicompost are indirectly contributed by the microbial partners such as bacteria, fungi and actinomycetes that resides in the gut of earthworms.

Application of vermicompost was found to increase the growth of vegetables, fruits, flowers and agriculturally important food crops not only by their macro and micro-element composition of the vermicast but also by their growth-promoting hormones such as auxins, gibberellins, cytokinins of microbial origin and enzymes and humic acids (Edwards, 1998). Further, occurance of microbial population in the vermicompost acts as bio-control agents due to the production of antibiotics and secretion of extracellular enzymes such as chitinase, protease and lipase which causes the lysis of fungal and bacterial phytopathogens. Vermicompost is an important source of antagonistic actinobacteria or bacteria against phytopathogens such as *Botrytis cinerea*, *Fusarium oxysporum*, *Rhizoctonia* spp., *Phytophthora* spp. and *Plasmodiophora brassicae* and also affects growth of insect pests such as leafhoppers, aphids, , mealy bugs, caterpillars and beetles. Application of vermicompost has been widely demonstrated and reported to manage plant diseases and insect pests in barley, balsam, pea, clover, cabbage, cucumber, grapes, tomatoes, radish and strawberry under field conditions.

Actinobacteria are a group of Grampositive bacteria, with a high G + C content belonging to the order Actinomycetales, found most commonly in soil, compost, fresh and marine water and play an important role in the PGP, plant protection, decomposition of organic materials

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and produce secondary metabolites of commercial interest. Actinomycetes, in the rhizosphere, help in enhancing root growth, shoot growth, plant hormone concentrations, nitrogen fixation, the solubilisation of minerals and the suppression of plant pathogens. Further, there is a growing interest in the use of secondary metabolites, such as toxins, proteins, hormones, vitamins, amino acids and antibiotics, from microorganisms, particularly from actinobacteria, for the control of plant pathogens as these are readily degradable, highly specific and less toxic to nature. Beneficial PGP and potential of actinobacteria was well documented in tomato, wheat, rice, bean, chickpea and pea. ICRISAT isolated number of such PGP actinobacteria from various herbal composts characterized for *in-vitro* PGP properties and further demonstrated for their usefulness under greenhouse and field conditions in rice, sorghum, chickpea and pigeonpea. This article gives an outline of how actinobacteria isolated from such herbal vermicompost at ICRISAT were demonstrated for crop production and crop protection and thus can be further exploited under farmer field conditions.

MATERIAL AND METHODS

Isolation of actinobacteria from herbal vermicompost

Foliages of 25 different herbals (*Jatropha curcas*, *Annona squamosa*, *Parthenium hysterophorus*, *Oryza sativa*, *Gliricidia sepium*, *Adhatoda vasica*, *Azadirachta indica*, *Capsicum annuum*, *Calotropis gigantea*, *Calotropis procera*, *Datura metal*, *Allium sativum*, *Zingiber officinale*, *Ipomoea batatas*, *Momordica charantia*, *Moringa oleifera*, *Argyranthemum frutescens*, *Nerium indicum*, *Allium cepa*, *Curcuma aromatica*, *Pongamia pinnata*, *Abacopteris multilineata*, *Nicotiana tabacum*, *Tridax procumbens* and *Vitex negundo*) were collected from the ICRISAT farm and composted with earthworms (*Eisenia foetida*). When the herbal compost was ready in about two months, 10 grams of it were used for isolation of actinobacteria as per the standardized protocols. No actinobacteria was found in the compost prepared from Datura foliage, while all the other vermicomposts contained actinobacteria in the range of 6.3"7.7 Log_{10} (CFU) populations with an exception of tobacco compost, which contained only 2.0 Log_{10} populations. Maximum diversity of actinobacteria was found in vermicomposts prepared with Chrysanthemum, Oleander and Pongamia. A total of 137 actinobacteria, the most prominent ones (the ones which were found abundantly, produced pigments and inhibited the adjacent colonies) in the starch casein agar plate, were isolated and further screened for their antagonistic potential against important diseases of chickpea such as *Fusarium* wilt, collar rot, dry root rot and *Botrytis* gray mold and sorghum such as charcoal rot by dual culture assay. Based on these results, a total of 19 actinobacterial isolates (CAI-13, CAI-17, CAI-21, CAI-24, CAI-26, CAI-68, CAI-78, CAI-85, CAI-93, AI-121, CAI-127, CAI-140, CAI-155, KAI-26, KAI-27, KAI-32, KAI-90, KAI-180 and MMA-32) were shortlisted for characterization of their enzymatic activities and secondary metabolite production.

Enzymatic activities and secondary metabolite production by the actinomycete isolates

Siderophore production

Siderophore production was determined according to the methodology described by Schwyn and Neilands (1987). Actinomycetes were streaked on chrome azurol S (CAS) agar media and incubated at 28 ± 2°C for four days. When the actinomycetes consume iron, present in the blue-colored CAS media, orange halos are produced around the colonies, which indicate the presence of siderophores. Observations were recorded on a 0"4 rating scale as follows: 0 = no change; 1 = positive; 2 = halo zone of 1"3 mm; 3 = halo zone of 4"6 mm and 4 = halo zone of 7 mm and above.

Cellulase production

The standardized protocols of Hendricks et al. (1995) were used to evaluate the cellulase

production. Actinomycetes were streaked on cellulose Congo red agar media and incubated at 28 ± 2 °C for four days. The plates were observed for halo zone around the actinomycete colonies, which indicate the presence of cellulase. Observations were recorded on a 0"4 rating scale as follows: 0 = no change; 1 = positive; 2 = halo zone of 1"3 mm; 3 = halo zone of 4"6 mm and 4 = halo zone of 7 mm and above.

Hydrocyanic acid (HCN) production

HCN was estimated qualitatively by the sulfocyanate colorimetric method (Lorck, 1948). The actinomycetes were grown in Bennett agar amended with glycine (4.4 g l-1). One sheet of Whatman filter paper no. 1 (8 cm diameter) was soaked in 1% picric acid (in 10% sodium carbonate; filter paper and picric acid were sterilized

Table 1. Plant growth-promoting and biocontrol traits of 19 actinobacteria isolated from vermicompost

Isolate	PGP traits			Biocontrol traits				
	IAA	Siderophore	HCN	Cel.	Lip.	Pro.	Chi.	β-1, 3-.
CAI-13	25.4	2	2	+	+	-	+	0.25
CAI-17	0.34	2	3	+	+	-	+	0.66
CAI-21	1.13	1	3	+	-	-	-	0
CAI-24	5.9	3	3	+	+	-	+	0
CAI-26	1.17	2	2	-	-	-	+	0
CAI-68	0.22	3	3	+	+	-	-	0.66
CAI-78	0.95	0	2	+	+	-	-	2.92
CAI-85	43.6	1	2	+	-	-	-	1.21
CAI-93	33.6	2	2	+	-	+	+	0
CAI-121	43.7	3	2	+	-	-	+	0
CAI-127	3.5	4	3	+	+	-	+	0
CAI-140	15.4	1.3	3	+	+	+	-	0.353
CAI-155	12.6	2	3	+	+	+	+	0.76
KAI-26	0.4	3	1	+	+	+	+	0.35
KAI-27	0.74	1	2	+	-	+	+	0.2
KAI-32	2.3	3	3	+	-	-	+	0
KAI-90	0	3	3	+	+	-	+	0
KAI-180	30.1	0	2	+	+	+	+	0
MMA-32	4.66	3	2	+	-	-	+	0

IAA = Indole acetic acid; ìg/ml: Sid. = Siderophore (1= positive, 2= halo zone of 1-2 mm, 3= halo zone of 4-6 mm and 4 = halo zone of 7 mm and above)**; HCN = Hydrocyanic acid (0 = no color change; 1 = light reddish brown; 2 = medium reddish brown and 3= dark reddish brown); Cel. = Cellulase; Lip. = Lipase; Pro. = Protease; Chi = Chitinase;**
(Scale 0-4 as follows**:** 0 =Negative; 1=positive; 2=halo zone of 1-3 mm; 3=halo zone of 4-6 mm and 4=halo zone of 7 mm and above) **β, 1-3. = β, 1-3, Glucanase (units)**

separately) for a minute and stuck underneath the Petri dish lids. The plates were sealed with Parafilm and incubated at 28 ± 2°C for four days. Development of reddish brown color on the filter paper indicated positive for HCN production. Observations were recorded (by a panel of three observers) on a 0"3 rating scale (they were rated based on the intensity of the reddish brown color) as follows: 0 = no color change; 1 = light reddish brown; 2 = medium reddish brown and 3 = dark reddish brown.

Indole acetic acid (IAA) production

It was done as per the protocols of Patten and Glick (1996). The actinomycetes were grown in starch casein broth supplemented with L-tryptophan (1 ì g ml-1) for four days. At the end of the incubation, the cultures were centrifuged at 10,000 g for 10 min and the supernatants collected. One ml of this culture filtrate was allowed to react with 2 ml of Salkowsky reagent (1 ml of 0.5 M $FeCl_3$ in 50 ml of 35% $HClO_4$) at 28 ± 2 oC for 30 min. At the end of the incubation, development of pink color indicated the presence of IAA. Quantification of IAA was done my measuring the absorbance in a spectrophotometer at 530 nm. A standard curve was plotted to quantify the IAA (ìg ml^{-1}) present in the culture filtrate.

Physiological traits of the prominent actinobacteria

The selected 19 potential antagonistic actinobacteria were able to grow in NaCl up to 12%, pH values between

Table 2. Usefulness of the 19 actinobacteria on different crops

Isolate	Scientific name	Chickpea	Pigeonpea	Sorghum	Rice
CAI-13	*Streptomyces* sp.	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	-	Growth and grain yield
CAI-17	*Streptomyces albus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	Growth and grain yield, antagonistic against charcoal rot	Growth and grain yield
CAI-21	*Streptomyces albus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	Nodulation, nitrogen fixation and grain yield	Growth and grain yield, antagonistic against charcoal rot	Growth and grain yield
CAI-24	*Streptomyces griseus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits, antagonistic against *Fusarium* wilt	-	Growth and grain yield	Growth and grain yield
CAI-26	*Streptomyces* sp.	Nodulation, nitrogen fixation and grain yield, Biofortification traits	Nodulation, nitrogen fixation and grain yield	Growth and grain yield	Growth and grain yield
CAI-68	*Streptomyces griseus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	Growth and grain yield	Growth and grain yield
CAI-78	*Streptomyces albus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	-	Growth and grain yield
CAI-85	*Streptomyces avermitilis*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	-	Growth and grain yield
CAI-93	*Streptomyces albus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	-	Growth and grain yield
CAI-121	*Streptomyces griseus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits, antagonistic against *Fusarium* wilt	-	Growth and grain yield	Growth and grain yield
CAI-127	*Streptomyces griseus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits, antagonistic against *Fusarium* wilt	-	Growth and grain yield	Growth and grain yield

Cont...

Table 2. Cont...

Isolate	Scientific name	Chickpea	Pigeonpea	Sorghum	Rice
CAI-140	*Streptomyces coelicolor*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	-	Growth and grain yield
CAI-155	*Streptomyces griseus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits, antagonistic against *Helicoverpa armigera*	-	-	Growth and grain yield
KAI-26	*Streptomyces griseus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	Growth and grain yield, antagonistic against charcoal rot	Growth and grain yield
KAI-27	*Streptomyces albus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	Growth and grain yield, antagonistic against charcoal rot	Growth and grain yield
KAI-32	*Streptomyces* sp.	Nodulation, nitrogen fixation and grain yield, Biofortification traits, antagonistic against *Fusarium* wilt	-	Growth and grain yield	Growth and grain yield
KAI-90	*Streptomyces coelicolor*	Nodulation, nitrogen fixation and grain yield, Biofortification traits, antagonistic against *Fusarium* wilt	-	Growth and grain yield	Growth and grain yield
KAI-180	*Streptomyces albus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	-	-	Growth and grain yield
MMA-32	*Streptomyces griseus*	Nodulation, nitrogen fixation and grain yield, Biofortification traits	Nodulation, nitrogen fixation and grain yield	Growth and grain yield, antagonistic against charcoal rot	Growth and grain yield
References		Gopalakrishnan *et al.,* 2011a, 2015a, 2015b, 2015c, 2015d, 2016b, Vijayabharathi *et al.,* 2014, Sathya *et al.,* 2016	Gopalakrishnan *et al.,* 2016a	Gopalakrishnan *et al.,* 2011b, 2013b, 2020a, 2021	Gopalakrishnan *et al.,* 2013a, 2013b, 2014

5 and 12 (acidic to highly alkaline) and temperatures between 20 and 40°C. However, the optimum conditions for good growth were 0"4% NaCl, pH values of 7"12 and temperatures of 20"30°C.

On growth-promotion and yield enhancement traits in grain legume pigeonpea

On pigeonpea, in the field conditions, 3 out of 19 strains (CAI-21, CAI-26 and MMA-32) of actinobacteria. were earlier reported to enhance nodule number, nodule weight, plant biomass, total dry matter and grain yield In the current study, the remaining sixteen actinobacteria strains were evaluated for their PGP in the pigeonpea under field conditions at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India. The trial was conducted in a randomized complete block design (RCBD) with three replications. The plot size was 4 rows of 1.2 m long with a row-to-row spacing of 60 cm and a plant-to-plant spacing of 10 cm. Pigeonpea seeds were sown in the field at a depth of 5 cm. The seeds were treated with the sixteen actinobacteria. strains (containing 10^8 CFU mL^{-1}) separately at sowing and at every 15 days interval up to 45 DAS. A negative control of only water was also maintained. Once the crops reach their physiological maturity stage (~30 days), the effect of actinobacteria. on the agronomic performance of the pigeonpea were evaluated. Later, at harvest, the effect of the sixteen actinobacteria. on agronomic performance and yield potential of pigeonpea under field conditions were also recorded.

RESULTS AND DISCUSSION

Enzymatic activities and secondary metabolite production by the prominent actinobacteria

When the 19 potential antagonistic actinobacteria (CAI-13, CAI-17, CAI-21, CAI-24, CAI-26, CAI-68, CAI-78, CAI-85, CAI-93, AI-121, CAI-127, CAI-140, CAI-155, KAI-26, KAI-27, KAI-32, KAI-90, KAI-180 and MMA-32) were evaluated further for their enzymatic activities and secondary metabolite production, all the isolates produced hydrocyanic acid (HCN), indole acetic acid (IAA; except KAI-90), siderophore (except CAI-78 and KAI-180) and cellulase (except CAI-26). Further, eleven of the isolates also produced lipase (except CAI-21, CAI-26, CAI-85, CAI-93, CAI-121, KAI-27, KAI-32 and MMA-32), fourteen produced chitinase (except CAI-21, CAI-68, CAI-78, CAI-85 and CAI-140) and nine produced â-1-3-glucanase (except CAI-21, CAI-24, CAI-26, CAI-93, CAI-121, CAI-127, KAI-32, KAI-90, KAI-180 and MMA-32). Hence, it was concluded that the 19 actinobacteria had rich enzymatic activities and secondary metabolite production capabilities (Gopalakrishnan *et al*., 2011a, 2013, 2015 (Table .1).

Physiological traits of the prominent actinobacteria

The physiological traits and usefulness of these selected actinobacteria on different crops from various studies at ICRISAT, Patancheru have been presented in Table 2

On growth-promotion and yield enhancement traits in grain legumes pigeonpea

The results showed that at 30 DAS, all the sixteen actinobacteria strains have significantly enhanced number of nodules (up to 80%), nodule weight (up to 77%), root weight (up to 30%) and shoot weight (up to 19%) of pigeonpea over the un-inoculated control (Table 3). At harvest, these selected actinobacteria have significantly enhanced the pigeonpea stover and pod weight (27% and 28% respectively), number of pods (up to 38%), seed weight and number (40% and 45% respectively), grain and stover yield (54% and 80% respectively) over the un-inoculated control. Of the 16 selected *Streptomyces* isolates, PGP traits were found maximum in KAI-180 followed by CAI-140, CAI-155 and CAI-17 over the un-inoculated control (Table. 4).

The selected 19 actinobacteria were also demonstrated for their biofortification traits in chickpea under field conditions. All the 19 actinobacteria were found to significantly increase minerals such as Fe, Zn, Ca, Cu, Mn and Mg over the un-inoculated control. The per cent increase might be due to the production of siderophore-producing capacity of the tested actinobacteria, which was confirmed in our previous studies by q-RT PCR on siderophore genes expressing up to 1.4 to 25 fold increased relative transcription levels (Sathya *et al*., 2016;). Five of the 19 actinobacteria (CAI-24, CAI-121, CAI-127, KAI-32 and KAI-90) were demonstrated for their antagonistic potential against *Fusarium* wilt, caused by *Fusarium oxysporum* f. sp. *ciceri* (FOC), under greenhouse and field conditions in chickpea (Gopalakrishnan *et al*., 2011a). Another set of six actinobacteria (CAI-17, CAI-21, KAI-26, KAI-27, MMA-32 and SAI-13) were demonstrated for their antagonistic potential against charcoal rot, caused by

Table 3. Effect of the sixteen actinobacteria **on agronomic performances of pigeonpea under field conditions - at 30 days after sowing**

Isolate	Nodule numbers (plant^{-1})	Nodule weight (mg plant^{-1})	Root weight (mg plant^{-1})	Shoot weight (g plant^{-1})
CAI-13	4.6	1.3	208	2.10
CAI-17	7.4	2.3	216	2.10
CAI-24	6.1	1.3	200	2.00
CAI-68	5.2	1.3	222	2.20
CAI-78	4.5	1.5	193	1.90
CAI-85	4.5	1.7	239	2.32
CAI-93	4.6	1.7	194	2.13
CAI-121	4.6	2.0	190	2.00
CAI-127	4.5	1.7	223	2.40
CAI-140	5.8	2.0	230	2.12
CAI-155	4.9	1.7	239	2.36
KAI-26	4.2	1.4	244	2.30
KAI-27	4.4	1.4	190	2.40
KAI-32	4.5	1.7	220	2.10
KAI-90	5.6	1.3	224	2.30
KAI-180	6.0	2.3	217	2.15
Control	4.1	1.3	184	2.02
Mean	5	1.6	214	2.17
SE±	0.408***	0.25^{NS}	13.57*	0.1546 ^{NS}
LSD (5%)	1.1753	0.7203	39.09	0.4454
CV%	6.2	5.8	3.8	2.5

SE= Standard error; LSD= Least significant differences; CV= Coefficients of variation; *= Statistically significant at 0.05, **= Statistically significant at 0.01, ***= Statistically significant at 0.001, NS= Not significant

Macrophomina phaseolina, under greenhouse and field conditions in sorghum (Gopalakrishnan *et al*., 2020a). The secondary metabolite responsible for the inhibition of the *M. phaseolina* was also purified and identified (Gopalakrishnan *et al*., 2020a).

One of the selected 19 actinobacteria (*Streptomyces* sp. CAI-155) was demonstrated to have entomopathogenic potential against *Helicoverpa armigera*, *Spodoptera litura* and *Chilo partellus*, important insect pests of chickpea and sorghum (Vijayabharathi *et al*., 2014). The active secondary metabolite (from the culture filtrates of CAI-155) was purified and identified as *N*-(1-(2, 2-dimethyl-5-undecyl-1, 3-dioxolan-4-yl)-2-hydroxyethyl) stearamide by NMR and mass spectral studies. The purified metabolite resulted in 70-78 per cent mortality in 2nd instar larvae of *H. armigera* in a diet impregnation assay, detached leaf assay and greenhouse assay (Gopalakrishnan *et al*., 2016).

Washings of vermi-compost called 'bio-wash' was also found to have inhibitory activity against phytopathogens and insect pests particularly against *H. armigera, S. litura* and *C. partellus* (Gopalakrishnan *et al*., 2011b). Among different bio-wash, bio-wash of *Jatropha curcas*, *Annona squamosa* and *Parthenium hysterophorus* marked their fungicidal activity with their crude extract and partially purified extracts on FOC, *S. rolfsii* and *M. phaseolina*. These studies suggest that vermicompost and bio-wash has the potency to promote

Table 4. Effect of the sixteen actinobacteria. on agronomic performances and yield potential of pigeonpea under field conditions - at harvest

Isolate	Stover weight (g plant^{-1})	Pod weight (g plant^{-1})	Pod number (plant^{-1})	Seed number (plant^{-1})	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})
CAI-13	21.36	17.17	44	148	1.90	1.35
CAI-17	23.85	16.13	45	153	1.57	1.77
CAI-24	25.73	18.97	52	199	1.94	1.63
CAI-68	23.07	18.40	60	186	1.75	1.23
CAI-78	24.26	16.03	45	141	1.51	1.85
CAI-85	22.61	16.30	47	153	1.49	1.46
CAI-93	25.62	18.03	52	163	1.67	1.80
CAI-121	25.61	20.70	51	189	1.97	1.65
CAI-127	22.71	16.37	52	184	1.72	1.57
CAI-140	25.22	21.73	62	209	2.20	1.26
CAI-155	24.26	19.83	56	203	1.91	1.23
KAI-26	21.71	18.97	60	150	1.87	1.04
KAI-27	21.93	17.98	46	156	1.58	1.49
KAI-32	26.32	16.87	47	152	1.88	2.36
KAI-90	23.66	17.60	48	170	1.69	1.38
KAI-180	27.51	20.63	58	199	2.05	1.61
Control	21.91	16.93	45	144	1.43	1.31
Mean	23.96	18.16	51	171	1.77	1.53
SE±	1.561^{NS}	1.448^{NS}	2.601***	12.52***	0.176^{NS}	0.265^{NS}
LSD (5%)	4.496	4.172	7.492	36.08	0.506	0.764
CV%	8.9	7.2	5	7.1	5.9	8.3

SE= Standard error; LSD= Least significant differences; CV= Coefficients of variation; *= Statistically significant at 0.05, **= Statistically significant at 0.01, ***= Statistically significant at 0.001, NS= Not significant

plant growth, control the infectious diseases and restrict the pest attack.

Complete genome sequence of the prominent actinobacteria

Out of the 19 prominent actinobacteria, the genome sequences of 16 actinobacteria (CAI-17, CAI-21, CAI-24, CAI-68, CAI-78, CAI-85, CAI-93, CAI-121, CAI-127, CAI-140, CAI-155, KAI-26, KAI-27, KAI-90, KAI-180 and MMA-32) have been decoded by whole genome sequences (WGS). The genome assemblies of the 16 actinobacteria strains ranged from 6.8 Mb to 8.31 Mb, with a GC content of 72 to 73%. The extent of sequence similarity in 16 actinobacteria strains showed 70 to 85% common genes to the closest publicly available *Streptomyces* genomes. Genome assemblies of the 16 actinobacteria strains have also provided genes involved in key pathways related to PGP and biocontrol traits such as siderophores, IAA, hydrocyanic acid, chitinase and cellulase (Gopalakrishnan *et al*., 2020b).

CONCLUSION

Vermicompost has been extensively used in organic agriculture not only for its beneficial effects on soil biota and structure, but also for its ability to promote plant growth and inhibit plant pathogens. Vermicompost contains complex group of beneficial microorganisms, which directly or indirectly contribute to its beneficial

properties in enhancing the soil health, plant growth and indeed the agricultural productivity. The present chapter narrates the successful selection of 19 prominent actinobacteria isolated from 25 different herbal vermicompost and their potentials in integrated pest, disease and nutrient management. The 19 actinobacteria have been demonstrated extensively for their PGP potentials in chickpea, pigeonpea, sorghum and rice by significantly enhancing nodulation, nitrogen fixation, crop productivity and root development. As biocontrol agents, they are effectively active against *Fusarium* wilt in chickpea, charcoal rot in sorghum and entomopathogenic towards *Helicoverpa armigera*, *Spodoptera litura* and *Chilo partellus*. It is concluded that the selected 19 actinobacteria could be exploited as PGP and biocontrol agents in furthering the use of eco-friendly biological products. However, further experiments are needed to determine the effectiveness of these isolates under different field conditions and to understand the nature of interaction with other soil native microflora and fauna and the host plant.

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RELATIONSHIP BETWEEN PROFILE OF FPO MEMBERS WITH PERFORMANCE OF FPO

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ABSTRACT

Assessing the relationship between profile of FPO members with performance of FPO would help to understand how the profile characteristics will influence the performance and socio-economic benefits of the FPO members after joining in the FPO. The present investigation was carried out in Anantapuramu and Chittoor districts of Rayalaseema region of Andhra Pradesh over a randomly drawn sample of 240 FPO members. The results revealed that education, annual income, extension contact, mass media exposure, innovativeness, training undergone, social participation, market orientation, economic orientation, achievement motivation, scientific orientation, risk orientation, cosmopoliteness and credit orientation had positive and significant relationship with the performance of FPO. Whereas, age, farm size and farming experience had non-significant relationship with the performance of FPO.

KEYWORDS: Andhra Pradesh, FPO, Profile, Members and Relationship

INTRODUCTION

Agriculture is vital for the economy, as more than 52 per cent of the workforce is engaged in a sector contributing only 14 per cent towards GDP. In an environment, where majority of landholdings are small and marginal, the challenge would be to achieve an economic size of operation leading to income enhancement and reduction in transaction costs. The declining size of the operational holdings in India is, no doubt, a major deterrent for the viability and sustainability of farming, making it unattractive for the youth. Aggregation is held as a veritable instrument to address the phenomenon of smallholdings in the sector such as Farmer Producer Organizations (FPO). This will go a long way in achieving the economies of scale and integrating farmers into value chains ensuring them better returns. FPO also has the potential to help the small farmers overcome some of the traditional limitations like stagnant productivity, poor quality of produce, low level of competiveness, poor access to market, etc. Aggregation is, of course, a hard nut to crack in Indian conditions, both in terms of engaging large number of dispersed farmers on a common platform on one hand and on the other, building their capacity to take advantage of the new organizational setup. So, it is necessary to study the relationship between profile of members how it will influence the performance and socio-economic benefits of members after joining in the FPO.

MATERIAL AND METHODS

The study was conducted with an *Ex post facto* research design to assess the influence of profile of FPO members on the performance of FPO. The study was conducted in the year 2020 in Anantapuramu and Chittoor districts of Rayalaseema region of Andhra Pradesh, the districts were purposively selected based on highest number of FPOs. From each selected district three FPOs functioning from more than three years were purposively selected, thus making a total of 6 six FPOs. From each of the selected FPO, 40 members were selected by following simple random sampling procedure, thus making a total of 240 members as the sample of the study. After review of literature and consultation with experts as set of 17 personal, psychological and socio-economic variables were selected. The data was collected through a structured comprehensive interview schedule and analysed using correlation and Multiple Linear Regression statistical tools for drawing meaningful interpretations.

RESULTS AND DISCUSSION

I. Correlation Analysis of Profile of the FPO members and the performance of FPO as perceived by the members

Age Vs Performance of FPO

From the Table 1 it is clearly indicate that the co-efficient of correlation value (-0.019) of FPO members

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Table 1. Correlation analysis of profile of FPO members and performance of FPOs

(n = 240)

S. No.	Independent variable	Correlation co-efficient 'r' value
X_1	Age	-0.019^{NS}
X_2	Education	0.482**
X_3	Farm size	0.052^{NS}
X_4	Farming experience	0.036^{NS}
X_5	Annual Income	0.285**
X_6	Extension contact	0.615**
X_7	Mass media exposure	0.536**
X_8	Innovativeness	0.575**
X_9	Training undergone	0.610**
X_{10}	Economic orientation	0.468**
X_{11}	Social participation	0.450**
X_{12}	Market orientation	0.336**
X_{13}	Achievement motivation	0.420**
X_{14}	Scientific orientation	0.569**
X_{15}	Risk orientation	0.339**
X_{16}	Cosmopoliteness	0.375**
X_{17}	Credit orientation	0.545**

** : Significant at 0.01 level; NS : Non-significant

age had negative and non-significant relationship with the performance of FPO. The possible reason could be that irrespective of age of the FPO members, the person who had interest and belief about the concept of FPO could be joined as a member. As per the operational guidelines of FPO, no limit on age to become a member of the FPO. This finding was in line with the results of Fayaz (2015) and Siddeswari (2018).

Education Vs Performance of FPO

The data presented in Table 1 clearly depicted that the co-efficient of correlation value (r = 0.482) of education of the FPO members had positive and significant relationship with the performance of FPO. It could be justified that educated FPO members had more knowledge about functions of FPO and services provided by FPO. They possess more power to govern and manage the FPO. Educated FPO members can easily understand the functions, roles and responsibilities in implementation at ground level. So education affects the performance of FPO. This finding was in tune with the results of Parthiban *et al.* (2015).

Farm size Vs Performance of FPO

The findings from the table 1 conveyed that the co-efficient of correlation value (r =0.052) of farm size was not significant with performance of FPO members. The possible reason might be that even though the target group of FPO was small and marginal farmers but there was no restriction on entry of large farmers into the group. Irrespective of different farm sizes the promoting agencies were forming FPOs mainly based on the commodity (or) community based, where every farmer had a chance to

join the FPO. Similar finding was endorsed by the results of Venkattakumar *et al.* (2019).

Farming experience Vs Performance of FPO

From the table 1 it was observed that the co-efficient of correlation value (r = 0.036) of farming experience was non-significant with performance of FPO members. The possible reason might be due to the fact that as farm management is different from FPO management, in farm farmers deal with factors of production and allocation resources whereas in case of FPO, the members had to deal with group, understand the administration, promotion of services timely and development of business. This concept of FPO is new to them and all the members have just 3-4 years' of experience in the FPO in spite of their high level of experience in farming. Governance and management activities of FPO for initial three years tenure were taken up by facilitating agencies. So, it will take some more time to run the FPO by the members effectively. Hence this trend was noticed.

Annual income Vs Performance of FPO

It is keenly observed from table 1 that the co-efficient of correlation value (r = 0.285) of annual income of the FPO members had positive and significant relationship with the performance of FPO. The reasons for this might be that FPO members with high level income had a natural tendency towards taking risk and accepting new ideas, technologies and imparting knowledge when compared to that of the low level of income category. The basic motive of FPO members is increased income. Hence this trend was noticed. The finding was in tune with the results of Ahire *et al.* (2015) and Darshan (2019).

Extension Contact Vs Performance of FPO

The table 1 projected that the co-efficient of correlation value (r = 0.615) of extension contact had positive and significant relationship with the performance of FPO. The probable reason might be that FPO members were more enthusiast to participate in the activities related to extension like exposure visits to successful FPOs, field trips, kisan melas, training programs and exhibitions organized by facilitating agencies, promoting agencies, agriculture and allied departments and that might be the reason for increasing their extension contact and this could have exhibited a positive significant relationship with the performance of FPO. Similar finding was endorsed by the results of Gopi *et al.* (2017) and Naveenkumar and Rathakrishnan (2017).

Mass media exposure Vs Performance of FPO

It is transparent from the table 1 found that the co-efficient of correlation value (r =0.536) of mass media exposure has significant relationship with the performance of FPO. This trend might be due to increase in the telecast of agricultural programs through different channels and number of newspapers publishing a full column on need and importance of FPO, different services rendered by FPOs, case studies on successful FPOs and successful members regularly. FPO members with good mass media exposure were in a position to pick up appropriate technologies at correct time and implement them, so better management and performance of FPO by members could be seen.

Innovativeness Vs Performance of FPO

It is obvious from the table 1 that the co-efficient of correlation value (r =0.575) of Innovativeness had positive and significant relationship with performance of FPO members. It could be justified that The FPO had fostered innovations, latest technologies and provided knowledge on advanced practices through exposure visits, training programs with the help resource institutes. This will improve the confidence of the farmers and motivate them to adopt new technologies. Thus FPO ultimately increases the socio – economic conditions of the members by adopting inventions in modern management practices other than non-members.

Training undergone Vs Performance of FPO

It is evident from the table 1 that that the co-efficient of correlation value (r =0.610) of training undergone had positive and significant relationship between training undergone and performance of FPO. The reason might be that the training programs organized by facilitating agencies might have exposed the FPO members about administration, maintenance of records and books, regular selection of board members, services, production, marketing and finance related issues of FPO. Further the training also might give the opportunity to visit to successful FPOs and to interact with members, which in turn developed their behavior, facilitated to understand the need and importance of FPO and resulted improvement in the performance of FPO. Hence, the above trend was noticed. Similar results were reported by Mukherjee *et al.* (2019).

Table 2. Multiple linear regression analysis of the profile of the FPO members with the performance of FPO (n = 240)

S. No.	Variable	Std. error	'b' values	't' values	'p' values
X_1	Age	0.275	-0.329	-1.196^{NS}	0.233
X_2	Education	0.384	0.940	2.980**	0.004
X_3	Farm size	0.335	-0.018	-0.053^{NS}	0.958
X_4	Farming experience	0.212	0.190	0.895^{NS}	0.372
X_5	Annual income	0.003	-1.312	-0.462^{NS}	0.644
X_6	Extension contact	0.393	0.097	3.516**	0.001
X_7	Mass media exposure	0.440	0.750	1.705^{NS}	0.090
X_8	Innovativeness	0.150	-0.203	-1.356^{NS}	0.177
X_9	Training undergone	0.523	1.307	2.688**	0.000
X_{10}	Economic orientation	0.182	-0.295	-1.625^{NS}	0.106
X_{11}	Social participation	0.381	-0.044	-1.168^{NS}	0.244
X_{12}	Market orientation	0.202	0.179	0.887^{NS}	0.376
X_{13}	Achievement motivation	0.180	0.247	1.369^{NS}	0.172
X_{14}	Scientific orientation	0.208	0.297	1.426^{NS}	0.155
X_{15}	Risk orientation	0.207	-0.073	-0.350^{NS}	0.726
X_{16}	Cosmopoliteness	0.652	0.155	2.381**	0.000
X_{17}	Credit orientation	0.345	0.707	1.536**	0.000

$R^2 = 0.870$

* : Significant at 0.05 level; ** : Significant at 0.01 level; NS : Non-significant

Economic orientation Vs Performance of FPO

It is apparent from table 1 that the co-efficient of correlation (r = 0.468) of economic orientation had positive and significant relationship between economic orientation and performance of FPO members. The possible reason for this trend might be that Economic orientation is that the fundamental trait around which other motives, drives and other attributes were built. It psychologically conditions the individual to motivate himself to achieve higher income. FPO is the critical intervention at present situation for economic empowerment of the farmers which provides better inputs, credit, marketing and other facilities that enhance their yield, income and reduces cost of production of members and ultimately improves the performance of FPO. Hence economic orientation had positive and significant relationship with performance of FPO. This findings was in conformity with the results of Naidu (2012).

Social participation Vs Performance of FPO

An overview of table 1 indicated that the co-efficient of correlation (r = 0.450) of social participation had positive and significant relationship with performance of FPO members. The reason behind this might be that FPO as a social and rural organization at grass root level had given scope for members to improve their abilities to interact with different type of people, actively participate in the social organization to express their own views,

exchange ideas, solutions for problems. So, farmers gain more knowledge about administration and managerial skills and try to implement them in their organization. Hence, the above trend was observed.

Market orientation Vs Performance of FPO

It is indicated from the table 1 that the co-efficient of correlation (r = 0.336) of market orientation had positive and significant relationship with performance of FPO. Market orientation is an important factor which enables the farmers to take appropriate market decisions. FPO provided time to time market related information from different resources and taking initiatives of marketing facilitates. Members with knowledge about market information and facilities provided by FPO, they realize more profit compared to non-members. Thus, ultimately improves performance of FPO. Hence, positively significant relationship was observed. This finding had drawn support from the findings of Sreeram (2013).

Achievement motivation Vs Performance of FPO

The data pertaining to table 1 revealed that the co-efficient of correlation (r = 0.420) of achievement motivation had positive and significant relationship with performance of FPO. The probable reason might be that FPO would act as catalyst for accomplishment of the needs and goals of members through capacity building activities and members might be motivated through their fellow members in the group and learn the ways and means to achieve their goals with continuous efforts. In this process members knew the importance of FPO and their role to achieve in the group which let to effective performance of FPO. Hence this trend was observed.

Scientific orientation Vs Performance of FPO

It is evident from the table 1 that the co-efficient of correlation (r =0.569) of scientific orientation was positively significant with the performance of FPO. The probable reason might be that FPO organizes training programs on latest technologies, production, storage and processing and value addition in scientific way with the help of resource agencies. This will provide ample scope for the FPO members to adopt and implement latest technologies logically and scientifically in their farm. In this process, performance of FPO will be increased in providing latest technologies, storage, processing and value addition facilities to its members. Hence, the above trend was observed with similar findings of Siddeswari (2018).

Risk orientation Vs Performance of FPO

The data in table 1 depicted that the co-efficient of correlation value (r = 0.303) of risk orientation had positive and significant relationship with performance of FPO. It could be conclude that FPO stimulates the members to bring the positive change in their lives by inculcating habit of risk bearing. Members with risk bearing ability are ready to accept innovations and with stand any uncertainty. FPO members with high risk bearing ability strive hard to take right innovations and interventions to meet success in their lives. Thus, risk orientation improves the profit of members as well as performance of FPO by providing appropriate innovations and interventions. This result was in accordance with the findings of Chopade *et al.* (2019).

Cosmopoliteness Vs Performance of FPO

It could be noticed from the table 1 that the co-efficient of correlation value (r =0.493) of cosmopoliteness had positive and significant relationship with performance of FPO. It might be fact that due to cosmopolite FPO members were having broader outlooks where there is a better scope for exchange of new ideas and facts. Further, the members who interact with members of other FPO outside their systems are likely to get information about how their FPO is functioning and providing services. Members with higher cosmopoliteness were in persistent contact with their relatives, friends and others at distant locations can be useful to improve the performance of the FPO. The result derived support from the findings of Chopade *et al.* (2019) and Madhuri (2020).

Credit orientation Vs Performance of FPO

A glance at the table 1 showed that the co-efficient of correlation value (r =0.548) of credit orientation was positively significant with performance of FPO. The reason might be that high profile thinking and telescopic vision might be the two important factors for the FPO members to view the credit as one of the critical source for achievement. The FPO members with high credit orientation were eager to utilize the credit as a hand holding support to realize their dreams. They also might have felt the need for institutional credit to have more credibility in operating the business. This attitude might have developed a favourable entrepreneurial behaviour.

Hence, the above trend was noticed with similar findings of Siddeswari (2018).

II. Combined effect of all Independent Variables on the performance of FPO

To determine the combined effect of all the selected independent variables in explaining variation in performance of FPO, Multiple Linear Regression analysis was carried out. The computed co-efficient of determination (R^2) value and partial regression co-efficient (b) values with their corresponding 't' values were presented in table 2. The R^2 and 'b' values were tested statistically for their significance.

As observed in the table 2. the 'R^2' value was 0.870 depicted that all the selected seventeen independent variables put together explained about 87.00 per cent variation in the performance of FPO.

The partial regression coefficients presented in table 2. Further revealed that the independent variables viz., education, extension contact, training undergone, cosmopoliteness and credit orientation were found positively significant as evident from their significant' values. This implied that education, extension contact, training undergone, cosmopoliteness and credit orientation are the most important variables that contributed to most of the variation in the performance of FPO.

From the table 2. It was evident that all the selected 17 independent variables put together explained about 87.00 per cent variation in performance of FPO, as indicated by 'R^2' value. Thus, it could be concluded that the variables selected, explained the variation to a large extent over the in performance of FPO. In other words, the variables selected for the study were relevant to the problem selected.

When partial regression coefficients were tested it was noted that education, extension contact, training undergone, cosmopoliteness and credit orientation were showed positively significant as indicated from their significant values. It depicted that education, extension contact, training undergone, cosmopoliteness and credit orientation had positively and significantly contributed for most of the variation in the Performance of FPO.

The FPO member with more education can easily understand the ideology of FPO and have more decision making ability in the activities related to FPO. Which improves the capacity to improve the performance of FPO through development of business, extending membership, increase share capita and grab the funds from external agencies. Thus the more number of educated members in the group then more will be the performance of FPO. Hence, education had positively and significantly contributed to the variation in the performance of FPO.

Facilitating agency provides opportunity to the FPO members to interact with various resource institutes such as agricultural and allied departments, financial and social institutes, which improves their knowledge and promotes to adoption of modalities of latest technologies. Thus extension contact improved the performance of FPO. So extension contact had positively and significantly contributed to the most of the variation in the performance of FPO.

FPO organized various training programs which imparts knowledge, brings change in attitude and improves the skills. It helped the FPO members to acquire knowledge on latest technologies, to improve their skills in office, books and records maintenance, leadership development and organization management. So training undergone improved the performance of FPO. Hence, training undergone had positively and significantly contributed to the most of the variation in the performance of FPO.

The members with high cosmopoliteness have more idea about the latest developments in farming, progress and status of FPO activities in outside of their social system, that information is very helpful to adopt and implement in their social system/ FPO. Thus improves the performance of FPO. Hence, cosmopoliteness had positively and significantly contributed to the most of the variation in the performance of FPO. The results derives support from the results of Madhuri (2020)

Credit orientation gives the opportunity to carry out farming activities timely and provides scope to quick adoption and implementation of latest technologies. Thus credit orientation had positively and significantly contributed to the most of the variation in the performance of FPO.

CONCLUSION

The results showed that the seventeen independent variables *viz.,* education, annual income, extension contact, mass media exposure, innovativeness, training undergone, economic orientation, scientific orientation ,

market orientation, achievement motivation, social participation, risk orientation, cosmopoliteness and credit orientation had positive and highly significant relationship with the performance of FPO. The age with performance was observed negative and non-significant relationship, whereas two variables *viz.,* farm size and farming experience had non-significant relationship with the performance of FPO. All the selected seventeen independent variables put together explained about 87 per cent variation in the performance of FPO. Education, extension contact, training undergone, cosmopoliteness and credit orientation were the most important variables that contributed to most of the variation in the performance of FPO. Therefore, there is immediate need to promote ideology of FPO among members and promoting agencies, facilitating agencies, extension agencies and NGOs should focus more in manipulating the significant variables for further improvement of performance of in terms of functioning and services provided to its members.

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PROFILE OF ECO-FRIENDLY TURMERIC GROWERS IN ERODE DISTRICT OF TAMIL NADU

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ABSTRACT

The study was conducted to study the profile of turmeric growers in Erode district of Tamil Nadu. The results revealed that majority of the turmeric growers were middle age (55.83%), educated up to middle school (50.00%), small farmers (38.33%), had medium level of farming experience (60.83%), training undergone (58.33%), social participation (40.00%), extension contact (65.00%), innovativeness (65.83%), mass media exposure (44.17%), risk orientation (51.67%), economic motivation (78.33%), marketing orientation (64.17%), scientific orientation (57.50%), achievement motivation (57.50%) and market intelligence (51.67%).

KEYWORDS: Eco-friendly turmeric growers, Profile characteristics, Tamil Nadu.

INTRODUCTION

In Tamil Nadu, turmeric, a significant spice crop, is grown in an area of 20,894 ha with the production of 86,513 tonnes of rhizome. The state contributes 14.04 per cent to the total production of turmeric and Erode district alone owns 33.37 per cent of the total turmeric production in the state. The district's 24.14 per cent (9473 hectares) of the total area is used for turmeric cultivation (Anonymous, 2019). Since, turmeric is being used for culinary and medicinal purposes, chemical residues in the produce must be kept as low as possible. Eco-friendly farming is widely practiced in turmeric cultivation in Erode district of Tamil Nadu. Export Value of eco-friendly spices stood at ₹ 24,369 lakh in the year 2019-20. Eco-friendly farming fetches huge export potential for Indian spices in the international market. In order to make use of this potential, eco-friendly practices have to be popularised among the farming community.

The present study had been taken up with an objective to study the profile of turmeric growers. The findings of the study would be of a great help to the extension personnel in formulating different strategies for increasing the adoption of eco-friendly practices suited to different clientele.

MATERIAL AND METHODS

The present study was conducted by following *Ex post facto* research design. Erode district of Tamil Nadu was selected for the study based on the highest area and production under eco-friendly turmeric cultivation. Two blocks *viz*., Kodumudi and Modakurichi with highest area and production were selected purposively for the study. From each of the selected blocks, four villages were selected by following simple random sampling procedure. From each village, a total of 15 turmeric growers having not less than five years of farming experience were selected using simple random sampling procedure. A total of 120 respondents were studied. After review of literature and consultation with experts, a set of 15 independent variables were identified. The data were collected through a structured comprehensive interview schedule and analysed with suitable descriptive statistics.

RESULTS AND DISCUSSION

Table 1 categorised the respondents based on their identified profile characteristics.

1. Age

It could be seen from the Table 1 that 55.83 per cent of the turmeric growers were middle aged, followed by old (36.67%) and young aged growers (7.50%) respectively. Since, most of the young people had migrated to other professions after graduation especially to private jobs, businesses and self-employment, the percentage of young people who took up farming was very less compared to middle age and old age people. The findings were in accordance with the findings of Rao (2016) and Prasad *et al*. (2018).

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Table 1. Distribution of eco-friendly turmeric growers according to their profile characteristics

(n = 120)

S. No.	Variables	Category	Frequency (f)	Percentage (%)	Mean	S.D.
1.	Age	Young (< 35 yrs)	9	7.50	-	-
		Middle (36 - 55 yrs)	67	55.83		
		Old (> 55 yrs)	44	36.67		
2.	Education	Illiterate	4	3.34	-	-
		Can read only	1	0.83		
		Can read and write	0	0.00		
		Primary school	6	5.00		
		Middle school	60	50.00		
		High school	24	20.00		
		Graduate	25	20.83		
3.	Farm size	Marginal farmer (< 2.5 acres)	38	31.67	-	-
		Small farmer (2.5 to 5.0 acres)	46	38.33		
		Medium farmer (5.0 to 25.0 acres)	32	26.67		
		Big farmer (> 25.0 acres)	4	3.33		
4.	Farming experience	Low	21	17.50	28.42	11.05
		Medium	73	60.83		
		High	26	21.67		
5.	Training undergone	Low	32	26.67	7.05	6.00
		Medium	70	58.33		
		High	18	15.00		
6.	Social participation	Low	39	32.50	1.05	0.97
		Medium	48	40.00		
		High	33	27.50		
7.	Extension contact	Low	28	23.33	6.06	4.65
		Medium	78	65.00		
		High	14	11.67		
8.	Innovativeness	Low	20	16.67	17.69	2.35
		Medium	79	65.83		
		High	21	17.50		
9.	Mass media exposure	Low	31	25.83	7.23	3.33
		Medium	53	44.17		
		High	36	30.00		
10.	Risk orientation	Low	28	23.33	21.83	6.11
		Medium	62	51.67		
		High	30	25.00		
11.	Economic motivation	Low	15	12.50	25.43	3.76
		Medium	94	78.33		
		High	11	9.17		
12.	Market orientation	Low	15	12.50	24.50	3.65
		Medium	77	64.17		
		High	28	23.33		
13.	Scientific orientation	Low	23	19.17	25.07	4.14
		Medium	69	57.50		
		High	28	23.33		
14.	Achievement motivation	Low	27	22.50	29.53	3.50
		Medium	69	57.50		
		High	24	20.00		
15.	Market intelligence	Low	26	21.67	12.11	2.20
		Medium	62	51.67		
		High	32	26.67		

2. Education

It is obvious from the Table 1 that, half of the respondents (50.00%) were educated up to middle school, followed by graduates (20.83%), high school (20.00%) and primary school education (5.00%) respectively. Further 0.83 per cent and 3.33 per cent of respondents formed can read only and illiterate categories respectively. It was clear that the availability of educational infrastructure in rural areas had increased and that respondents had got a better understanding of the necessity of education for their overall development.

3. Farm size

Table 1 results reveal that majority of the respondents were small farmers (38.33%) followed by 31.67 per cent marginal farmers, 26.67 per cent medium farmers and only 3.33 per cent of the turmeric growers were big farmers. Majority of the farmers were found be small and marginal farmers. It could be substantiated that the sub division and fragmentation of the farm land from one generation to another generation was the foremost reason for decline in the land holding size of each farmer in the rural areas. The above results were in accordance with Govind *et al.* (2018) and Prasad *et al.* (2018).

4. Farming experience

Table 1 results indicate that majority of the turmeric growers had medium farming experience (60.83%), followed by high farming experience (21.67%) and the remaining respondents (17.50%) had low farming experience. Undoubtedly, farming experience was an important factor which influences the farmers to accept, evaluate and experiment the innovative technologies in their farm. As most of the turmeric farmers were middle aged, they had medium level of experience in farming. Results from Rao (2016) and Phenica (2018) were in line with the study findings.

5. Training undergone

From the Table 1, it could be inferred that more than majority of the respondents had undergone medium training (58.33%), followed by low (26.67%) and high (15.00%) trainings. Young and middle-aged persons who were interested in learning about new agricultural innovations in turmeric cultivation would make time to attend the training programme. The elderly might not be willing to attend the trainings as they might not find the training sessions quite suitable and would not accept the new technologies coming in agriculture. In order to attract all age group of turmeric growers, the trainings should be conducted timely and by appropriate agencies using innovative training modules. The results were in line with the results obtained by Naidu (2012) and Rani (2020).

6. Social Participation

Table 1 results show majority (40.00%) of the respondents had medium, followed by low (32.50%) and high (27.50%) levels of social participation respectively. Since, major proportion of turmeric growers had medium education level, extension contact and mass media exposure, they either did not realize the importance of social participation or denied the opportunities of social participation.. The studies by Saiva (2012) and Babu (2014) also showed similar results.

7. Extension Contact

An overview of the Table 1 inferred that, majority of the respondents had medium (65.00%) extension contact followed by low (23.33%) and high (11.67%) extension contact. The probable reason for above trend might be that, lack of sufficient numbers of field level extension functionaries, especially Assistant Horticultural/Agricultural Officers working at grass root level for transfer of technologies. Hence, regular visits and follow up by the extension personnel to farmers might secure high extension contact. The results were in similarity with Phenica (2018).

8. Innovativeness

The results from the Table 1 indicated that majority of the respondents had medium (65.83%), followed by high (17.50%) and low (16.67%) levels of innovativeness respectively. It was one of the several factors contributing for adoption of improved practices. Farmers with middle school to graduate level of education and bright exposure to mass media might have high chances of success in the endeavours they took up. This might have improved their self-confidence in turn impacting the farmers' innovativeness. This outcome is in similarity with Babu (2014) and Govind *et al.* (2018).

9. Mass Media Exposure

It is certain from the Table 1 that, majority of the respondents were with medium (44.17%) mass media exposure, followed by high (3.00%) level of mass media exposure and low (25.83%) level of mass media exposure.

Being exposed to mass media such as television, radio, magazines, internet and mobile apps improved the knowledge and awareness of farmers on latest farm technologies. Availability of mass media channels for technological development such mobile apps, agri tech portals etc. might be the reason for above trend. The sizeable number of farmers who had low level of mass media exposure might be the old-aged farmers lacking acquaintance with mass media such as internet, magazines, television, etc. The results of Ramu (2005) and Phenica (2018) also depicted similar results.

10. Risk orientation

It could be understood from Table 1 that majority of the respondents had medium (51.67%) followed by high (25.00%) and low (23.33%) levels of risk orientation. Risk orientation was found to play a major role in the adoption of new technologies by the farmers. Above trend might have resulted due to small and marginal farm size of majority of the turmeric growers. This outcome is in line with Govind *et al.,* (2018)

11. Economic Motivation

From the Table 1, it could be concluded that more than three-fourth of the respondents had medium (78.33%) economic motivation and low (12.50%) level of economic motivation followed by high (9.17%) economic motivation. The probable reason for the above trend might that the farmers were unable to get remunerative price for their produce. Requirement of hard labour to get economic yields, lack of farm resources and higher education, small and marginal farm size and low exposure to mass media could also be attributed as the reasons for the findings obtained. The above results were in conformity with Narbaria (2017).

12. Marketing Orientation

From the Table 1, it could be seen that majority of the respondents had medium (64.17%) marketing orientation followed by high (23.33%) and low (12.5%) levels of marketing orientation. When the farmers were oriented towards the marketing of the produce, they would be able to end with a good sale of their produce which in turn would motivate the farmer to adopt new scientific farm technologies. The reason for the above trend might be the availability of proper marketing channels for turmeric sale such as regulated market and lack of warehouse facilities. The results were in conformity with the conclusion of Babu (2014).

13. Scientific Orientation

From the overview of the Table 1, it could be found that majority of the respondents had medium (57.50%) scientific orientation. The remaining respondents had high (23.33%) and low (19.17%) levels of scientific orientation. Orientation of farmers towards scientific methods in farming and for decision making is indispensable for the acceptance and adoption of new technologies. The farmers level of education might be the reason for the above trend. Extension methods such as demonstrations, models and exposure visits which facilitate easy understanding of scientific technologies may be used to align the farmers' thought process scientifically. The results were supported by the conclusions of Prasad (2014) and Govind *et al*. (2018).

14. Achievement Motivation

It is obvious from the Table 1 that respondents had medium (57.50%) followed by low (22.50%) and high (20.00%) levels of achievement motivation. Achievement motivation puts oneself in the pathway to success. The more a farmer is motivated towards achievement, the more is the persuasion to adopt an improved farm technology. Not getting adequate price for the produce and lack of follow up from the extension officials might be the possible reasons for weakening the farmers' desire for success. Gopinath (2005) and Begum (2008) reported similar results.

15. Market Intelligence

Table 1 results indicate that, majority of the respondents had medium (51.67%) followed by high (26.67%) and low (21.67%) levels of market intelligence. Market intelligence enables the respondents to make better marketing decisions depending on the market information. Possible reason for the above results might be the farmers' interest and understanding of need to access market information to sell their produce for better price. Exposure and education also contributed to the above trend. The results were found to be in accordance with Dhara *et al* (2015).

CONCLUSION

The research results revealed that there is an ample need for various actions such as attracting youth towards farming, gearing up non-formal educational programmes, emphasizing the harmful effects of chemical farming, strengthening the communication channels, proper follow up by extension agency and encouraging the innovative farmers by inculcating their ideas while framing schemes and policies. Since, most of the turmeric growers belong to medium category of all the selected profile characteristics, it is suggested to improve some of the manageable profile characteristics through training programs, demonstrations, field visits and suitable extension methods.

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STUDIES ON LIFE HISTORY PARAMETERS OF MELON FRUIT FLY, *Zeugodacus cucurbitae* (Coquillet) REARED ON FRUIT-BASED DIETS

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ABSTRACT

Maggots of melon fruit fly, *Zeugodacus cucurbitae* were mass reared on seven semi-synthetic fruit based diets. Biological parameters of melon fruit fly were recorded and compared with control diet to develop an effective semi-synthetic fruit based diet for mass production of pupae in support of sterile insect technique. Seven semi- synthetic diets with different quantities of protein powder (7.5, 10.0, 15.0 and 20.0 g) and sucrose (7.0 and 10.0 g) were formulated. Among the seven diets evaluated, semi-synthetic fruit based diet-IV (SSFD-IV) composed of pumpkin fruit (1000 g), yeast extract (7.5 g), brewer's yeast (7.5 g), Sucrose (7.0 g) and 2.0 ml of wheat germ oil was found as the most appropriate diet with significantly higher pupal recovery (77.8%), pupal weight (1.61 g), adult emergence (80.2%), active fliers (75.87%), sex ratio (1.23) fecundity (28.0 eggs/female) and fertility (71.81%). The diets, SSFD-III and SSFD-VII are the next best diets for mass rearing of melon fly.

KEYWORDS: Biological parameters, Melon fruit fly, Pumpkin fruit, Semi-synthetic diet, Yeast extract

INTRODUCTION

Melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) is considered as the foremost important fruit fly that attacks 61 plant species belonging to 19 different families, of which twenty-eight of them are cucurbits and remaining are non-cucurbit hosts (De Meyer *et al.,* 2015). The pest damages the crop by means of ovipositional injury, larval feeding on ovaries, fruit pulp, and rottening of fly-damaged fruits (Viraktamath *et al.,* 2003). Both major and minor cucurbits are being cultivated in India and sharing about 7.0 per cent of the total vegetable production (Anonymous, 2020). Melon fruit fly damages over 60 per cent of cucurbit crops in India (Kapoor, 2005) and the extent of losses vary from 30 to 100 per cent (Shooker *et al.,* 2007).

Mass production of insects on improved diets provide large supply of insects for various studies in methods of pest management such as release of parasitoids, predators and sexually sterile insects *etc.,* (Cohen, 2015). Hence, majority of pest management strategies largely rely on establishment of effective mass rearing methods. The Laboratory rearing of insects on solid based diets may results in undesirable changes in insect biology, behavior and physiology which could undermine the overall viability of adult insects. Hence, there is a need to develop suitable diet for mass rearing of insect without compromising with quality of insects. In the present study, pumpkin fruit was used as natural fruit substrate, to which different sources of protein, fatty acid, and carbohydrate were fortified at different concentrations to develop a suitable semi-synthetic fruit based diet for mass rearing of melon fly. The performance of these diets were assessed by recording biological parameters of melon fly such as larval duration, pupal recovery, pupal weight, adult emergence, adult flying ability, sex ratio, fecundity egg hatch and were compared with diet-I (Control).

MATERIAL AND METHODS

The studies on dietary effect of semi-synthetic fruit-based diets on biology of melon fruit fly, *Zeugodacus cucurbitae* was conducted during 2020-21 at Insectary, Department of Entomology, S.V. Agricultural College, Tirupati, Andhra Pradesh. Diets were evaluated based on pupal recovery, larval duration, pupal weight, adult emergence, active fliers, fecundity and egg hatch.

Raising and maintenance of melon fruit fly culture

Melon fly culture was raised by collecting infested fruits from farmers' field and horticulture garden of S.V. Agricultural College, Tirupati. Infested bitter gourd fruits were brought to the laboratory and were kept at controlled conditions (25-27°C, 65-75% RH) in 8"×6" glass jars provided with 5 cm thick sterilized sand for pupation. The fully-grown larvae pop out from the fruit for pupation

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into soil. Male and female pupae were collected and transferred to adult rearing cages (30×30×30cm) provided with a mixture of sugar and yeast hydrolysate (3:1) as adult food and water-soaked cotton swabs in 100 ml conical flask as source of water. Male and female pupae were differentiated by observing the colour, size, and shape of pupa. Male pupae were dark brown, round, spherical with blunt tip at posterior region. Whereas, female pupae were light brown in colour, elongated with tapering or pointed at posterior end and larger in size than male pupa. After pre-oviposition period of 12 days, equal number of males and females of same age were confined to ovipositional cages. Petri dishes containing semi solid pumpkin fruit substrate covered by a thin parafilm were provided as oviopositional substrate to the females to collect the eggs required for the experiment. Cages were cleaned and replaced with adult food and water as and when necessary.

Diet formulation and rearing system

The diets were formulated using pumpkin fruit (*Cucurbita moschata*), protein source (yeast extract and brewer's yeast), fatty acid (wheat germ oil), sucrose and antimicrobial agents (sodium benzoate and methyl paraben) as basic ingredients obtained from HiMedia Laboratories. Seven SSFDs were formed with different quantities of protein (7.5, 10.0, 15.0 & 20.0 g), sucrose (7.0 & 10.0 g) and wheat germ oil (2.0 ml) as given in Table 1. The effectiveness of all the diets were assessed by recording the life history parameters of melon fly reared as larvae and compared with artificial liquid diet (Panduranga *et al.,* 2018). Sliced pieces of well refined pumpkin fruit (*Cucurbita moschata*) were grinded in an electric mixture. Remaining ingredients were added into semi-solid pumpkin fruit substrate and the entire mixture was again blended till it forms homogeneous mixture. Ingredients of all the seven semi-synthetic fruit based diets are given in the table 1. Collected eggs were inoculated at the rate of 500 eggs per 250 g of SSFD in a stainless-steel tray (25×20×2.5 cm). Diet trays inoculated with eggs were kept in plastic container (60×40×7.5 cm) provided with 5-6 cm thickness of sterilized sand. These containers were covered with black coloured muslin cloth secured by rubber band. Each diet was replicated thrice.

Recording of biological parameters

Larval duration: Larval duration (days) was arrived based on the period between egg hatch and initiation of pop out of maggots from each larval diet.

Pupal recovery: Pupal recovery is the number of pupae produced out of total number of eggs inoculated.

Pupal recovery (%) =

$$\frac{\text{Number of pupae harvested}}{\text{Initial number of eggs inoculated}} \times 100$$

Pupal weight: For each larval diet, pupal weight was measured by taking the weight of 100 pupae (2-days old) from daily collection and expressed as gram/100 pupae.

Adult emergence: 100 pupae from each diet were taken in glass Petri dish and were kept in adult rearing cage provided with adult food and water. After complete ceasing of adult emergence, number of adults emerged out of 100 pupae were worked out.

Adult emergence (%) =

$$\frac{\text{Number of adult emerged}}{\text{Initial number of pupae kept for test}} \times 100$$

Adult flying ability: Sample of 100 pupae from each diet were randomly selected and placed in a glass Petri dish. A tube of black PVC pipe (20 cm in length and 8.5 cm in diameter) coated with talcum powder was placed over the Petri dish. An entire set up was kept in adult rearing cages for fly emergence. The flies emerged and flewed out of PVC pipe were recorded daily. When emergence was ceased, the remaining flies inside the tubes were counted and adult flying ability was calculated by the number of flies that flew through pipe out of the total number of pupae kept for adult emergence.

Adult flying ability (%) =

$$\frac{\text{No. of adult flew out of 20 cm height pipe}}{\text{Total No. of pupa kept for emergence}} \times 100$$

Sex ratio: It is the ratio of number of females to number of males emerged out of pupae kept for emergence test.

Fecundity: Twenty pairs of freshly emerged male and female flies of same age were confined to ovipositional cages provided with adult diet (3:1 ratio of sugar and yeast hydrolysate) and water. After the pre-oviposition period of 12 days, Petri dishes containing semi-solid pumpkin fruit substrate covered with paraffin membrane were provided as egging devices for collection of eggs. Egg production was recorded for each cage for seven

consecutive days. Fecundity was expressed as a number of eggs per female.

Egg Hatch: Three sets of 100 eggs were collected from each diet and inoculated on to the moistened black coloured cotton muslin cloth held in Petri dishes. Number of hatched and unhatched eggs was worked out after 4-days of inoculation.

$$\text{Egg hatch (\%)} = \frac{\text{No. of egg hatched}}{\text{Total no. of eggs inoculated}} \times 100$$

Statistical analysis

Data collected on biological parameters of melon fly reared as larvae on semi-synthetic fruit-based diets were subjected to ANOVA using and mean of three replications for each parameter were separated by using DMRT analysis ($\alpha = 0.05$).

RESULTS AND DISCUSSION

Biological parameters *viz.,* larval duration (days), pupal recovery (%), pupal weight (g/100pupae), adult emergence (%), adult flying ability (%), sex ratio(females/males), fecundity (no. of eggs/female) and F1 egg hatch (%) of melon fly reared as larvae on artificial liquid diet and semi-synthetic fruit-based diets (SSFD) are presented in table 2.

Pupal recovery and pupal weight

Statically significant and higher pupal recovery (77.8%) was recorded in SSFD-IV composed of 7.5 g of yeast extract, 7.0 g of sucrose and 2.0 ml of WGO with pupal weight of 1.61 g per 100 pupae followed by SSFD -III and SSFD -VII with pupal recovery of 75.76 and 74.67 per cent and pupal weight of 1.60 and 1.58 g respectively. In comparison to diet I (control); SSFD –V, SSFD -VI and SSFD -II diets were recorded with lowest pupal recovery (73.67, 73.35 and 68.45%) with pupal weight of 1.55, 1.52 and 0.82 g, respectively which are inferior over the control diet.

Larval duration

Maggots of melon fly able to complete its larval stage in 6.90 days on SSFD -IV followed by SSFD -III and SSFD -VII with 6.50 and 7.77 days, respectively. While, relatively longer larval duration (8.32 days) was recorded in SSFD -V followed by control diet-I, SSFD -II and SSFD -VI with 7.60, 7.56 and 7.21 days, respectively which were statistically on par.

Adult emergence and adult flying ability

Semi-synthetic fruit-based diet-IV (SSFD-IV) showed significantly higher suitability for melon fly with high percentages of adult emergence (81.8%) and adult flying ability (75.87%) compared to diet-I (control). Diets; SSFD-III and SSFD-VII are next best diets with 80.2 and 78.1 per cent of adult emergence with flying ability of 74.23 and 73.43 per cent, respectively which were statistically on par. Semi-synthetic fruit-based diet-V, V I and II were found inferior with lower adult emergence (72.3, 70.37 and 68.72%) and least adult fliers (71.87, 69.2 and 55.9%) compared to control diet I (75.23 and 72.56%, respectively).

Sex ratio

There is no significant difference with respect to sex ratio (female to male) among the fruit-based diets ranging from 1.17 to 1.23.

Fecundity and egg hatch

Significantly higher egg production (28.0 eggs/female) was recorded in SSFD-IV with 71.81 per cent of egg hatch. Egg production of females reared on SSFD-III, SSFD-VII and control diet-I are ranging from 26.82 to 23.12 eggs/female with egg hatchability of 68.45 to 64.23 per cent. Lowest fecundity was recorded in SSFD-II (17.92 eggs/female), SSFD-VI (21.42 eggs/female) and SSFD-V (22.37 eggs/female) with egg hatchability of 46.62, 56.74 and 60.22 per cent, respectively.

Pupal weight is the key quality parameter and significant indicator of overall viability of pupae (Sharp *et al.,* 1983). Pupal recovery and pupal weight were significantly increased with addition of protein, sucrose and WGO to semi-synthetic fruit-based diet. When compared to diet-I (control), SSFD-IV with equal concentration of protein (7.5 g of yeast extract and brewer's yeast), sucrose (7.0 g) and WGO (2.0 ml) was found superior with significantly higher pupal recovery and pupal weight over the remaining diets. Next best diets are SSFD-III (15.0 g yeast extract, 7.0 g sugar and 2.0 ml WGO) and SSFD-VII (10.0 g brewer's yeast, 10.0 g yeast extract, 10.0 g sugar and 2 ml (WGO).

Yeast extract and brewer's yeast are the products of *Saccharomyces cerevisiae* used as protein source in

Table 1. Composition of experimental diets for mass rearing of *Z. cucurbitae*

Diet Ingredients	Diet-I (Control)	Diet-II (SSFD-II)	Diet-III (SSFD-III)	Diet-IV (SSFD-IV)	Diet-V (SSFD-V)	Diet-VI (SSFD-VI)	Diet-VII (SSFD-VII)
Methyl paraben (g)	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sorbic acid (g)	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Yeast extract (g)	15.0		15.0	7.5	-	20.0	10.0
Brewer's yeast (g)	-	15.0		7.5	20.0		10.0
Sugar (g)	-	7.0	7.0	7.0	10.0	10.0	10.0
Wheat germ oil (ml)	-	0.2	0.2	0.2	0.2	0.2	0.2
Pumpkin fruit (g)	1000	1000	1000	1000	1000	1000	1000

SSFD : Semi synthetic fruit based diet

Table 2. Life history parameters of melon fly, *Zeugodacus cucurbitae* reared as larvae on fruit-based diets

Parameters	Diet I (Control)	Diet-II (SSFD-II)	Diet-III (SSFD-III)	Diet-IV (SSFD-IV)	Diet-V (SSFD-V)	Diet-VI (SSFD-VI)	Diet-VII (SSFD-VII)
Pupal recovery (%)*	72.32^{b} (58.27)	68.45^{c} (55.83)	75.76^{ab} (60.52)	77.8^{a} (61.90)	73.67^{b} (59.14)	73.35^{b} (58.93)	74.67^{ab} (59.79)
Pupal weight (g)**	1.57^{a} (1.60)	0.82^{b} (1.35)	1.60^{a} (1.61)	1.61^{a} (1.61)	1.55^{a} (1.60)	1.52^{a} (1.59)	1.58^{a} (1.61)
Larval duration (days)**	7.60^{b} (2.92)	7.56^{b} (2.91)	6.50^{a} (2.72)	6.90^{b} (2.80)	8.32^{ab} (3.04)	7.21^{b} (2.85)	7.77^{a} (2.95)
Adult emergence (%)*	75.23^{cd} (60.16)	68.72^{f} (56.00)	80.2^{ab} (63.60)	81.8^{a} (64.77)	72.3^{d} (58.25)	70.37^{ef} (57.03)	78.1^{bc} (62.11)
Sex ratio (f/m)**	1.19^{a} (1.48)	1.17^{a} (1.47)	1.21^{a} (1.49)	1.23^{a} (1.49)	1.18^{a} (1.48)	1.18^{a} (1.48)	1.20^{a} (1.48)
Adult fliers (%)*	72.56^{abc} (58.42)	55.9^{d} (48.39)	74.23^{ab} (59.50)	75.87^{a} (60.59)	71.87^{bc} (57.98)	69.2^{c} (56.30)	73.43^{ab} (58.92)
Fecundity*** (eggs/female)	23.12^{bc} (1.38)	17.92^{d} (1.28)	26.82^{ab} (1.44)	28.00^{a} (1.46)	22.37^{c} (1.37)	21.42^{c} (1.35)	24.71^{abc} (1.41)
F1 Egg hatch* (%)	64.23^{c} (53.27)	46.62^{e} (43.06)	68.45^{b} (55.83)	71.81^{a} (57.94)	60.22^{d} (50.90)	56.74^{d} (48.88)	66.72^{bc} (54.77)

Within a row, means followed by the same letter are not significantly different (á = 0.05; DMRT). Figures in the parentheses are retransformed values (*Arc sign transformation; **Square root transformation; ***Logarithmic transformation), SSFD : Semi synthetic fruit based diet.

various diets for mass culturing of organisms. They are rich source of amino acids, proteins, vitamins and growth factors which are essential components of nutritional diets. Yeast extract is composed of 50 per cent of protein (20% glutathione), 18 amino acids, 0.5 per cent of vitamin-B complexes and 3.1 per cent of minerals. Yee (2010) reported the role of yeast extract in enhancing fecundity and survivability of western cherry fruit fly. Brewer's yeast is essential dietary component for many fruit flies, composed of 24.80 g of amino acids (includes essential amino acids (20.76 g) and non-essential amino acids (4.0 g)), vitamins (501.89 mg) and minerals (24.35 mg) in 100 g of brewer's yeast. Chang *et al*. (2004) reported the significant improvement of life history parameters of melon fly reared on brewer's yeast supplemented diets. Significant positive effects of Brewer's yeast (17.77 g) was observed in larval liquid diet with respect to pupal recovery, pupal weight, adult emergence, adult flying ability, fecundity and fertility of melon fly.

Wheat germ oil (WGO) is a rich source of fatty acid responsible for enhancement of quality of flies. Nutritional composition of WGO was reported by Kahlon (1989) that WGO is composed of linolenic acid (42-59%), oleic acid (12-28%), palmitic acid (11-19%), α-linolenic acid (2-11%), stearic acid (1%) and vitamin E (0.14%). Fraenkel and Blewett (1946) reported the role of linoleic acid and vitamin E of wheat germ oil in enhancing emergence, growth and wing scales development. Coudron *et al.* (2010) reported the significant influence of WGO on expression of various genes encoding for range of proteins and lipids. Chang *et al*. (2006) reported the substantial improvement of flying ability, fecundity and fertility with unsaturated fatty acids (linolenic acid and oleic acid); pupal recovery and flying ability with saturated fatty acid (Palmitic acid) in med fly.

Non-significant differences was noticed with respect to larval duration though melon fly completes their larval stage early on semi-synthetic fruit-based diets with higher concentrations of protein, sucrose and WGO (SSFD-V, VII and II) compared to the diets with lower concentrations (SSFD-IV and III). The larvae of *C. capitata* fed with artificial host fruit containing protein and sugar was heavier with faster development (Kapsi *et al.,* 2002). Nestel and Nemny-Lavy (2007) reported the reduced larval period of *C. capitata* on the diet with increased protein concentration.

Performance of Semi-synthetic fruit-based diet on adult emergence and adult fliers was enhanced through increased addition of protein, sucrose and wheat germ oil into the diet. SSFD-IV with 7.5 g of yeast extract, 7.5 g of brewer's yeast, 7.0 g of sucrose and 2.0 ml of WGO performed superior with higher adult emergence and active fliers followed by SSFD-III and SSFD-VII over the liquid diet (Control). Semi-synthetic fruit-based diets with lower concentration of protein, sucrose and WGO (SSFD-II, V and VII) were found inferior than control diet. Fraenkel and Blewett (1946) for the first time reported the nutritional impact of WGO on adult emergence, growth and wing development. Panduranga *et al.* (2018) reported the increased performance of larval diet with higher adult emergence and adult fliers of melon fly by the addition of brewer's yeast, sucrose and WGO to diet. Satisfactory adult emergence of *C. capitata* was recorded in diets with higher brewer's yeast and sucrose. Higher adult emergence was recorded in diet with higher proportion of WGO and sucrose.

Males and females have equal chances to produce but due to their differential nutritional requirement, some diets may favour metamorphosis of one sex than others (Khan, 2013). Negative correlation between male proportion and sugar content was reported by Vera *et al.* (2014). Similarly, Panduranga *et al.* (2018) reported the higher male production from the diet with reduced sugar content. Shinwari *et al.* (2015) reported the significantly higher male from the tarula yeast-based diet.

Adult survival is mainly depending on amount of food accumulated during larval period. Larvae fed on diet with higher nutritional quality was able to accumulate more protein and fatty acid which helps to survive under food stress, which reflects the nutritional status of the diet. Melon flies reared on SSFD with higher nutritional level has the significantly higher percentages of survival. Similar findings were reported by Nestel and Nemny-Lavy (2007) that the med fly larvae reared on diet with increased brewer's yeast to sucrose ratio resulted in increased ability of larvae to accumulate the protein, lipid and produced pupae with higher pupal weight. Whereas, the diet with decreased brewer's yeast to sucrose ratio resulted in decreased ability of larvae to accumulate the protein, lipid with lower pupal weight.

For higher fecundity and egg hatchability, females and males must be of quality flies and reach their maturity in time for coupling. Maturity of flies is significantly

depending on nutritional quality of larval diet. Fecundity and fertility of melon fly showed positive relationship with increase of protein, sucrose and WGO in diet which was significantly higher in SSFD-III followed by SSFD-II and SSFD-V. The present result was supported by Ashraf *et al.* (1978) who reported the increased rates of fecundity and fertility of oriental fruit fly on sugarcane bagasse diet with increased wheat germ. Vargas and Mitchell (1987) found that the *Dacus latifrons* reared on wheat based larval diet resulted in high fecundity and fertility. Vargas *et al.* (1994) reported the significantly higher fecundity and egg hatch by increasing wheat germ oil concentration to 3 per cent with constant yeast and sucrose. Similar findings were reported by Panduranga *et al.* (2018) that addition of wheat germ oil has increased the adult emergence, adult fliers, fecundity and egg hatchability in *B. cucurbitae.*

An effective diet can be developed for mass production of quality flies by using natural host fruits externally supplied with protein, carbohydrates and fatty acids to meet the nutritional requirement of fly. Finney (1956) a pioneer in development of fresh and fortified carrot diet supplied with brewer's yeast as source of protein for rearing of oriental fruit fly, *Dacus darsalis* and reported 80 per cent of egg hatch and matured maggots, 95 per cent of pupal recovery and adult emergence. Similarly, Abadin *et al.* (2014) reported the reduced larval duration, higher pupal recovery, adult emergence, egg viability and egg hatchability of *B. cucurbitae* reared on natural host fruit (bottle gourd) without any supplements of protein and fatty acids.

Panduranga *et al.* (2018) reported the increased pupal recovery (83.20%) and pupal weight (1.34 g) of *B. cucurbitae* larvae reared on fruit-based diet supplied with yeast extract (15.0 g). Present findings are supported by Kirti *et al.* (2018) that melon fly reared as larvae on fruit-based diet composed of 15 g of yeast extract resulted in significantly higher pupal recovery (80.93%), pupal weight (1.41 g), adult emergence (69.00%), adult flying ability (74.36%), fecundity (15.84 eggs/female) and fertility (65.3%). Therefore, supplement of nutritional elements *viz.,* protein, sugar and fatty acid in fruit-based diet in adequate quantity is crucial to produce good quality flies.

Based on performance of melon fly reared as larvae on semi-synthetic fruit-based diets with differential concentration of protein, sucrose and WGO revealed that, the SSFD-IV with 7.5 g of yeast extract, 7.0 g of sucrose and 2.0 ml of WGO was the most suitable diet for mass rearing of melon fly followed by SSFD-III with 15.0 g of yeast extract, 7.0 g of sucrose and 2.0 ml of WGO followed by SSFD-VII with 10.0 g of yeast extract, 10.0 g of brewer's yeast, 10.0 g of sucrose and 2.0 ml of WGO which were statistically on par with respect to quality standards recommended by FAO/IAEA/USDA for sterile insect technique.

CONCLUSION

Semi-synthetic fruit based diet-IV (SSFD-IV) composed of 7.5 g of yeast extract (protein source), 7.0 g of sucrose (carbohydrate source) and 2.0 ml of WGO (fatty acid source) is the most appropriate diet as it fulfilled the quality standards for sterile insect technique recommended by FAO/IAEA/USDA. Hence, it is concluded that SSFD-IV as suitable larval medium for mass rearing of melon fly larvae to produce enough pupae required for irradiation in support of sterile insect technique.

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PROFILE OF CLUSTER FRONT LINE DEMONSTRATIONS (CFLDs) BENEFICIARY AND NON-BENEFICIARY FARMERS IN CHITTOOR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The present study was carried out to know the profile of CFLDs beneficiary and non-beneficiary farmers in Chittoor district of Andhra Pradesh over a randomly drawn sample of 120 respondents. The results revealed that majority of the CFLDs beneficiary farmers were in middle age (58.33%), completed high school education (35.00%), small farmers (46.67%), medium level of farming experience (70.00%), medium training undergone (66.67%), had medium level of extension contact (60.00%), medium level of mass media exposure (50.00%), medium social participation (60.00%), medium level of innovativeness (65.00%), high level of scientific orientation (41.67%), high management orientation (50.00%), medium level of economic orientation (65.00%), medium level of risk orientation (63.33%) and medium level of achievement motivation (63.33%). Whereas in case of CFLDs non-beneficiary farmers majority were in middle age (50.00%), completed primary school education (26.67%), marginal farmers (50.00%), medium level of farming experience (60.00%), low training undergone (43.33%), had medium level of extension contact (43.33%), low level of mass media exposure (45.00%), low social participation(63.33%), medium level of innovativeness (50.00%), low level of scientific orientation (40.00%), medium management orientation(41.67%), medium level of economic orientation (53.33%), medium risk orientation (56.67%) and medium level of achievement motivation (50.00%)

KEYWORDS: Profile, Cluster Front Line demonstrations (CFLDs), beneficiary and non-beneficiary farmers.

INTRODUCTION

Krishi Vigyan Kendra, a district level front-line extension system, plays a critical role in technology assessment and refinement and conduct large scale demonstrations on successful technologies to convince the farming community and increase adoption. In order to enlarge the production and productivity of oilseed crops in the country, Ministry of Agriculture and Farmers' Welfare, Government of India sanctioned a project on "Cluster Frontline Demonstrations of Oilseeds in 2017-18" under National Mission on Oilseeds and Oil Palm (NMOOP) implemented through eleven ICAR-Agricultural Technology Application Research Institutes (ATARI) all over India. KVKs were assigned to conduct Cluster Front Line Demonstrations (CFLD's) under NFSM, for demonstrating the production potential of newly released technologies on the farmer's fields at different locations in a given farming system and organize farming and extension activities for farmer and extension workers for diffusion of various technologies. They are conducted under the supervision of scientists of Krishi Vigyan Kendras, SAUs, and Regional Agricultural Research Stations.

MATERIAL AND METHODS

The study was conducted by following *Ex post facto* research design to assess the profile of CFLDs beneficiaries as well as non-beneficiaries in Chittoor district of Andhra Pradesh. Two KVKs operating in chittoor district were selected purposively for the study. Out of 66 mandals in Chittoor district, two mandals adopted by each KVK were selected purposively for the study. From each of the selected mandals three villages were selected by purposive sampling technique, thus making a total of six villages. From each of the selected villages, ten CFLD beneficiary and ten non-beneficiary farmers were selected by following simple random sampling procedure, thus making a total of 120 respondents. After going through review of literature and consultation with experts as set of 14 personal, psychological and socio-economic variables were selected. The data was collected through a structured comprehensive interview schedule and analyzed using mean standard deviation, frequencies and percentages for drawing meaningful interpretations.

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RESULTS AND DISCUSSION

The beneficiaries and non-beneficiaries farmers of CFLDs were distributed into different categories based on their selected profile characteristics and the results were presented in the table 1.

Age

More than half (58.33%) of the CFLDs beneficiary farmers were middle aged followed by old age (26.67%) and young age (15.00%) groups. Whereas in case of CFLDs non-beneficiary farmers half (50.00%) were middle aged followed by old (30.00%) and young age (20.00%) groups. From above findings it is clear that the majority of CFLDs beneficiary farmers as well as non-beneficiaries were in the middle age groups. The probable reasons might be that young farmers showed less interest in farming and they are more interested in non-agricultural pursuits, while older farmers were moving away from farming and given their land holdings for lease to other farmers. This finding was similar to the findings of Borole (2010) and Babu (2016)

Education

More than one-third (35.00%) of the CFLDs beneficiary farmers were educated up to high school followed by middle school (28.33%), graduate (13.33%), primary school (10.00%), illiterate (6.67%), can read and write (5.00%), and can read only (1.67%). Whereas, in case of CFLDs non-beneficiary farmers 26.67 per cent were educated up to primary school level, followed by middle school (23.33%), high school (20.00%), illiterate (16.67%), can read and write (8.33%), graduate (3.33%) and can read only (1.67%). This might be because majority of the CFLDs beneficiary farmers as well as CFLD non-beneficiary farmers were literates having education from primary school to graduation.It is a universal truth that education is critical in moulding and bringing about desired changes in human behavior. Educated farmers had better access to all types of communication media and had more information seeking tendencies. Because most of the farmers were educated, they were able to learn about new agriculture technologies and modern methods and the messages sent by KVK scientists are well utilized by the beneficiaries. These findings are in tune with findings of Padmaiah *et al.* (2014) and yadav (2016).

Farm size

Nearly half (46.67 %) of the CFLDs beneficiary farmers possess small land holding followed by 20.00 per cent possess marginal land holding, 18.33 per cent possess semi-medium land holding, 11.67 per cent possess medium land holding and very few 3.33 per cent possess large holding. Whereas, in case of CFLDs non-beneficiary farmers half of them possess (50.00%) marginal land holding followed by 23.33 per cent possess small land holding, 16.67 per cent semi-medium land holding, 8.33 per cent possess medium land holding and very few 1.67 per cent possess large land holding. The possible reason might be due to the fact that majority of the farmers in Chittoor district fall under small and marginal land holding category.Hence above trend was noticed. This finding was in conformity with the findings of Kalyan (2011), Badhala (2012) and Yashashwini (2013).

Farming experience

Majority (70.00%) of CFLDs beneficiary farmers had medium level of farming experience followed by low (20.00%) and high (10.00%) levels of farming experience. Whereas, CFLDs non-beneficiary farmers more than half (60.00%) had medium level of farming experience followed by low (26.67%) and high (13.33%) levels of farming experience. This might be due to the fact that majority of them belonged to middle age followed by old age group. Younger generation has not chosen farming as a profession and it was continued by their parents only. Many farmers were engaged in agriculture after their education. Hence most of the CFLDs beneficiary farmers had medium farming experience. This result was in accordance with the results of Vohra (2016) and Deshmukh *et al* (2018).

Training Undergone

Majority (66.67 %) of the CFLDs beneficiary farmers had medium level of training followed by high (25.00%) and low (8.33%) levels of training. Whereas in case of CFLDs non-beneficiary farmers two-fifth (43.33%) had low level of training followed by medium (40.00%) and high (16.67%) levels of training. The probable reason might be due to the fact that during the demonstration season, KVKs provide seed to seed training programs to CFLD beneficiary farmers, assured that they acquired a thorough understanding of the production technology. Few farmers regularly attended KVK training programs because inputs were delivered under CFLDs and

Table 1. Distribution of CFLDs beneficiary and non-beneficiary farmers

S. No.	Variables	Category	CFLDs beneficiary farmers (n = 60)		CFLDS non-beneficiary farmers (n = 60)	
			Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
1.	Age	Young age (<35 years)	9	15.00	12	20.00
		Middle age (36-55 years)	35	58.33	30	50.00
		Old age (>56 years)	16	26.67	18	30.00
		Mean		-		-
		S.D		-		-
2.	Education	Illiterate	4	6.67	10	16.67
		Can read only	1	1.67	1	1.67
		Can read and write	3	5.00	5	8.33
		Primary school	6	10.00	16	26.67
		Middle school	17	28.33	14	23.33
		High school	21	35.00	12	20.00
		Graduate	8	13.33	2	3.33
		Mean		-		-
		S.D		-		-
3.	Farm Size	Marginal land holding	12	20.00	30	50.00
		Small land holding	28	46.67	14	23.33
		Semi-medium land holding	11	18.33	10	16.67
		Medium land holding	7	11.67	5	8.33
		Large land holding	2	3.33	1	1.67
		Mean		-		-
		S.D		-		-
4.	Farming Experience	Low	12	20.00	16	26.67
		Medium	42	70.00	36	60.00
		High	6	10.00	8	13.33
		Mean		20.47		16.8
		S.D		7.16		5.4
5.	Training Undergone	Low	5	8.33	26	43.33
		Medium	40	66.67	24	40.00
		High	15	25.00	10	16.67
		Mean		3.70		1.00
		SD		1.48		0.90
6.	Extension Contact	Low	8	13.33	24	40.00
		Medium	36	60.00	26	43.33
		High	16	26.67	10	16.67
		Mean		31.10		20.2
		S.D		5.17		5.3
7.	Mass Media Exposure	Low	14	23.33	27	45.00
		Medium	30	50.00	22	36.67
		High	16	26.67	11	18.33
		Mean		10.07		8.8
		S.D		1.89		2.0
8.	Social Participation	Low	14	23.33	38	63.33
		Medium	36	60.00	21	35.00
		High	10	16.67	1	1.67
		Mean		2.00		1.2
		S.D		1.01		1.1
9.	Innovativeness	Low	3	5.00	21	35.00
		Medium	39	65.00	30	50.00
		High	18	30.00	9	15.00
		Mean		36.57		26.8
		S.D		2.75		7.0

Cont...

Table 1. Cont...

S. No.	Variables	Category	CFLDs beneficiary farmers (n = 60)		CFLDS non-beneficiary farmers (n = 60)	
			Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
11.	Scientific Orientation	Low	14	23.33	24	40.00
		Medium	21	35.00	23	38.33
		High	25	41.67	13	21.67
		Mean	25.63		19.8	
		S.D	2.00		2.8	
12.	Management Orientation	Low	10	16.67	23	38.33
		Medium	20	33.33	25	41.67
		High	30	50.00	12	20.00
		Mean	73.13		64.3	
		S.D	6.25		4.3	
13.	Economic Orientation	Low	7	11.67	21	35.00
		Medium	39	65.00	32	53.33
		High	14	23.33	7	11.67
		Mean	20.30		16.5	
		S.D	2.95		2.5	
14.	Risk Orientation	Low	6	10.00	22	36.67
		Medium	38	63.33	34	56.67
		High	16	26.67	4	6.66
		Mean	20.50		17.5	
		S.D	3.81		2.1	
15.	Achievement Motivation	Low	4	6.67	22	36.67
		Medium	38	63.33	30	50
		High	18	30	8	13.33
		Mean	26.83		19.9	
		S.D	2.33		2.0	

supervised by KVK employees. As a result, majority of the beneficiary farmers belonged to medium to high training undergone categories. Similar findings were observed with the findings of Vishwakarma (2016).

Extension contact

About 60.00 per cent of the CFLDs beneficiary farmers had medium extension contact followed by high (26.67%) and low (13.33%) levels of extension contact. Regarding CFLDs non-beneficiary farmers (43.33%) had medium extension contact followed by low (40.00%) and high (16.67%) levels of extension contact. The feasible reason for this may be that most of CFLDs beneficiary farmers had frequent contact with KVK scientists for the implementation of the CFLDs. Farmers sought timely extension assistance from KVK scientists for their day-to-day farm operations in order to improve productivity using CFLDs. In case of non-beneficiary farmers they don't have much contact with the KVK scientists and others for accepting new technologies. As a result, this pattern was found with similar findings of Dhaneswar (2008).

Mass media exposure

About half (50.00%)of the CFLDs beneficiary farmers had medium level of mass media exposure followed by high (26.67%) and low (23.33%) levels of mass media exposure. Regarding CFLDs non-beneficiary farmers more than two-fifth (45.00%) had low level of mass media exposure followed by medium (36.67%) and high (18.33%) levels of mass media exposure This might be because CFLDs beneficiary farmers had more frequent contact with department officials or extension functionaries, and the intrinsic incentive elicited by these officials or

functionaries could have exposed them to various mass media channels, to obtain up-to-date information on new technologies than CFLDs non-beneficiary farmers. But in case of non-beneficiary farmers they did not receive any message from KVKs as they are not having contact with extension personnel's. Hence the above trend was noticed. This finding had drawn its support from the findings of Sharma *et al.* (2015).

Social participation

Majority (60.00 %) of the CFLDs beneficiary farmers had medium level of social participation followed by low (23.33%) and high (16.67%) levels of social participation. whereas in case of non-beneficiary farmers more than three-fifth (63.33%) had low level of social participation followed by medium (35.00%) and high (1.67%) levels of social participation. This might be that beneficiary farmers were more interested in engaging in many village activities because they were educated up to high school and KVK officials might have selected farmers who were members of various social organizations as they would have more exposure to various sources of information and influence on the fellow farmers. On the other hand, non-beneficiaries had a low level of social participation since they are marginal farmers with low economic status and poor education background, so they were not involved in engaging in social activities. This result was consistent with previous research of Kumar (2006).

Innovativeness

Majority (65.00%) of the CFLDs beneficiary farmers had medium level of innovativeness followed by (30.00%) high and (5.00%) low levels of innovativeness. Whereas in case of CFLDs non-beneficiary farmers half (50.00%) had medium level of innovativeness followed by (35.00%) low and (15.00%) high levels of innovativeness. The above pattern may be due to the fact that CFLDs tend to increase farmers' capacity to test new technologies or innovations in their own fields and evaluate findings and their relevance to specific circumstances. It assists farmers in learning new and creative cultivation technologies. The demonstrations, field days and other activities conducted by KVKs about new technologies, the farmers tried to gain a better understanding of the different practices in order to know the benefits and drawbacks before implementing them. These results were in confirmation with the findings of Gajanan (2019).

Scientific orientation

Nearly 41.67 per cent of the CFLDs beneficiary farmers had high level of scientific orientation followed by medium (35.00%) and low (23.33%) levels of scientific orientation. Regarding CFLDs non-beneficiary farmers 40.00 per cent had low level of scientific orientation followed by medium (38.33%) and high (21.67%) levels of scientific orientation. The possible reason might be that majority of CFLDs beneficiary farmers were found to be educated and had higher percentage of scientific orientation which is a positive sign and spoke on the interest of farmers to perceive things scientifically. Whereas in case of CFLDs non-beneficiary farmers most of the farmers were less educated and have low innovativeness they don't show much interest in the scientific technologies. The findings support the findings of Bapu (2017).

Management orientation

About half (50.00%) of CFLDs beneficiary farmers had high management orientation followed by medium (33.33%) and low (16.67%) levels of management orientation. Regarding non-beneficiary farmers more than two-fifth (41.67%) had medium management orientation followed by low (38.33%) and high (20.00%) levels of management orientation. The probable reason might be that the majority of CFLD's beneficiary farmers possess managerial skills, allowing them to effectively manage resources and produce the desired output of an activity. But non-beneficiary farmers face a difficult task in maximizing resource utilization in order to achieve their objectives because they lack proper guidance. The training programmes organized by KVKs have sensitized the farmers on resource conservation technologies which in turn developed maximum output from minimum resources than the non-beneficiary farmers. The results are in line with the findings of Siddeswari (2015).

Economic orientation

Majority (65.00%) of CFLDs beneficiary farmers had medium economic orientation followed by high (23.33%) and low (11.67%) levels of economic orientation. Whereas in case of non-beneficiary farmers more than two-fourth had (53.33%) medium level of economic orientation and low (35.00%) and high (11.67%) levels of economic orientation. The feasible reason might be that CFLDs were conducted under close supervision of scientists and it strengthens the capacity

of farmers to examine their production systems, identify their main constraints and come up with the best feasible solutions. By adding their own knowledge to existing information, farmers eventually identify and implement the most appropriate practices and technologies to their farming system and needs to become more productive, profitable and responsive to changing conditions.. Hence majority of CFLDs beneficiary farmers had medium to high economic orientation than non-beneficiary farmers. This result was in consistent with the findings of Sharma *et al.* (2015).

Risk orientation

Majority (63.33%) of the CFLDs beneficiary farmers had medium level of risk orientation followed by high (26.67 %) and low (10.00%) levels of risk orientation. Whereas in case of non-beneficiary farmers more than two-fourth (56.67 %) had medium level of risk orientation followed by low (36.67%) and high (06.66%) levels of risk orientation.This pattern of results may be attributed to the fact that in the case of CFLDs beneficiary farmers, the risk will be medium to high because they have medium innovativeness and show some anxiety in implementing new technologies, so the risk will be medium to high. Capacity building programmes organized by KVK had improved the risk orientation attribute of CFLDs beneficiary farmers with this motivation the CFLDs came forward to adopt new technologies of KVK in their farm hence, above trend was noticed. Non-beneficiary farmers, on the other hand, were mostly marginal farmers with low innovation, so they aren't interested in introducing new technologies and the risk is low for them. The results are backed up by the findings of Patel (2009).

Achievement Motivation

Majority (63.33%) of the CFLDs beneficiary farmers had medium level of achievement motivation followed by high (30.00%) and low (6.67%) levels of achievement motivation. In case of non-beneficiary farmers half (50.00%) had medium level of achievement motivation followed by low (36.67%) and high (13.33%) levels of achievement motivation. This might be that achievement motivation compels people to move ahead and accomplish their goals by emotionally motivating them to act on their active needs. Farmers' inner motivation to meet their objectives and goals may have increased as a result of their involvement in CFLDs. As a result, the pattern described above was observed. The results are in line with the research done by Siddeswari (2015).

CONCLUSION

The results revealed that majority of the CFLDs beneficiary farmers belonged to medium to high level of profile characteristics. Regarding non-beneficiary farmers majority belonged to low to medium level category with respect to most of the variables selected, hence there is immediate need to promote CFLDs in non-beneficiary farmers , focusing more on need of the CFLDs scheme by showing its distinctly superior results through demonstrations, organizing large scale field days in the fields of beneficiary farmers to orient them towards adoption of new technologies.

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Research Note

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INTEGRATED DISEASE MANAGEMENT (IDM) OF *TOBACCO STREAK VIRUS* IN GROUNDNUT

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Tobacco streak virus (TSV) is the type member of Ilarvirus genus in the family *Bromoviridae* (Fauquet *et al.,* 2005). The genus Ilarvirus is one of the six genera included in the family *Bromoviridae* and is the largest genus in the family with more than 15 members and seven or eight subgroups (Hull, 2002). Tobacco streak virus, being a destructive virus of economically important crops, knowledge on disease diagnosis, reliable detection method and characterization plays key role in disease management.

As the TSV transmission is assisted by thrips vector, present emphasis has been given more on management of thrips by using border cropping with sorghum and different insecticides. Continuous use of chemicals led to residual toxicity and health hazards, besides increasing cost of cultivation due to higher input costs. The perusal of literature pertaining to the management of the TSV indicates that very few efforts were made to integrate or combine the available compatible methods of control for efficient management of TSV in groundnut. So, in order to evolve an effective integrated approach for management of TSV in groundnut, the present investigation was undertaken with the integration of different modules or treatments using susceptible groundnut cv. K-6 under field conditions for two consecutive years during *Kharif* seasons (2014-15 and 2015-16) in Randomized Block Design (RBD) at Agricultural Research Station (ARS), Kadiri, Andhra Pradesh.

Sowings were done on the first day of second fortnight of june month during two consecutive kharif seasons. The details of the treatments or modules are given in Table 1.

The net plot size of 5m X 4m was maintained for each treatment with 60 cm distance between rows and 30 cm distance between plants. Seed treatment with imidacloprid 600FS @ 2 ml/Kg was done prior to sowing and all the recommended package of practices was followed and the plots were irrigated whenever necessary. Weeding was done manually twice at 15 and 30 Days After Sowing (DAS). Seeds of sorghum were sown in three rows 15 days prior to groundnut sowing as a border crop with a spacing of 45 X 30 cm around the treatment plots.

In treatments where rouging is one of the components, the TSV infected plants were removed and destroyed as and when observed after recording incidence of TSV. Subsequently next rouging was taken up after 15 days.

The insecticide application was done as per the schedule and dosages mentioned in each treatment, wherein first foliar application of the insecticides was done at 15 DAS followed by the other applications at 30 and 45 DAS using a hand compression sprayer during evening hours. Care was taken to ensure complete drenching of the plants in each treatment and drift avoided.

In each treatment, data on population of thrips incidence of the disease were recorded. The data collected in different observations were statistically analysed and pooled analysis of both the seasons provided as per the design.

The results revealed significant differences among the treatments pertaining to PSND incidence at 7 and 14 days after 1st and 2nd spraying. All treatments were significantly different when compared to control with reference to PSND incidence at 7 and 14 days after 1st

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Table 1. Treatments or modules used to study Integrated Disease Management (IDM) of TSV in groundnut

Treatment or modules	Description
T_1 : Farmer's practice	One foliar spray of Dimethoate @ 1 l/ha at 20 DAS
T_2 : Recommended practice	Border crop with jowar (4 rows) + Seed treatment with Imidacloprid 17.8 SL @ 2 ml/kg seed + M-45 (Indofil) @ 3 g/kg seed. Foliar sprays using Dimethoate @ 1 l/ha at 20 DAS followed by Imidacloprid @ 200 ml/ha at 35 DAS
T_3 : Improved practice	Border crop with Jowar (4 rows) + Seed treatment with Gaucho 600 FS @ 1 ml/kg seed +Raxil @ 1 g/kg seed. Foliar spray using Thiocloprid 480 SC @ 150 ml//ha at 20 DAS followed by Acetamiprid 20 SP @ 100 g/ha at 35 DAS.
T_4 : Bio-Control	Border crop with Jowar (4 rows) + Seed treatment with Trichoderma viride @ 10 g/kg seed + 2 sprays of neem kernel extract (5%) at 20 and 35 DAS.
T_5 : Absolute control	Absolute control

spraying. Lowest (0.2 and 0.3 per cent) PSND incidence was recorded in Treatment 3 (T_3) followed by Treatment 2 (T_2) (0.4 and 0.7 per cent) (Table 2).

Significant differences were observed among the different modules or treatments with respect to thrips damage at 7 and 14 days after 1st and 2nd spraying. Pooled data for both years *Kharif* 2014-15 and *Kharif* 2015-16 revealed that Treatment 3 (T_3) recorded lowest thrips damage per cent of 14.6 and 21.2 at 7 and 14 days after 1nd spraying which was significantly different from other treatments and control. The next best treatment is recommended practice (T_2) with per cent thrips damage of 19.3 and 27.2 per cent at 7 and 14 days after 1st spraying which is significantly different when compared to control (T_5) (Table 2).

Similar attempts were made to develop management strategies against TSV in groundnut and other crops by using various Treatments or modules. Halakeri (2006) reported that the spread of *Tobacco streak virus* could be minimized by spraying Imidacloprid (0.025%). Use of border crops like sorghum reduced the incidence of disease from 18 to 7 per cent. Similarly spray of imidacloprid @ 0.05 per cent at 30 DAS reduced the incidence of disease from 27 to 5 per cent (Mesta *et al.,* 2003). Seed treatment with imidacloprid (5g/kg) + spray (@ 0.25ml/L) at 30, 45 and 60 days after sowing and sorghum as a border crop, by way of reducing the vector movement kept the TSV incidence at low (Halakeri, 2006). Similarly, Mesta *et al*. (2003) reported that use of sorghum border crop reduced the incidence of TSV in sunflower from 18 to 7 per cent and seed treatment and spray of imidacloprid @ 0.05 per cent at 30 DAS reduced disease incidence from 27 to 5 per cent. Besta (2004) reported that, the seed treatment (5 g/kg) with imidacloprid followed by confidor spray (0.5 ml/L) inhibited the disease and increased yield (90.52% and 13.61 q/ha, respectively) as compared to control (40.12 PDI and 5.78 q/ha yield). Shirshikar (2008) revealed that if the sunflower crop is bordered with Sorghum and treated with imidacloprid (Gaucho 70 W.S., 5 g / kg) along with spraying of imidacloprid (Confidor 200 S.L. 005 %) three sprays at 15, 30 and 45 days after sowing, the incidence of sunflower necrosis diseases can be minimized. Shirshikar (2010), reported that sunflower necrosis disease can be managed by treating seeds with Thiamethoxam at 4 g/kg along with two sprays of the chemical at per cent 30 and 45 days after sowing.

No single method can currently provide adequate control of vector transmitted virus diseases. However, integrated management systems using moderately resistant cultivars and suppressive chemicals and cultural practices have been developed and successfully deployed for minimizing losses caused by viruses in various crop plants. Although the impact of management practices developed in the present study is encouraging, the disease continues to pose threat to groundnut production. Concerned efforts in research for identification of resistant sources in germplasm and further incorporation and development of varieties/hybrids must be continued to sustain progress in understanding the factors that contribute to epidemics of the disease and in developing improved strategies for disease management.

Table 2. Effect of different treatments or modules on thrips damage, PSND incidence and yield parameters (Pooled analysis of *Kharif* 2014-15 and *Kharif* 2015-16)

Modules	Germination (%)	Before 1st spray	7 days after 1st spray		14 days after 1st spray		Before 2nd spray	
		Thrips damage (%)	PSND (%)	Thrips damage (%)	PSND (%)	Thrips damage (%)	PSND (%)	Thrips damage (%)
T_1	68.8 ± 1.6 (56.0)	33.1 ± 1.9 (35.0)	0.7 ± 0.1 (1.2)	33.7 ± 1.6 (35.4)	1.3 ± 0.1 (1.5)	40.0 ± 1.2 (39.2)	1.5 ± 0.1 (1.5)	41.3 ± 1.9 (39.9)
T_2	75.0 ± 1.8 (60.0)	20.3 ± 2.2 (26.6)	0.4 ± 0.1 (1.1)	19.3 ± 2,8 (25.8)	0.7 ± 0.2 (1.2)	27.2 ± 1.0 (31.3)	0.9 ± 0.2 (1.3)	28.3 ± 1.1 (32.1)
T_3	80.6 ± 2.4 (63.0)	13.1 ± 1.1 (21.1)	0.2 ± 0.1 (1.0)	14.6 ± 1.2 (22.4)	0.3 ± 0.1 (1.1)	21.2 ± 0.3 (27.3)	0.5 ± 0.1 (1.2)	20.0 ± 2.1 (26.4)
T_4	67.3 ± 1.1 (55.1)	30.4 ± 1.6 (33.4)	0.5 ± 0.1 (1.2)	31.7 ± 1.9 (34.2)	1.0 ± 0.1 (1.4)	39.2 ± 1.4 (38.7)	1.4 ± 0.2 (1.5)	39.5 ± 1.9 (38.9)
T_5	62.4 ± 1.2 (52.1)	34.5 ± 3.3 (35.8)	1.0 ± 0.2 (1.4)	42.3 ± 2.1 (40.5)	1.7 ± 0.2 (1.6)	44.8 ± 1.3 (41.9)	2.3 ± 0.3 (1.8)	45.9 ± 2.3 (42.6)
CD (P = 0.05)	3.8	4.6	0.1	2.5	0.1	2.0	0.1	4.0
S.Em ±	1.2	1.4	0.05	0.8	0.04	0.6	0.06	1.3
CV (%)	4.3	9.7	8.4	5.0	6.8	3.6	8.1	7.2

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Table 2. Contd...

Modules	7 days after 2nd spray		14 days after 2nd spray	
	PSND (%)	Thrips damage (%)	PSND (%)	Thrips damage (%)
T_1	1.9 ± 0.2 (1.6)	48.2 ± 2.4 (43.9)	5.4 ± 0.2 (2.5)	60.7 ± 1.4 (51.1)
T_2	1.0 ± 0.2 (1.4)	28.6 ± 1.2 (32.3)	2.9 ± 0.5 (1.9)	36.4 ± 1.7 (37.0)
T_3	0.6 ± 0.1 (1.2)	23.4± 1.8 (28.8)	2.6 ± 0.4 (1.8)	30.9 ± 1.6 (33.7)
T_4	1.6 ± 0.2 (1.5)	42.1 ± 1.3 (40.4)	4.2 ± 0.3 (2.2)	55.0 ± 1.6 (47.8)
T_5	2.8 ± 0.4 (1.9)	51.4 ± 1.5 (45.7)	7.6 ± 0.6 (2.9)	60.3 ± 1.9 (50.9)
CD (P = 0.05)	0.2	3.2	0.2	3.0
S.Em ±	0.07	1.0	0.07	0.9
CV (%)	8.8	5.4	6.4	4.4

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