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INFLUENCE OF TEMPERATURE AND pH ON MYCELIAL GROWTH AND CHLAMYDOSPORE PRODUCTION OF PADDY STRAW MUSHROOM *Volvariella volvaceae* (Bull. Ex Fr.) Sing

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ABSTRACT

The present study was conducted to identify the optimum temperature and pH for both mycelial growth and chlamydospore production of *Volvariella volvacea* strain CBE TNAU 1505. The mycelium was subjected to varied temperatures (15^{0}C-40^{0}C) and pH (5-10). The optimum temperature that favoured the maximum mycelial growth and chlamydospore production of *V. volvacea* was 35^{0}C and 30^{0}C, respectively and the optimum pH range was 6 to 8. The temperatures below 20^{0}C and above 40^{0}C and the pH of below 6.0 and above 8.0 are not favourable for the growth and chlamydospore production of *V. volvacea*. Strain specific preference for temperature and pH optima to induce chlamydospores and stress metabolism needs future attention.

INTRODUCTION

Volvariella volvaceae (Bull.Ex Fr.) Sing is the tropical as well as subtropical mushroom that prefers to grow at high temperature and humidity. Optimum temperature for the production of paddy straw mushroom is 30^{0}C-35^{0}C (Chang, 1969). Amidst the cultivated mushrooms, it is the fastest growing one and the fruiting bodies are formed within 10-12 days of spawning. Regulation of temperature between 35 to 37^{0}C by covering the beds with polybag gives the maximum sporophore production of *V. diplasia* (Ramakrishnan *et al*., 1968). Temperatures below 15^{0}C cause chilling damage to the fruiting body and adversely affect the viability of fungal mycelia. Storage at low temperatures (4^{0}C) causes autolysis of fruiting body (Chang, 1978), thereby shortening mushroom shelf life (Bao *et al.,* 2013). *V. diplasia* prefers 28^{0}C to 35^{0}C for mycelial growth whereas, optimum temperature for spore germination was 40^{0}C (Singh and Saxena, 1983 and Banerjee *et al*., 1990). Hydrogen ion concentration of around 6.0 was most favourable for the growth, protein production and cellulase activity of *V. diplasia* (Banerjee and Samajpati, 1989 and Gupta *et al.,* 1996). A potential high yielding strain of *Volvariella* is apparent based on luscious morphological characters, mycelial growth rate, type of mycelia, aerial hyphae formation and chlamydospore production (Chang and Yau, 1971). The asexual chlamydospore is a thick walled vegetative cell normally formed at hyphal tips and are visually represented as pink coloured dots in culture. Factors such as pH, low temperature and oxygen limitation are also likely to be important inducers of the morphogenetic pathways required for chlamydospore formation (Citiulo *et al.,* 2009). Keeping this acquirable literature as background, the present disquisition has been intended for selecting the best suitable temperature and pH for enhancing chlamydospore production of *V. volvacea*.

MATERIAL AND METHODS

V. volvacea strain CBE TNAU 1505 obtained from the germplasm repository of Mushroom Research Laboratory, Tamil Nadu Agricultural University, Coimbatore was used in this experiment.

Maintenance of Pure Cultures

The sub-culture of paddy straw mushroom strain used in the study was maintained on Potato Dextrose Agar (PDA) medium. In order to maintain the vigour fresh isolations were made from the fruiting

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bodies every time after 2 to 3 subcultures. For this purpose the strains were propagated in straw spawn and grown on paddy straw following the method suggested by Thomas *et al.* (1943). Freshly harvested sporophores were swabbed with 70 per cent ethanol. At the junction of the pileus and stipe, tissue bits were removed aseptically, surface sterilized with 70 per cent ethanol for 30 sec and repeatedly washed in sterile water and placed on PDA medium taken in sterile Petri dishes. The dishes were incubated at 30 to 35^{0}C for seven days. Following single hyphal tip method (Rangasamy, 1972) pure cultures were made and stored in PDA slants to carry out further studies. Micrometric observations on the diameter of hyphae and chlamydospores were observed with the help of image analyzer (N-400T, Optika, Italy).

Effect of Temperature

To assess the best temperature range which would favour the growth and chlamydospores production, a 9 mm mycelial disc of CBE TNAU 1505 strain was inoculated aseptically on PDA medium in sterile Petri dishes. The plates in 4 replicates were incubated in B.O.D. incubators set at different temperature optima *viz.,* 15^{0}C, 20^{0}C, 25^{0}C, 30^{0}C, 35^{0}C and 40^{0}C. Linear hyphal growth, colony characters, production of aerial hyphae were recorded periodically at 2 days interval for every 20 days. Chlamydospores production was also visually observed and the conclusions were drawn out.

Effect of pH

To check the best pH for the growth and chlamydospores production of CBE TNAU 1505 isolate, PDA medium was prepared by adjusting the pH with 0.1 N hydrochloric acid or 0.1 N sodium hydroxide at different pH levels *viz.,* 5.0, 6.0, 7.0, 8.0, 9.0 and 10.0. A 9 mm mycelial disc of CBE TNAU 1505 isolate was inoculated aseptically on PDA medium maintained at respective pH in 4 replicates and incubated at 35^{0}C. The radial growth of mycelia, colony characters and production of aerial hyphae were recorded periodically at 2 days interval for every 20 days. Chlamydospores production was visually observed and the conclusions were drawn out.

Statistical Analysis

Statistical software AGRES (Developed by Department of Physical Science, TNAU, Coimbatore) was used for analysis of data obtained in the experiment. All the visual and micrometric observation parameters were carried out in 4 and 25 replicas, respectively. In case of zero values the data was log transformed (X+0.5) before statistical analysis.

RESULTS AND DISCUSSION

Influence of Temperature

Optimum temperature that favoured the maximum growth of the *V. volvacea* strain CBE TNAU 1505 was 30^{0}C-35^{0}C. At temperature below 20^{0}C, the fungus did not grow well. Growth of the fungus increased positively with the number of days of incubation. At 30^{0}C and 35^{0}C, 89.2 and 90 mm radial growth of the fungus, respectively was recorded on sixth day. This was followed by 25^{0}C (84.7 mm).However, in lower temperature *i.e.,* at 15^{0}C very poor growth was observed. At 35^{0}C, the 90 mm Petri dish was covered within 6.10 days followed by incubation at 30^{0}C (6.4 days) and 25^{0}C (7.3 days). Whereas, it had taken 12.2 days at 15^{0}C. More number of chlamydospores was observed at 25^{0}C and 30^{0}C than at lower and higher temperatures. No chlamydospore production was noticed at 15^{0}C and 40^{0}C (Table 1 and Fig. 1).

Optimum temperature for mycelial growth and fruiting bodies differs with the stage of mushrooms (Zadrazil and Grabbe, 1983). In accordance to Chang (1978), temperature below 15^{0}C affects the viability

Table 1. Influence of temperature on mycelial growth and chlamydospores production of *V. volvacea* strain (CBE TNAU 1505)

Temperature (^{0}C)	Radial growth in mm* (6 DAI)	DTTCPP*	Aerial hyphae*	Colony morphology*	DTFCP*	Chlamydospores density*	Micrometric observations#	
							Hyphal diameter (µm)	Chlamydospore diameter (µm)
15	54.0^e	12.2^f	-	Very thin slow growing	NP	-	3.2	-
20	79.2^c	8.4^d	+	Thin cottony	16.4^b (4.1)	++	3.9	22.7
25	84.7^b	7.3^c	+++	Thin cottony	13.5^a (3.7)	++++	4.5	28.4
30	89.2^a	6.4^b	++++	Thick fluffy	13.9^a (3.8)	++++	5.1	24.9
35	90.0^a	6.1^a	++++	Thick fluffy	14.2^a (3.8)	+++	5.7	26.4
40	66.2^d	11.2^e	-	Thin radiating	NP	-	3.7	-
CD@5 %	4.0	0.3			0.1			

Aerial hyphae, chlamydospores density "- to ++++" absent to highly densed; DTTCPP (Days taken to cover 90 mm Petri plate); DTFCP (Days taken for chlamydospores production). Data in parenthesis are square root transformed values. *, #Values are mean of 4 and 25 replications. Means followed by a common letter are not significantly different at P = 0.05 by one-way ANOVA

Table 2. Influence of pH on mycelial growth and chlamydospores production of *V. volvacea* strain (CBE TNAU 1505)

pH	Radial growth in mm* (6 DAI)	DTTCPP*	Aerial hyphae*	Colony morphology*	DTFCP*	Chlamydospores density*	Micrometric observations#	
							Hyphal diameter (µm)	Chlamydospore diameter (µm)
5	82.2^{c}	7.9^{d}	-	Thin depressed	16.4^{cd}	+	4.0	24.6
6	86.2^{b}	7.3^{c}	+++	Thin at center and thick raised cottony at margins	15.9^{c}	+++	4.4	28.5
7	90.0^{a}	6.3^{a}	++++	Very thick fluffy	14.4^{a}	++++	5.2	27.0
8	88.0^{ab}	6.9^{b}	+++	Thick fluffy	15.2^{b}	+++	4.8	26.3
9	80.5^{c}	8.6^{e}	+	Thin cottony irregular	16.9^{de}	+	4.2	24.1
10	74.1^{d}	9.7^{f}	+	Thin cottony irregular	17.3^{e}	+	3.9	22.2
CD@5 %	2.7	0.3			0.6			

Aerial hyphae, chlamydospores density "- to ++++" absent to highly densed; DTTCPP (Days taken to cover 90 mm Petri plate); DTFCP (Days taken for chlamydospores production). Data in parenthesis are square root transformed values. *, #Values are mean of 4 and 25 replications. Means followed by a common letter are not significantly different at P = 0.05 by one-way ANOVA

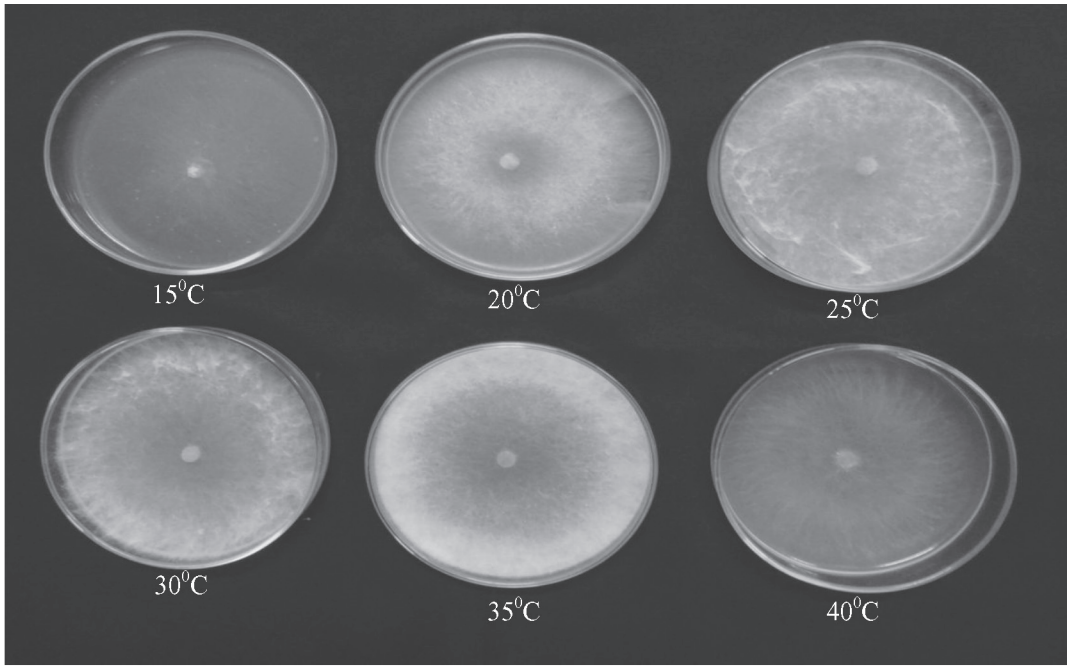

Fig. 1. Influence of temperature on mycelial growth and chlamydospores production of *V. volvacea*

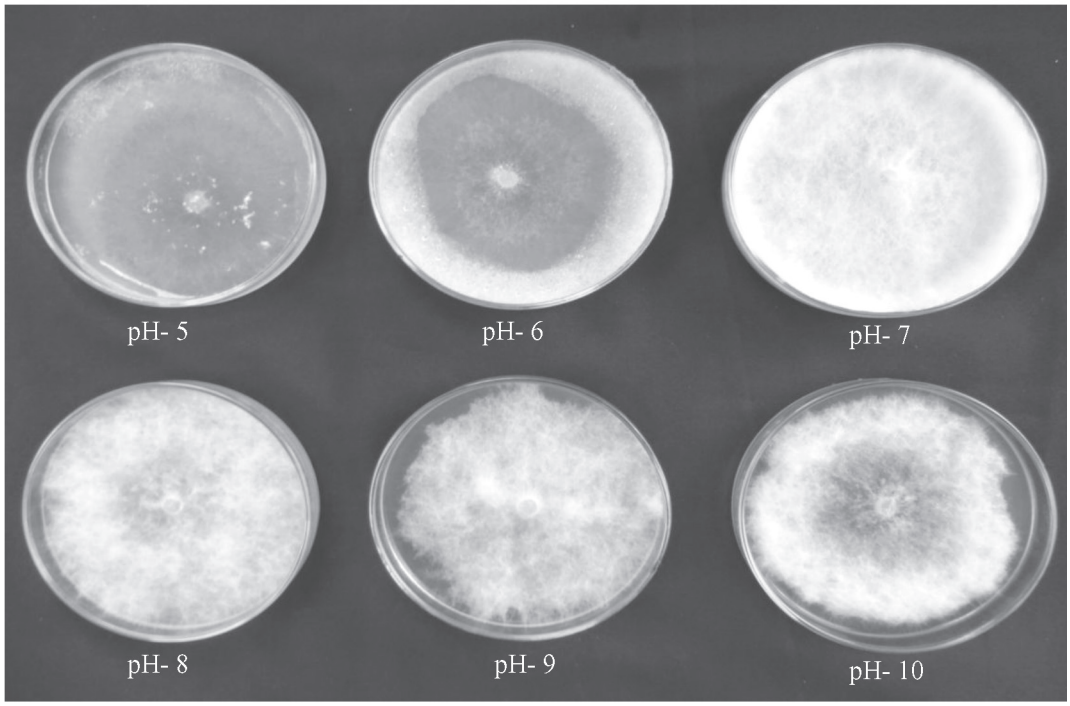

Fig. 2. Influence of pH on mycelial growth and chlamydospores production of *V. volvacea*

of fungal mycelia and also invokes chilling injury to the fruiting bodies of *Volvariella*. The present findings indicated that the optimum temperature that favoured the maximum growth of *V. volvacea* strain CBE TNAU 1505 was 35^{0}C. However, the mycelium does not grow well below 20^{0}C and above 40^{0}C. At these extreme temperatures the hypha was found to be very thin. Cognate results were reported by Sangeetha (2002) and Prabhu (2006). Slightly deviating from these results the maximum mycelial growth of the *V. volvacea* was observed between 25 and 30^{0}C and the highest mycelial dry weight of 80 mg was obtained at 30^{0}C by Akinyele and Adetuyi (2005).

In the present disquisition, chlamydospores were produced with more density at 30^{0}C.

This may be attributed to the induction of mild stress at 30^{0}C resulting in more number of chlamydospores on aerial hyphae. However, with increased stress well below 25^{0}C, no chlamydospore production was observed which may be attributed to lack of initiation of biosynthesis of unsaturated fatty acids, trehalose and glycogen that are incredibly essential for the formation of chlamydospores (Bao *et al.,* 2013).

Influence of pH

Hydrogen ion concentration of 7.0 and 8.0 were statistically on par favouring radial mycelial growth followed by pH of 6.0 (Table 2). The mycelial growth was minimum at a pH 10.0 (74.1 mm). At pH 7.0, the fungus took a minimum duration of 6.3 days to cover the entire Petri plate of 90 mm diameter, followed by pH 8.0 (6.9 days). However, at pH 10.0, it had taken 9.7 days. The mushroom fungus grown at pH 6.0, 7.0 and 8.0 produced more number of chlamydospores at 15.9, 14.4 and 15.2 days with high density (Fig. 2 and Fig. 3).

CONCLUSION

The present study indicated that *V. volvacea* produced the maximum radial growth and chlamydospores at pH 6.0 to 8.0. However,

Fig. 3. Chlamydospores produced terminally on apical cells (20 X)

Sangeetha (2002) reported that slightly acidic to neutral pH of 6.5 to 7.0 was quite suitable for chlamydospores production of *V. volvacea.* Banerjee and Samajpati (1989) and Kalra *et al.* (1997) reported that pH 6.0 favoured the growth and protein production of *V. diplasia*.

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EVALUATION OF CERTAIN BLACKGRAM VARIETIES FOR RESISTANCE TO PULSE BRUCHID, *Callosobruchus maculatus* (F.)

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ABSTRACT

A laboratory experiment was conducted to know the relative susceptibility of blackgram varieties to pulse beetle at Post Harvest Technology Centre, Bapatla during 2014-15. The Trombay blackgram varieties- TU 80 and TU 68 were found resistant to the pulse bruchid as the number of eggs, 2.67 and 3.0/ 100 seeds, respectively and adults, 1.33 and 4.33 emerged were significantly less compared to the other varieties. The variety LBG 752 recorded higher number of eggs, 25.67 /100 seeds and 189.0 adults emerged in 80 days. Grain damage was 0.33 and 1.0% and per cent weight loss was 0.04 and 0.1, which were also significantly less in TU 80 and TU 68 when compared to LBG 752 (99.33% and 39.53%).The developmental periods of pulse beetle on TU 80 and TU 68 were also longer compared to LBG 752 and TU 72 indicating the presence of some antibiotic constituents.

INTRODUCTION

Blackgram (*Vigna mungo* L.), is one of the important pulse crops cultivated in India that constitutes the major source of dietary protein for majority of the Indians. The produce is stored in various quantities for various periods by farmers, traders and millers for consumption or processing or as seed for sowing. Bruchids; *Callosobruchus maculatus* (F.) and *C. chinensis* (L.) (Coleoptera: Bruchidae) are the most devastating widespread storage pests of pulses that can infest from the field itself and can cause considerable damage both in terms of quality and quantity. Concerns about the harmful residues of insecticides in stored produce and the emergence of resistant strains of pests necessitate the search for viable non–chemical means of controlling stored product pests. Host plant resistance is one of the most promising methods of reducing bruchid attack in an ecofriendly manner (Keneni *et al.,* 2011). However, blackgram varieties known for their superior performance in field in terms of crop pest tolerance and yield; were found susceptible to pulse bruchid in storage (Gopala Swamy *et al*., 2010). Reduced oviposition, less seed damage, low adult emergence and prolonged development period of pulse bruchid were attributed to the tolerance in wild plants of blackgram (Soundararajan *et al*., 2013).

The blackgram cultivars UH 82-5, IC 8219 and SPS 143 were found moderately resistant to pulse bruchid (Duraimurugan *et al*., 2014). Thus, tolerance to storage insect pests is also an important feature to be considered while crop improvement. An experiment was conducted to evaluate the relative susceptibility or tolerance of different blackgram varieties to pulse bruchid, *C. maculatus* at Post Harvest Technology Centre, Bapatla, Andhra Pradesh during 2014-15.

MATERIAL AND METHODS

Nine varieties of blackgram were screened for bruchid tolerance under ambient laboratory conditions. They include six blackgram varieties (TU 26, TU 40, TU 68, TU 72, TU 80 and TU 94-2) obtained from Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Trombay and three popular varieties (PU 31, LBG 623 and LBG 752) obtained from the Regional Agricultural Research Station, Lam. Infestation free, sound and healthy blackgram grains of each variety were sun dried for three days. Grain moisture was tested before start of

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the experiment by following hot air oven method and it ranged from 11.23% to 11.79%.**Test Insects:** Adult beetles of *C. maculatus* were obtained from the stock culture maintained in plastic jars of one liter capacity containing blackgram grain. The mouth of the jar was covered with muslin cloth and fastened tightly with the help of a rubber band. Freshly emerged insects from the culture were used for the experiments.

No Choice Test: Blackgram grain (20g) of each variety was taken in a plastic container into which two pairs of freshly emerged bruchids were released. After collecting the adults from stock culture, they were kept in deep freezer for few minutes in order to inactivate, count and sexing. After introducing the bruchids into each jar, the mouth of the jar was secured with perforated lids. The experiment was replicated thrice under normal room temperature. After five days, the adults were removed and data on oviposition was recorded. Later, they were allowed for the progeny development and data on number of adults emerged, per cent grain damage and per cent weight loss at 40 and 80 days after release of adults were recorded.

Multi Choice Test: Grains of all the test varieties were taken at equal number (30 grains) in individual petri plates and randomly arranged in a circle in a rectangular plastic container. Ten pairs of freshly emerged bruchids were released in the middle of the circle giving a choice to adults to settle and oviposition on their preferred grain. After allowing for five days, data on oviposition was recorded. At 40 and 80 days after release of insects, data on progeny emergence, per cent grain damage and weight loss were recorded from each variety. Loss in grain weight was computed. The relative preference of *C. maculatus* among the varieties was analysed and the means were compared based on least significant difference (LSD) at *P= 0.05*.

RESULTS AND DISCUSSION

The genotypes have shown differential level of tolerance to *C. maculatus.* There were significant differences in terms of oviposition by bruchids, adult emergence and grain damage among the blackgram varieties tested under no choice conditions (Table 1). Oviposition ranged from 2.67 eggs to 25.67 eggs 100 grains^{-1}. The variety LBG 752 received the highest number of eggs (25.67 eggs 100 grains^{-1}) and remained on par with TU 94-2 and LBG 623 (24.33 and 24.0 eggs 100 grains^{-1} respectively). The variety TU 80 (2.67 eggs 100 grains^{-1}) recorded the least number of eggs among all the varieties and remained on par with TU 68 which recorded 3.0 eggs 100 grains^{-1}.

The mean number of adults emerged from 20g of grain was also the lowest (1.33) in case of TU 68 and TU 80 at 40 days after release of adult insects, while the emergence was highest in case of TU 94-2 (41 adults). The mean number of adults emerged from the remaining varieties ranged from 20.67 to 27.67. Similarly, at 80 days after release of adult insects *i.e.*, during their second generation as many as 161.33 adults were emerged from the variety LBG 752, while there was none from TU 80. Overall, the total number of adults emerged was the highest from LBG 752 (189 adults) which remained on par with TU 72 (186.33 adults). The TU 80 recorded the lowest emergence (1.33 adults) followed by TU 68 (4.33 adults). Similar trend was observed in grain damage with highest per cent (99.33) from LBG 752 which recorded highest number of adult emergence. Whereas, the varieties TU 80 and TU 68 recorded less per cent grain damage 0.33 and 1.0, respectively. Weight loss was also recorded minimum in these varieties (0.04% and 0.1%, respectively), while the maximum loss in weight was observed in LBG 752 (39.53%) followed by TU 72 (33.89%).

Table 1. Screening of certain blackgram varieties for resistance to pulse bruchid under no - choice conditions

S.No.	Variety	No of eggs 100 grains^{-1}	Adult emergence (No.)			Grain damage (%)	Weight loss (%)
			40 DAR	80 DAR	Total		
1	TU 26	14.67 (3.95)	21.33 (4.70)	63.67 (7.99)	85.0 (9.26)	50.33 (45.19)	19.4 (25.98)
2	TU 40	20.67 (4.65)	23.0 (4.88)	48.67 (7.05)	71.67 (8.52)	37.67 (37.85)	15.27 (22.98)
3	TU 68	3.0 (1.96)	1.33 (1.52)	3.0 (1.97)	4.33 (2.29)	1.0 (4.62)	0.1 (1.05)
4	TU72	17.33 (4.28)	27.33 (5.29)	159.0 (12.64)	186.33 (13.68)	93.67 (75.99)	33.89 (35.41)
5	TU 80	2.67 (1.90)	1.33 (1.47)	0 (1.0)	1.33 (1.47)	0.33 (1.91)	0.04 (0.60)
6	TU 94-2	24.33 (5.03)	41.0 (6.47)	105.67 (10.29)	146.67 (12.12)	92.0 (74.39)	24.8 (29.88)
7	PU 31	19.0 (4.47)	20.67 (4.65)	68.67 (8.34)	89.33 (9.50)	82.0 (64.99)	19.83 (26.33)
8	LBG 623	24.0 (5.16)	25.0 (5.08)	125.67 (11.21)	150.67 (12.27)	93.0 (75.36)	21.46 (27.34)
9	LBG 752	25.67 (4.99)	27.67 (5.35)	161.33 (12.74)	189.0 (13.78)	99.33 (87.29)	39.53 (38.92)
	S Em±	**0.11**	**0.29**	**0.43**	**0.40**	**2.70**	**2.34**
	CD at 5%	**0.34**	**0.86**	**1.30**	**1.20**	**8.09**	**7.02**
	CV%	**8.42**	**11.3**	**9.2**	**7.5**	**9.0**	**17.5**

The values in parentheses are transformed values; DAR: Days after release of insects

Under multi choice, the number of eggs per 30 seeds was lowest in TU 68 (0.67) which was similar with TU 80 (1.0) (Table 2). The highest number of eggs was recorded on LBG 752 (8.0 eggs 30 seeds^{-1}). At 40 days after release of adults, there was no emergence from TU 68 while the mean number of adults emerged was only one in case of TU 80. The emergence was highest in case of LBG 752 (5.67 adults). Similarly, at 80 days after release of adults as many as 14.0 adults were emerged from the variety LBG 752, while the varieties TU 68 and TU 80 recorded 0.67 and 1.67 adults only. Thus, the total number of adults emerged was the highest from LBG 752 (19.67 adults); while TU 68 (0.67 adults) and TU 80 (2.67 adults) recorded less.

Observance of less number of eggs on TU 68 and TU 80 in both no choice and multi choice tests indicated that these varieties were not preferred by bruchids for oviposition compared to other varieties tested. The differences in susceptibility or tolerance may be attributed to varietal differences of blackgram in their physical and chemical composition. Grain size, seed coat surface texture and thickness have been shown to influence oviposition by adults on mungbean (Dharmasena and Subasinghe, 1986) and chickpea (Sarwar, 2013). The period of development from egg to adult was also observed on these two varieties; TU 68 and TU 80 compared with LBG 752 and TU 72. For each variety, a total of twenty grains with single egg on each grain were observed till the

Table 2. Screening of certain blackgram varieties for resistance to pulse bruchid under multi-choice conditions

S.No.	Variety	No of eggs 30 grains^{-1}	Adult emergence (No.)		
			40 DAR	80 DAR	Total
1	TU 26	1.67 (1.46)	2.33 (1.68)	4.67 (2.27)	7.0 (2.74)
2	TU 40	6.0 (2.54)	5.67 (2.48)	8.67 (3.03)	14.33 (3.85)
3	TU 68	0.67 (1.05)	0 (0.71)	0.67 (1.05)	0.67 (1.05)
4	TU72	6.0 (2.54)	4.67 (2.27)	10.0 (3.23)	14.67 (3.89)
5	TU 80	1.0 (1.17)	1.0 (1.17)	1.67 (1.46)	2.67 (1.74)
6	TU 94-2	1.67 (1.46)	1.67 (1.46)	5.0 (2.34)	6.67 (2.68)
7	PU 31	2.0 (1.58)	1.67 (1.46)	6.0 (2.54)	7.67 (2.86)
8	LBG 623	5.33 (2.41)	4.67 (2.27)	13.30 (3.72)	18.0 (4.30)
9	LBG 752	8.0 (2.91)	5.67 (2.48)	14.0 (3.81)	19.67 (4.49)
	S Em±	**0.13**	**0.12**	**0.12**	**0.13**
	CD at 5%	**0.40**	**0.35**	**0.36**	**0.38**
	CV%	**12.22**	**11.37**	**8.06**	**7.27**

The values in parentheses are transformed values. DAR: Days after release of insects

adult emergence. The mean development period of bruchid from egg to adult took longer on TU 68 (57.63 days) followed by TU 80 (49.78 days) compared to other two varieties; TU 72 (41.35 days) and LBG 752 (44.5 days) (Fig. 1). This indicated that the physical traits and surface chemicals of grains can influence

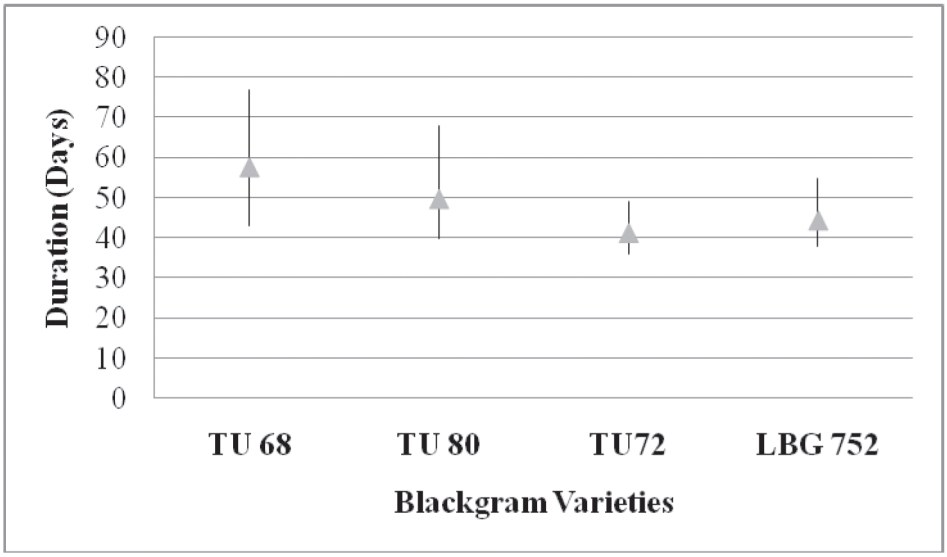

Fig. 1. Development (egg to adult emergence) of pulse beetle on certain blackgram genotypes

adult oviposition, while the presence of unfavourable chemical constituents inside the cotyledons may be responsible for delaying the development of a growing grub as noticed by Somta *et al.,* (2008) in mungbean. The findings are in conformity with Kuldeep *et al*., (2012) who found cowpea cultivars; IC 107466, IC 106815 and Pusa Momal resistant to *C. maculatus* based on the growth indices of the insect. Higher amounts of total phenols conferred resistance from bruchid attack; higher amounts of proteins and free amino acids favored the successful development of pulse beetle in various legumes (Venugopal *et al*., 2000; Beenam and Ranjana, 2011; Divya *et al*., 2013; Lazar *et al*., 2014).The results are also in agreement with the findings of Sambasiva Rao and Seshamahalakshmi (2014).

CONCLUSION

It can be concluded that the two Trombay varieties namely TU 68 and TU 80 were found less susceptible to pulse beetle compared to other genotypes tested and can hold promise as genetic source in breeding programme of blackgram for bruchid pest resistance. A variety with moderate resistance to bruchid attack although its other agronomic characteristics are relatively poor can be used for improving the local cultivars through conventional breeding methods or by application of appropriate gene transfer techniques.

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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE STUDIES FOR YIELD AND FIBRE QUALITY TRAITS IN AMERICAN COTTON (*Gossypium hirsutum* L.)

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ABSTRACT

Fifty genotypes of American cotton were evaluated during *Kharif,* 2015-2016 for genetic variability, heritability and genetic advance as per cent of mean based on 15 characters. High phenotypic coefficient of variation (PCV) and moderate genotypic coefficient of variation (GCV) values were observed for the traits, number of monopodia plant^{-1} and lint yield plant^{-1}. High heritability coupled with high genetic advance as per cent of mean was recorded for characters *viz.,* plant height (cm), boll weight (g) and micronaire (10^{-6} g in^{-1}) indicating the preponderance of additive gene action making selection effective.

INTRODUCTION

Cotton is an important cash crop in India and popularly called as white gold. Cotton is widely cultivated profitable fibre crop to boost up national economy and gained too much attention by the researchers (Haidar *et al*., 2012). It contributes raw materials to the textile industry such as cotton lint as an export item, crude oil and cotton seed cake to oil and live stock industries, respectively. The knowledge of genetic variation existing in germplasm is an important and essential aspect for initiating any crop breeding programme. The genetic improvement of plant population depends on the presence of magnitude of genetic variability and the extent to which the desirable traits are transmissible. Thus, besides genetic variability knowledge on heritability and genetic advance plays a predictive role in breeding, expressing the reliability of phenotype as a guide to its breeding value. Higher the heritability, greater would be the response to selection, *i.e*., again in yield as heritability is directly proportional to genetic advance making selection more effective.

MATERIAL AND METHODS

The present study was carried out with 50 genotypes of cotton (*Gossypium hirsutum* L.) obtained from different research centers across the country in randomized complete block design (RCBD) with three replications at Regional Agricultural Research Station, Lam, Guntur during *kharif,* 2015-16. The inter-row and intra-row spacing adapted was 105 cm x 60 cm. Each plot consisted of one row of 6 m length and observations were recorded on five randomly selected plants from each genotype per replication for characters *viz*., plant height (cm), number of monopodia plant^{-1}, number of sympodia plant^{-1}, number of bolls plant^{-1}, boll weight (g), seed index (g), lint index (g), lint yield plant^{-1} (g) and seed cotton yield plant^{-1} (g). Days to 50% flowering, ginning out turn (%), 2.5% span length (mm), micronaire (10^{-6} g in^{-1}) bundle strength (g tex^{-1}) and uniformity ratio were recorded on plot basis. The fibre quality characters were analysed at Central Institute for Research on Cotton Technology Regional Unit, Lam, Guntur. The data was statistically analysed to estimate phenotypic and genotypic coefficients of variation (PCV and GCV) as indicated by Burton (1952). Heritability in broad sense was estimated as per the formula given by Hanson *et al*. (1956) and the genetic advance as per cent of mean as suggested by Johnson *et al*. (1955).

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RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating presence of considerable amount of genetic variability in the germplasm studied (Table 1). The phenotypic expression of the character is the result of interaction between the genotype and environment. The genotypic coefficient of variation measures the range of variability available in a crop and also enables to compare the amount of variability present in different characters. In the present study, the estimates of phenotypic coefficients of variation for all the characters were higher than the estimates of genotypic coefficients of variation, which may be due to interaction of genotypes with the environment.

The phenotypic and genotypic coefficients of variation (Table 2) were high and moderate for the trait number of monopodia plant^{-1} and lint yield plant^{-1}, respectively. Similar results were also reported by Vineela *et al*.(2014). While, low phenotypic and genotypic coefficient of variation were recorded for the characters *viz.,* days to 50% flowering, number of sympodia plant^{-1}, ginning out turn, seed index (g), 2.5% span length (mm), bundle strength (g tex^{-1}) and uniformity ratio. These results are in agreement with those of Dhivya *et al.* (2014) for days to 50% flowering, Rajamani *et al*. (2015) for number of sympodia plant^{-1}, 2.5% span length (mm), bundle strength (g tex^{-1}) and uniformity ratio, Khan *et al*.(2015) for ginning out turn, Dahiphale *et al*. (2015) for seed index (g) and Vinodhana *et al*.(2013) for lint index (g). Moderate phenotypic and genotypic coefficients of variation were observed for the characters *viz.,* number of bolls plant^{-1}, boll weight, micronaire. Similar results were reported by Hafiz *et al*. (2013) for number of bolls plant^{-1} and boll weight and Rajamani *et al*. (2015) for micronaire.

Coefficient of variability along with heritability gives an idea of expected genetic gain from selection (Burton, 1952). Eventhough, heritability estimates provide an indication of the relative value of selection based on phenotypic expression, heritability and genetic advance when calculated together gives more information in predicting resultant effect of selection.

High heritability coupled with high genetic advance as per cent of mean was observed for plant height, boll weight and micronaire indicating the predominance of additive gene action and hence, direct phenotypic selection may be useful with respect to these traits. These results were in agreement with Vineela *et al*. (2013) and Khan *et al*. (2015) for plant height and boll weight. High heritability coupled with moderate genetic advance as per cent of mean was observed in case of days to 50% flowering, seed index, lint index and 2.5% span length revealing the role of additive and non additive gene action. These results were in agreement with those of Dhivya *et al*. (2014) and Erande *et al*. (2014) for plant height, seed index and 2.5% span length.

Moderate heritability coupled with moderate genetic advance as per cent of mean was recorded for number of bolls per plant while, moderate heritability coupled with low genetic advance was observed for number of sympodia plant^{-1}. Moderate heritability coupled with high genetic advance as per cent of mean was observed for number of monopodia plant^{-1}, seed cotton yield plant^{-1} and lint yield plant^{-1}. Low heritability coupled with low genetic advance was observed for the trait uniformity ratio which was in conformity with earlier work of Rajanna (2010).

Table 1. Analysis of variance for yield and yield components of cotton

Source	d.f.	Plant height (cm)	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	Ginning-out-turn (%)	Seed index (g)
Mean sum of squares									
Replications	2	25.946	0.740	0.078	0.711	0.405	0.008	0.085	0.005
Varieties	49	509.440**	50.966**	0.271**	6.010**	102.642**	0.553**	1.368**	0.746**
Error	98	38.062	0.801	0.063	2.094	29.542	0.027	0.091	0.053

Source	d.f.	Lint index (g)	2.5% span length (mm)	Micronaire (10^{-6} g in^{-1})	Bundle strength (g tex^{-1})	Uniformity ratio	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)
Mean sum of squares								
Replications	2	0.002	0.019	0.045	0.078	0.031	71.269	5.569
Varieties	49	0.379**	6.487**	0.530**	1.914**	0.265*	1001.687**	124.363**
Error	98	0.025	0.277	0.029	0.179	0.165	333.170	41.789

d.f. = degrees of freedom ** = Significant at 1% level *= Significance at 5% level

Table 2. Mean, genetic variability, heritability (broad sense) and genetic advance as per cent of mean for seed cotton yield and yield components

S. No.	Character	Mean	Range		Coefficient of variation		Heritability (%) (broad sense)	Genetic advance as per cent of mean
			Minimum	Maximum	PCV (%)	GCV (%)		
1	Plant height (cm)	131.21	97.00	165.33	10.65	9.55	80.50	22.63
2	Days to 50% flowering	63.76	53.67	76.67	6.57	6.41	95.43	16.54
3	No. of monopodia plant^{-1}	1.67	1.10	2.17	21.88	15.79	52.09	30.09
4	No. of sympodia plant^{-1}	19.00	13.93	21.40	9.70	6.01	38.40	9.84
5	No. of bolls plant^{-1}	45.51	34.67	59.67	16.13	10.85	45.20	19.25
6	Boll weight (g)	4.00	3.13	5.05	11.26	10.47	86.54	25.72
7	Ginning out-turn (%)	34.08	32.63	35.51	2.11	1.91	82.24	4.58
8	Seed index (g)	8.86	7.85	10.50	6.02	5.42	81.27	12.91
9	Lint index (g)	4.59	3.95	5.71	8.25	7.49	82.49	17.96
10	2.5% Span length (mm)	26.85	24.13	31.71	5.71	5.36	88.19	13.29
11	Micronaire (10 $^{-6}$g in^{-1})	3.96	3.19	4.78	11.20	10.31	84.81	25.07
12	Bundle strength (g tex^{-1})	20.39	18.74	21.91	4.27	3.73	76.35	8.61
13	Uniformity ratio	46.25	45.72	46.96	0.96	0.40	16.92	0.43
14	Seed cotton yield plant^{-1} (g)	118.01	79.85	164.65	19.98	12.65	40.08	21.14
15	Lint yield plant^{-1} (g)	40.57	26.80	58.33	20.52	12.93	39.71	21.52

CONCLUSIONS

Moderate to high variability and high heritability coupled with high genetic advance as per cent of mean was observed for plant height, boll weight and micronaire indicating the predominance of additive gene action and hence, direct phenotypic selection may be useful with respect to these traits. High heritability coupled with moderate genetic advance was observed in case of days to 50% flowering, seed index, lint index and 2.5% span length revealing the role of additive and non additive gene action. The other traits *viz*., no. of monopoia plant^{-1}, seed cotton yield plant^{-1} and lint yield plant^{-1} showed moderate to high heritability and high genetic advance indicating the operation of additive gene action. No. of sympodia plant^{-1}, number of bolls plant^{-1}, ginning out turn, bundle strength and uniformity ratio showed moderate to high heritability and moderate to low genetic advance indicating the operation of non additive gene action. It might be exploited through heterosis breeding, cyclic hybridization, biparental mating and diallel selective mating system.

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SUITABILITY OF CLUSTERBEAN VARIETIES FOR RAINFED ALFISOLS OF SCARCE RAINFALL ZONE

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ABSTRACT

A field experiment was conducted to study the suitability of clusterbean varieties for alfisols of scarce rainfall zone under rainfed conditions for two years during *kharif*, 2014-15 and 2015-16 at Agricultural Research Station, Anantapur, Andhra Pradesh. Results revealed that number of pods plant^{-1}, test weight, seed yield and haulm yield was not significantly influenced by different varieties during both the years of experimentation. The correlation studies between yield attributes and yield based on two years investigation revealed that number of seed per plant was significantly and positively influenced by plant height and number of pods plant^{-1}. The test weight has significant positive correlation with plant height, number of pods and number of seeds plant^{-1}. Seed yield was positively and significantly correlated with number of pods plant^{-1}, number of seeds plant^{-1} and test weight. The haulm yield expressed significant positive correlation with number of seeds plant^{-1} and seed yield. Performance of all clusterbean varieties was similar under rainfed conditions of scarce rainfall zone and farmers can grow any of the varieties tested for profitable yield.

INTRODUCTION

Clusterbean, popularly known as guar is *Kharif* legume crop, drought tolerant, sun-loving but susceptible to frost that requires only 300-400 mm annual rainfall, recently classified in arid legume group and is grown for vegetable, green fodder, green manure and for grain. Clusterbean tolerates high temperatures and dry conditions and is adapted to arid and semi-arid climates (Undersander *et al*., 1991). It is a principal source of galactomannan (28 -33% guar gum) and has numerous food and industrial uses *viz.,* textiles, paper, petroleum, pharmaceuticals, food processing, cosmetics, mining explosives, oil drilling etc. In India during the 2013, clusterbean was cultivated in 32 lakh hectares and production was around 25 lakh tons. (Economic Times, 2013). Rajasthan is the largest clusterbean producing states as it dominates the Indian production scenario contributing to 70% of the total production in India. Clusterbean is basically grown under arid rainfed conditions and there was year to year huge yield fluctuations due to erratic rainfall (Pathak *et al*., 2009 and Singh *et al*., 2003 and Singh *et al*., 2005).

After seeing great revenues with the crop during previous years by Rajasthan farmers, farmers in Anantapur, Guntur, Kurnool, Karimnagar, Nellore, Prakasam and Ranga Reddy districts of Andhra Pradesh have also started the cultivation of this crop for seeds in more than 1000 ha (NRAA, 2014). Anantapur district is the second most drought affected district of India. It receives around 500 mm rainfall annually. Rainfed agriculture in Anantapur district is greatly influenced by water shortage caused by low, highly variable and erratic rainfall.

Most of the clusterbean varieties currently being grown were developed under arid conditions and research need to be focused on their suitability for different environments and identifying the management strategies to enhance both seed yield and recovery of quality gum which are crucial to expand the cultivation of this commercially important crop to new areas. With growing international demand for the guar gum, identification of suitable varieties for different agro climatic conditions is necessary, as most of the varieties currently being grown were developed under arid conditions. To address these

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issues, eight clusterbean varieties were evaluated for their yield potential during *kharif* season in nontraditional areas such as Anantapur district of Andhra Pradesh.

MATERIAL AND METHODS

A field experiment was conducted to study the suitability of clusterbean varieties for alfisols of scarce rainfall zone under rainfed conditions for two years during *kharif*, 2014-15 and 2015-16 at Agricultural Research Station, Anantapur of Andhra Pradesh. The soil of the experimental site was red sandy loam with shallow depth, low in organic carbon (0.38%) and low in available nitrogen (138 kg ha^{-1}), medium in available phosphorous (28 kg ha^{-1}) and potassium (215 kg ha^{-1}). The experiment was laid out in randomized block design with three replications. The treatments consisted of eight varieties *viz*., T_1: JJ-1,T_2: JG- 2,T_3: HG 365,T_4: RGC 936,T_5: RGC 963,T_6: RGC 1002,T_7: RGC 1025 andT_8: RGC 1066. The individual plots were laid out according to the layout plan. Healthy seeds of clusterbean were sown by dibbling in furrows at a depth of 5 cm.Thinning was done at 15DAS retaining one healthy seedling $hill^{-1}$.The recommended dose of N, P_2O_5 and K_2O kg ha^{-1} was applied at the time of sowing through urea, single super phosphate(SSP) and muriate of potash(MOP), respectively. At harvest five plants were randomly selected from each treatment for recording growth parameters such as plant height, number of pods $plant^{-1}$, number of seeds pod^{-1} and test weight. At harvest in each treatment grain and haulm yield from the net plot (5 m x 5 m) was recorded and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

Rainfall distribution during the crop period

The data on sowing and harvest dates, rainfall distribution during the two years of investigation and crop growth period (Table 1) shows that in the year 2014-15, annual rainfall received was 65.8% (375.2mm in 26 rainy days) of normal annual rainfall (570 mm). In 2014-15, crop was sown on 16.7.2014 and harvested on 10.10.2014 with 86 days crop duration. During this period 160.6 mm rain is received in 10 rainy days. In 2015-16, annual rainfall received was 108% (641mm in 44 rainy days) of 590.6 mm normal annual rainfall. In 2015-16, crop sown on 19.6.2015 and harvested on 11.9.2015 with crop duration of 84 days. During this period 212.6 mm rainfall received in 14 rainy days. The average seed yield during 2015 was higher by 23.8% compared to 2014 and was attributed to optimum soil moisture resulted through sufficient rainfall received in 11 rainy

Table 1. Rainfall and rainy days during crop period

Parametre	2014-15	2015-16
Date of sowing	16.07.2014	19.06.2015
Date of harvesting	10.10.2014	11.09.2015
Crop duration (days)	86	84
Normal annual rainfall (mm)	570	590.6
Actual annual rainfall (mm)	375.2	641
Rainfall during crop period (mm)	160.6	212.6
Number of rainy days during the year	26	44
Number f rainy days during crop period	10	14

days during different phenophases especially during pod initiation to pod development and pod development to maturity. Higher seed yield during 2015 compared to 2014 was also attributed to higher number of pods plant^{-1}, seeds pod^{-1} and test weight.

Data pertaining to plant height, yield attributes and seed yield are presented in Table 2. It is revealed that different varieties had shown significant difference in plant height during 2014-15 where as in 2015-16 there was no significant disparity. Number of pods plant^{-1}, test weight, seed yield and haulm yield was not significantly influenced by different varieties during both the years of experimentation. Number of seeds pod^{-1} varied significantly during 2014-15. However, no significant difference in number of seed was evidenced during 2015-16.

The highest plant height was observed with JJ-1 which was comparable with JG-2, HG-365, RGC-1025 and significantly superior to other varieties during 2014-15. Maximum plant height of 28.5 cm was recorded with RGC-1066 followed by RGC-963 in 2015-16. Pooled analysis of data revealed that plant height was not influenced significantly by the cluster bean varieties however highest plant height was recorded with JJ-1 followed by JG-2.

HG-365 and JJ-2 produced higher number of pods per plant during both the years of study. The lowest number of pods plant^{-1} was registered with RGC-936 and RGC-1066. Pooled analysis of data indicated that different cluster bean varieties did not exert significant influence on number of pods plant^{-1}. However, the highest number of pods plant^{-1} obtained with JG-2 followed by HG-365, whereas RGC-1066 produced least number of pods plant^{-1} owing to its erect growing habit with less number of branches and majority of the pod formation on the main stem.

In 2014-15, highest number of seeds per pod was registered with JJ-1 which was comparable with RGC-936, RGC-1025, HG-365 and RGC-963 and significantly superior to other varieties. Highest number of seeds pod^{-1} was recorded with RGC-936 followed by RGC-1025 during 2015-16. Lowest number of seeds pod^{-1} was obtained with RGC-1066 followed by RGC-1002 and JJ-2, RGC-963 during 2014 and 2015, respectively. Pooled analysis of data revealed that different clusterbean varieties did not execute significant influence on number of seeds pod^{-1}. However, JJ-1, RGC-936, RGC-1025 produced higher number of seeds pod^{-1} and least number of seeds pod^{-1} obtained with JG-2 and RGC-1066.

Table 2. Growth and yield attributes of different clusterbean varieties in rainfed alfisols

Treatments	Plant height (cm)			Number of pods plant^{-1}			Number of seeds pod^{-1}		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
JJ-1	37.3	26.1	31.7	18.2	16.2	17.2	6.3	6.5	6.4
JG- 2	32.8	25.3	29.1	18.7	23.3	21.0	5.6	6.3	5.9
HG 365	31.7	23.1	27.4	22.1	19.1	20.6	5.9	6.4	6.2
RGC 936	28.0	25.4	26.7	15.9	18.8	17.3	6.1	6.8	6.4
RGC 963	28.5	26.9	27.7	19.2	19.9	19.6	5.9	6.1	6.0
RGC 1002	25.3	21.6	23.4	17.7	19.3	18.5	5.6	6.5	6.1
RGC 1025	31.0	21.0	26.0	17.6	20.0	18.8	6.1	6.7	6.4
RGC 1066	27.5	28.5	28.0	19.4	14.0	16.7	5.5	6.4	5.9
S.Em ±	2.24	2.55	5.36	2.37	3.42	3.49	0.14	0.21	0.98
CD at 5%	6.86	NS	NS	NS	NS	NS	0.43	NS	NS

Table 3. Seed and haulm yield of different clusterbean varieties in rainfed alfisols

Treatments	Test weight (g)			Seed yield (kg ha^{-1})			Haulm yield (kg ha^{-1})		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
JJ-1	32.6	35.7	34.1	809	785	797	1096	2081	1589
JG- 2	33.1	32.2	32.7	631	687	659	910	1180	1045
HG 365	32.6	34.6	33.6	626	792	709	904	1317	1111
RGC 936	32.5	33.8	33.2	646	658	652	1083	1191	1137
RGC 963	31.9	36.2	34.1	659	600	630	903	1435	1169
RGC 1002	34.2	33.7	33.9	590	881	736	821	1820	1320
RGC 1025	32.0	33.6	32.8	716	653	685	942	1372	1157
RGC 1066	33.3	34.9	34.1	609	701	655	866	1640	1253
S.Em ±	1.55	0.90	5.71	103.5	71.3	133.5	164.1	226	201
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

During both the years of study test weight was not significantly influenced by different varieties. However, RGC-1002 recorded highest test weight during 2014-15 whereas RGC-963 followed by JJ-1 recorded highest test weight during 2015-16. Lowest test weight was observed with RGC-963 and JG-2 during both years of investigation. Pooled analysis of data indicated that test weight was not significantly influenced by various varieties. However, higher test weight was observed with JJ-1 followed by RGC-1066, RGC-963 and RGC-1002 where as JG-2 and RGC-1025 produced lesser test weight.

Seed yield was not significantly influenced by different varieties during both the years of experimentation. However, JJ-1 and RGC-1025 produced higher seed yield during 2014 and RGC-1002 followed by HG-365 and JJ-1 given higher seed yield during 2015. The lowest seed yield was obtained with RGC-1002 and RGC-963 during both the years of study. Pooled analysis of data revealed that JJ-1 followed by RGC-1002 produced maximum seed yield whereas seed yield was reduced with RGC-963. These results were contradictory to Satyavathi *et al.* (2014) who reported that selected clusterbean genotypes recorded highly significant difference for biomass and seed yield at harvest. The genotype RGC-936 was prominent in its plant growth habit with profuse branching from base of the stem with smaller lamina and the seed yield was also high. The guar genotypes were considered as short day plants and

Table 4. Correlation coefficient between yield attributes and yield of different clusterbean varieties in rainfed alfisols during 2014-15

Parametre	Plant Height (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test Weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
No. of pods plant^{-1}	0.928**	1.0				
No. of seeds pod^{-1}	0.961**	0.947**	1.0			
Test weight (g)	0.934**	0.963**	0.983**	1.0		
Seed yield (kg ha^{-1})	0.980**	0.909**	0.981**	0.946**	1.0	
Haulm yield (kg ha^{-1})	0.960**	0.893**	0.983**	0.949**	0.978**	1.0

Table 5. Correlation coefficient between yield attributes and yield of different clusterbean varieties in rainfed alfisols during 2015-16

Parameter	Plant Height (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test Weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
Plant height (cm)	1.0					
No. of pods plant^{-1}	-0.460	1.0				
No. of seeds pod^{-1}	-0.421	-0.152	1.0			
Test weight (g)	0.412	-0.572	-0.371	1.0		
Seed yield (kg ha^{-1})	-0.404	-0.182	0.093	-0.012	1.0	
Haulm yield (kg ha^{-1})	0.108	-0.602	-0.028	0.419	0.515	1.0

sensitive to photoperiod. This phenomenon influence their fodder and seed yield in different reasons with varying photo period (Paroda *et al*., 1977).

Significant difference in haulm yield was not observed among the tested varieties. However, during 2014, JJ-1 has recorded maximum haulm yield followed by RGC-936. During the year 2015, JJ-1 produced maximum haulm yield followed by RGC-1002. Lowest haulm yield obtained with RGC-1002, RGC-936 followed by JG-2 during 2014 and 2015. Pooled analysis of data indicated that haulm yield was not significantly influenced by different varieties however higher haulm yield obtained with JJ-1 where as JG-2 registered lowest haulm yield. These results were contradictory to Singh *et al.* (2005) who observed that twenty-five clusterbean genotypes tested were significantly different for all the characters *viz.,* plant height, pods plant^{-1}, seeds pod^{-1}, seed yield and haulm yield.

Correlation between yield attributes and yield

In 2014-15, number of pods plant^{-1} was positively and significantly correlated with plant height (Table 4). Number of seeds pod^{-1} was positively and significantly correlated with plant height and number of pods plant^{-1}.Test weight was positively and significantly correlated with plant height, number of pods plant^{-1} and number of seeds pod^{-1}. Seed yield was positively and significantly correlated with plant height, number of pods plant^{-1}, number of seeds pod^{-1} and test weight. Haulm yield was positively and significantly correlated with plant height, number of pods plant^{-1}, number of seeds pod^{-1} and test weight. During the year 2015-16, the correlation was not significant between yield and yield attributes. The correlation studies between yield attributes and yield for pooled data (Table 6) revealed that number of seeds plant^{-1} was significantly and positively

Table 6. Correlation coefficient between yield attributes and yield of different clusterbean varieties in rainfed alfisols (Mean of two years)

Parameter	Plant height (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test Weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
Plant height (cm)	1.0					
No. of pods plant^{-1}	0.732	1.0				
No. of seeds pod^{-1}	0.763*	0.86**	1.0			
Test weight (g)	0.799*	0.870**	0.968**	1.0		
Seed yield (kg ha^{-1})	0.723	0.776*	0.928**	0.892**	1.0	
Haulm yield (kg ha^{-1})	0.357	0.477	0.749*	0.711	0.782*	1.0

** = Significant at 1 % level * = Significant at 5 % level

influenced by plant height and number of pods plant^{-1}. The test weight has significant positive correlation with plant height, number of pods and number of seeds plant^{-1}. Seed yield was positively and significantly correlated with number of pods plant^{-1}, number of seeds plant^{-1} and test weight. The haulm yield expressed significant positive correlation with number of seeds plant^{-1} and seed yield.

CONCLUSION

The present studies indicated that the performance of all cluterbean varieties was similar under rainfed conditions of scarce rainfall zone and farmers can grow any of the varieties tested for profitable yield.

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EVALUATION OF CERTAIN INSECTICIDE MOLECULES AGAINST CHILLI POD BORER, *Spodoptera litura* IN ANDHRA PRADESH

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ABSTRACT

Field experiments were conducted during 2010 -11 and 2011- 12 at Horticultural Research Station, Lam, Guntur to evaluate the new insecticides for the management of chilli pod borer, *Spodoptera litura*. Among the eleven insecticides tested in 2010-11, Spinosad 45 SC @125 ml ha^{-1} (23.16) recorded lowest pod borer damage followed by Emamectin Benzoate @200 g ha^{-1} (24.31) and Novaluran 10 EC @ 375 ml ha^{-1}(27.61). In 2010-11, Spinosad 45 SC @125 ml ha^{-1}(4.16), Emamectin Benzoate@ 200 g ha^{-1} (4.52) were found to be significantly superior in reducing the pod borer damage. With respect to yield (q ha^{-1}), Spinosad 45 SC @125ml ha^{-1}sprayed plot recorded highest yield (33.57 q ha^{-1}) followed by Emamectin Benzoate@200 g ha^{-1} (29.06 qha^{-1}), Novaluran 10 EC@375 ml ha^{-1} (28.96 q ha^{-1}) and Lufenuron @500 (27.96 q ha^{-1}) in 2010-11 where as in 2011-12,Spinosad 45 SC @125 ml ha^{-1}(32.93 q ha^{-1}) treated plot recorded highest yield than other insecticides. Based on the overall efficacy of insecticides over two years, Spinosad 45 SC @125 ml ha^{-1}proved as most effective insecticide in controlling pod borer infesting chilli.

INTRODUCTION

Chilli (*Capsicum annum* L.), is the fourth most important vegetable crop in the world and first in Asia. Worldwide it is cultivated in an area of 15 lakh ha with 70 lakh tons productivity and it is very remunerative spice crop of the Indian subcontinent. It occupies an area of about 0.81million ha accounting 40 per cent of the world production. (Indian Horticultural Database, 2013). The use of chilli as a major spice is on account of pungency, pleasant flavour and also to offer colour to various food items. It is a rich source of Vitamin A, C, E and Oleroresin and Capsanthin. In India, it is cultivated in 7.9 lakh ha with an annual production of 12.99 lakh tons. The important chilli growing states of India are Andhra Pradesh, Karnataka, Tamilnadu, Odissa, Maharastra, Rajasthan and West Bengal (Saideswara Rao *et al*., 2013).

In Andhra Pradesh, chilli is an important cash crop possessing both domestic and export market as vegetable and also a condiment. From Andhra Pradesh, chilli is being exported to USA, UK, Japan, France, Srilanka, etc to a tune of Rs 3000 crores annually (National Horticultural Board, 2012). At fruiting stage, pod borers, *S. litura and S.exigua* damage decides the price of the marketable green and dry chilli as the larvae feeds the pericarp by making holes and even seeds. These borers cause extensive defoliation, flower drop, reduces fruit set and cause 40-50% yield loss by damaging the pods. In order to control the borers and get higher market price, farmers are indiscriminately using insecticides even just before harvest, resulting in increased pesticide residues in chilli exports and domestic marketed chilli samples (Dhandapani *et al.,* 2008). To minimize the pesticide residues in marketable chilli, there is a need to manage the pod borer, *S. litura* with effective insecticides. Hence, the present study was conducted keeping in view the above constraints.

MATERIAL AND METHODS

Field experiments were conducted in 2010 - 11 and 2011 -12 at Horticultural Research Station, Lam, Guntur to evaluate the new insecticides for the

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management of chilli pod borer, *S.litura* with leading popular chilli variety LCA 334.The trials were conducted in Randomized Block Design (RBD) with three replications. Chilli seedlings raised in the nursery were transplanted at age of 40 days in the main field by adopting a spacing of 75 cm X 30 cm and a plot size of 12 m^2 area. All the recommended agronomical practices were implemented to raise sound crop except plant protection measures against pod borers.

The selected insecticides belonging to different groups *viz.,* Organophosphates(Chlorpyriphos, Triazophos, Profenophos), Carbomates (Carbosulfan), Neonicotinoids (Imidacloprid), Microbial insecticide (Spinosad, Emamectin Benzoate), Pyroles (Chlorfenpyr), Thiourea derivatives (Diafenthiuron) and insect growth regulators (Lufenuron and Novaluron) along with untreated control were evaluated for two years, 2010-11 and 2011-12. First spray was initiated when the per cent pod damage $plant^{-1}$ reached its economic thresh hold levels (ETL) (one damaged fruit $plant^{-1}$) (Kumar *et al*., 2007).Three sprays at 15 days interval were made during the crop season.

Observations on pod damage, the per cent damage $plant^{-1}$ was recorded on one day before spray and 3,5,7 days after spray from five randomly selected and tagged plants $treatment^{-1}$. Mean per cent damage (post spray) was calculated and the recorded values were subjected to arc-sin transformation and analysis of variance. The yield data was taken from 3 to 4 pickings per plot and converted in to q ha^{-1}. The data recorded from all the observations was pooled and given in the Table 1.

RESULTS AND DISCUSSION

The mean of three sprays in 2010-11 revealed that Spinosad 45 SC @125 ml ha^{-1} (23.16) recorded lowest pod borer damage followed by Emamectin Benzoate@200 g ha^{-1}(24.31) and Novaluran 10 EC@375 ml ha^{-1} (27.61) which were found significantly superior in reducing the pod borer damage. Lufenuron@500 ml ha^{-1}(29.2), Chlorfenpyr 10 EC 1000 ml ha^{-1}(29.2) was also found significantly superior in reducing the pod borer damage and was on par with each other. Other tested insecticides *viz*., Diafenthiuron 50WP @ 750 g ha^{-1} (31.3), Carbosulfan 25% EC @ 500 ml ha^{-1} (33.15), Triazophos 40 EC 625 ml ha^{-1}(34.19), Chlorpyriphos @1250ml ha^{-1} (35.96), Imidacloprid 17.8SC @150 ml ha^{-1} (39.22) and Fipronil 5SC @ 1000 ml ha^{-1} (39.69) were significantly superior in reducing the pod borer damage in comparision to untreated control (67.18).

Pod yield (q ha^{-1}) was also found in the same trend as the efficacy of insecticides against pod borer, Spinosad 45 SC@125 ml ha^{-1}sprayed plot recorded highest yield (33.57 q ha^{-1}), followed by Emamectin Benzoate@200 g ha^{-1} (29.06q ha^{-1}), Novaluran 10 EC@375 ml ha^{-1} (28.96q ha^{-1}) and Lufenuron @500 ml ha^{-1}(27.96q ha^{-1}). Other insecticides, Chlorfenpyr 10EC 1000 ml ha^{-1} (25.96), Diafenthiuron 50WP @ 750 g ha^{-1} (22.74 q ha^{-1}),Carbosulfan 25 % EC @ 500 ml ha^{-1} (19.06 q ha^{-1}),Triazophos 40EC 625 ml ha^{-1} (18.96 q ha^{-1}),Chlorpyriphos@1250 ml ha^{-1}(18.84 q ha^{-1}), Imidacloprid 17.8 SC @150 ml ha^{-1} (17.88 q ha^{-1}), Fipronil 5 SC@1000 ml ha^{-1} (14.15 q ha^{-1}),were also significantly superior in recording higher dry pod yield compared to untreated control (9.14 q ha^{-1}) (Table 1).

Pooled mean of three sprays during 2011-12 data revealed that Spinosad 45 SC @125 ml ha^{-1}(4.16), Emamectin Benzoate@200 g ha^{-1} (4.52) were significantly superior in reducing the pod borer damage

Table 1. Evaluation of certain insecticide molecules against chilli pod borer, *spodoptera litura* (2010-11 & 2011-12)

Sl. No.	Treatment	2010-11		2011-12	
		% pod damage plant^{-1}	Yield q ha^{-1}	% pod damage plant^{-1}	Yield q ha^{-1}
1	Triazophos 40 EC @ 625 ml ha^{-1}	34.19(34.30) #	18.96	14.28(22.13)#	18.96
2	Chlorfenpyr 10 EC@1000 ml ha^{-1}	29.25(29.97)	25.95	10.39(18.81)	21.97
3	Fipronil 5 SC @1000 ml ha^{-1}	39.69(37.91)	14.15	19.00(25.84)	19.04
4	Lufenuron@500 ml ha^{-1}	29.25(29.97)	27.96	9.18(17.56)	25.55
5	Spinosad 45 SC @125 ml ha^{-1}	23.16(26.68)	33.57	4.16(11.83)	32.93
6	Imidacloprid 17.8 SC @150 ml ha^{-1}	39.22(37.57)	17.88	27.29(31.50)	18.76
7	Chlorpyriphos@1250 ml ha^{-1}	35.96(35.08)	18.84	25.85(30.53)	18.09
8	Novaluran 10 EC@375 ml ha^{-1}	27.61(30.43)	28.96	7.08(15.45)	25.93
9	Diafenthiuron 50 WP@750 g ha^{-1}	31.8(31.27)	22.74	16.44(23.89)	19.80
10	Emamectin benzoate 5 SG@200 g ha^{-1}	24.31(27.74)	30.06	4.52(12.25)	29.43
11	Carbosulfan@500 ml ha^{-1}	33.15(32.65)	19.06	27.61(31.69)	15.20
12	Control	67.18(55.19)	9.14	32.50(34.76)	12.97
	SEM	7.83	101.84	0.963	112.6
	CD @ 5 %	13.43	436.72	2.92 SIG	345.4
	CV%	2.65	12.6%	10.40 %	11.70%

Figures in parenthesis are Arc-sin transformed values. Mean of three sprayings, three replications, Five plants treatment^{-1} and replication

and were on par with each other. The next best insecticides were Novaluran 10 EC@375 ml ha^{-1}(7.08) and Lufenuron@500 ml ha^{-1}(9.18) which were found on par with each other. Other tested insecticides, *viz*., Chlorfenpyr 10 EC 1000 ml ha^{-1} (10.39),Triazophos 40 EC 625 ml ha^{-1} (14.28), Diafenthiuron 50 WP @ 750 g ha^{-1} (16.44), Fipronil 5 SC @ 1000 ml ha^{-1} (19.00), Chlorpyriphos@1250 ml ha^{-1}(25.85), Imidacloprid 17.8 SC @150 ml ha^{-1}(27.29) and Carbosulfan 25% EC @ 500 ml ha^{-1} (27.61) were also proved significantly superior in reducing pod borer damage compared to untreated control(34.76).

Pod yield (q ha^{-1}) which was in order of efficacy of insecticides against pod borer,Spinosad 45 SC @125 ml ha^{-1} sprayed plot recorded highest yield (32.93 q ha^{-1}) followed by Emamectin Benzoate@200 g ha^{-1} (29.43 q ha^{-1}), Novaluran 10 EC@375 ml ha^{-1} (25.93 q ha^{-1}) and Lufenuron @500 ml ha^{-1}(25.55 q ha^{-1}).Other insecticides *viz.,* Chlorfenpyr 10 EC 1000 ml ha^{-1} (21.97 q ha^{-1}), Diafenthurion 50WP @ 750 g ha^{-1} (19.80 q ha^{-1}),Fipronil 5SC @ 1000 ml ha^{-1} (19.04q ha^{-1}), Triazophos 40 EC 625 ml ha^{-1} (18.96 q ha^{-1}), Imidacloprid 17.8 SC @150 ml ha^{-1} (18.76 q ha^{-1}), Chlorpyriphos@1250 ml ha^{-1}(18.09 q ha^{-1}) and Carbosulfan 25% EC@ 500ml ha^{-1} (15.20 q ha^{-1}) were found significantly superior in recording higher dry pod yield compared to untreated control (12.97 q ha^{-1}).The present findings were in conformity with those reported by Sidde *et al*. (2003), Srinivas *et al*. (2007) and Krishna Kumar (2009) .

Based on the overall efficacy of insecticides over two years, Spinosad 45 SC @125 ml ha^{-1} was proved as the as the most effective insecticide for controlling pod borer infesting chilli. Spinosad possess spectrum of activity against a range of agricultural insect pests, pod borer, *Helicoverpa armigera* (Hines

and Hutchison (2001) and Gundannavar and Giraddi (2007)), cabbage butter fly, *Pieris rapae* (Linnaeus), diamond back moth (DBM), *Plutella xylostella* (Linnaeus) (Shivalingaswamy *et al*., 2006), cabbage looper, *Trichoplusia ni* (Hubner) (Satpathy *et al*., 2007) and brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) (Aparna and Dethe, 2012). Spinosad may also be used on row crops, vegetables and ornamentals (Copping and Duke, 2007). Spinosad is rapidly degraded on soil surfaces by photolysis and below the soil surface, by soil microorganisms (Saunders and Bret, 1997).Spinosad, a naturally occurring mixture of spinosyn A and spinosyn D, is a secondary metabolite from the aerobic fermentation of *Saccharopolyspora spinosa* on nutrient media. The superior efficacy is due to the excitation of insect nervous system leading to involuntary muscle contraction, prostration with tremors and paralysis. These effects are consistent with the activation of nicotinic acetylcholine receptors by a mechanism that is clearly novel and unique. Spinosad also effects GABA receptor function that may contribute further to its insect activity (Sparks *et al*., 2001).This is the reason Spinosad clearly shows significant superiority than other insecticides in managing the pod borer. It can be integrated with other methods of pest control involving botanical and biocontrol agents to develop sustainable integrated pest management. In addition to this, it is highly active at low use rates, it has less impact on certain predatory beneficial insects (Coccinellid beetles, Predatory mite *Ambyseius longispinosis*), lack of cross resistance, quicker speed of control, provides longer residual control in the field and has no special handling or use restrictions. On the other hand, it is considered to be ecofriendly without phytotoxicity and not highly systemic in plant.

CONCLUSION

Spinosad 45 SC @ 125 ml ha^{-1} can be included in the spray schedules for the management of chilli pod borer rather than continuous use of routine Organic Phosphate and Carbamates insecticides which pose important problem of residues in chillies.

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GENETIC DIVERGENCE STUDIES FOR MORPHO-PHYSIOLOGICAL CHARACTERS INCLUDING SEED YIELD IN CHICKPEA (*Cicer arietinum* L.)

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ABSTRACT

Utilization of genetically variable accessions in plant breeding programmes helps in developing potential breeding material for the future. The present investigation was carried out with thirty genotypes of chickpea to study the nature and magnitude of genetic divergence using Mahalanobis's D^2 Statistics. The data was recorded on eleven important yield and yield attributing traits from the genotypes raised in Randomized Block Design with three replications. Based on genetic diversity values thirty chickpea genotypes were grouped into five clusters. The maximum inter cluster distance was observed between cluster III and V followed by cluster I and V, cluster III and IV, cluster I and IV, cluster II and V, cluster II and IV and cluster II and III. The maximum intra-cluster D^2 distances were recorded by cluster II, while minimum distance was noticed in clusters III and V. While studying the pedigree of the genotypes, it was interesting to note that three genotypes clustered in cluster I had same pedigree. Similarly, another three grouped into cluster II also have same pedigree. On the other hand, two genotypes, though bred from same cross were grouped into different clusters. Four characters *viz*. days to 50 per cent flowering, specific leaf area, plant height and seed yield contributed maximum in manifestation of genetic diversity. Promising genotypes with high *per se* performance and genetic divergence *viz*., N BeG 49, ICCIL 01031, N BeG 510 and N BeG 119 from cluster I; N BeG 47 from cluster II; ICCV 09106 from cluster III and ICCV 97007 from cluster V were identified which can be utilized in crossing programme to recover an array of transgressive segregants for various traits.

INTRODUCTION

Annually chickpea is grown in an area of 14.80 M ha in the world producing 14.23 M t with a productivity of 962 kg ha^{-1}. In India, chickpea is cultivated in 10.74 M ha with production of 9.88 M t and productivity of 919.9 kg ha^{-1} (FAO STAT, 2016). Major producers of chickpea include India, Pakistan, Mexico, Turkey, Canada, Iran, Australia, Tanzania, Ethiopia, Spain and Burma. In India, chickpea contributes 40% and 48% to the national pulse acreage and production, respectively (Statistics DAC, 2013). Although the cultivation of chickpea is very wide in India, the productivity and production of legumes in general and chickpea in particular have remained stagnant over the years. These crops have a narrow genetic base, due to the bottlenecks associated with their evolution and domestication, as well as due to the replacement of locally adapted landraces by the genetically advanced modern varieties. Therefore, there is need to critically analyze the extent of genetic diversity in the germplasm before initiating planned breeding programmes. This in turn helps in establishing the selection strategy and identification of diverse parents which upon hybridization lead to a wide spectrum of gene combination. Genetic divergence analysis therefore, was attempted to identify suitable parents among 30 genotypes of chickpea. Mahalanobis's D^2 statistic, a tool for quantifying the degree of divergence and Tocher's method were utilized for grouping the genotypes into different clusters. The present study with 30 genotypes is an attempt in this direction to ascertain the nature and magnitude of genetic diversity.

MATERIAL AND METHODS

The present study was conducted during *Rabi*, 2015 at Regional Agricultural Research Station, Nandyal, Andhra Pradesh located at $15^0$29' North latitude and $78^0$29' East longitude at an altitude of 211.76 m above mean sea level, which falls under

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the Scarce Rainfall Agro-climatic Zone of Andhra Pradesh. The experimental material for present investigation comprised of 30 genotypes out of which 25 were obtained from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru and remaining five were obtained from genetic stock of Regional Agricultural Research Station, Nandyal, Andhra Pradesh. The study was conducted in a randomized complete block design with three replications. The experimental material was sown on November 9th, 2015 in which each genotype was raised in one row plot of 4 m length with inter row spacing of 30 cm and plant to plant spacing of 10 cm. Border rows were planted around the entries to increase the precision of study and reduce border effect. Crop was fertilized with 20 kg N + 50 kg P_2O_5 per hectare. The entire dose of P_2O_5 and nitrogen was applied as basal dose at the time of sowing. Standard recommended agronomic measures were taken up to raise a healthy crop. Two irrigations were provided through drip at 35 DAS and 55 DAS. Observations were recorded on five randomly selected plants for 11 characters such as days to 50% flowering, days to maturity, plant height, number of branches plant^{-1}, number of pods plant^{-1}, SPAD chlorophyll meter reading (SCMR), specific leaf area (SLA), shoot biomass, 100 seed weight, harvest index and seed yield. Using Mahalanobis D^2 statistic (1936) and Tocher's method, the genotypes were grouped into different clusters as described by Rao (1952). The mean values of 30 genotypes [$(X_1) – (X_2)$] were transformed into standardized uncorrelated mean values [$(Y_1) – (Y_2)$] using the pivotal condensation method. The D^2 values were computed for all the possible [n (n-1)/2] 435 pairs of 30 genotypes.

RESULTS AND DISCUSSION

The D^2 values and the average intra and inter-cluster D^2 values of various clusters are furnished in Table 1. Inter cluster average D^2 values ranged from 4.66 to 18.66. The maximum inter-cluster distance was observed between cluster III and V (18.66) followed by cluster I and V (16.66), cluster III and IV (16.43), cluster I and IV (13.99), cluster II and V (11.44), cluster II and IV (8.82) and cluster II and III (8.74) indicating wide diversity among these genotypes (Table 1). The minimum inter-cluster distance noticed between cluster I and III (4.66) followed by cluster IV and cluster V (5.78) and clusters I and II (6.57) indicated that most of the genotypes

Table 1. Average inter and intra cluster distances among 30 chickpea genotypes

Cluster	I	II	III	IV	V
I	3.57	6.57	4.66	13.99	16.66
II		3.60	8.74	8.82	11.44
III			0.00	16.43	18.66
IV				3.09	5.78
V					0.00

had similar values in these clusters. Hence, genotypes from the clusters having maximum inter cluster distance may be utilized as parents for hybridization which would result in high heterotic expression for yield components and wider segregation in filial generations. By using such genotypes as parents in hybridization programme, superior recombinants can be obtained.

The maximum intra-cluster D^2 (3.60) distances were recorded by cluster II. While minimum distance (0.00) was noticed in clusters III and V as they included single genotype each. Maximum intra-cluster distance was observed in cluster II (3.60) followed by cluster I (3.57) and cluster IV (3.09) wherein closely related genotypes were grouped into each cluster indicating less divergence among them.

Genetic diversity is considered to be important for realizing heterotic response in F_1 and a broad spectrum of variability in segregating generations (Arunachalam, 1981). Genetic relationship among the genotypes can be measured by similarity or dissimilarity of any number of quantitative characters assuming that the difference between characters of genotypes reflects the divergence of genotypes. All the 30 genotypes of chickpea were grouped into five clusters using Tocher's method (Singh and Chaudhary, 1977).

The distribution of the genotypes into clusters is presented in Table 2. Cluster II had maximum number of 15 genotypes followed by cluster I and cluster IV with nine and four genotypes respectively. The clusters III and V had one genotype each. Greater divergence between different genotypes of clusters might be due to differential adaptation to the environment to which the genotypes were exposed. Selection criteria and selection pressure exercised by the breeders might also be responsible for greater divergence between the genotypes. The 15 genotypes in cluster II might be relatively less divergent, may be due to free flow (or) exchange of breeding material from one place to another or/and the unidirectional selection practiced by breeders of different locations (Singh and Bains, 1982). The clustering pattern in the present study revealed that there was no

Table 2. Distribution of 30 genotypes of chickpea into different clusters

Cluster Number	Number of genotypes	Genotype(s)
I	9	ICCIL 01034, N BeG 49, ICCIL 01031, N BeG510, ICCIL 01026, ICCV 11101, N BeG 119, ICCV 93054, JG-11
II	15	ICCV 10, ICCV 95013, ST-3-D-2, JAKI 9218,]N BeG 3, KAK 2, ICCIL 04016, ICCIL 04021, ICCV 96005, ICCIL 04004, ICCV 08109, ICCV 08102, ICCV 95008, ICCV 04307, N BeG 47
III	1	ICCV 09106
IV	4	ICCV 97105, JSC 38, ICCV 93122, ICC 1205
V	1	ICCV 97007

correlation between geographic diversity (place where the genotype was developed) and genetic diversity. The genotypes grouped together in cluster II are originated from different centres. Similar results were substantiated by the reports of Devi *et al.* (2004) in chickpea.

However, when pedigree of the genotypes was studied, it was interesting to note that three genotypes *viz.,* ICCIL 01034, ICCIL 01026 and ICCIL 01031 clustered in cluster I had same pedigree (ICCV 93954 x ICC 4958) x 3*ICCV 93954). Similarly, ICCIL 04021, ICCIL 04004 and ICCIL 04016 grouped into cluster II also have same pedigree {(ICCV 10 x ICC 4958) x 3*ICCV 10)} and have originated from same centres. On the other hand, genotypes N BeG 3 and N BeG 49, though bred from same cross (Annegiri x ICC 4958) were grouped into different clusters. Murthy and Arunachalam (1996) reported that random genetic drift and selection in specified environments could cause greater diversity than geographical distance.

Number of times that each of the 11 characters appeared first and their respective per cent contribution towards diversity is presented in Table 3. Among all the characters studied, days to 50 per cent flowering contributed maximum (54.94%) by ranking 239 times followed by SLA (20.92 %, by taking first rank 91 times), plant height (8.74%, by ranking 38 times first) and seed yield (6.21%, by ranking 27 times). The characters *viz.,* days to maturity, number of branches plant^{-1}, number of pods plant^{-1}, shoot biomass, harvest index and 100 seed weight contributed 2.76%, 0.46%, 1.38%, 1.84%, 1.15% and 1.61%, respectively to the total genetic divergence and ranked respectively 12, 2, 6, 8, 5 and seven times first. The greater contribution of days to 50 per cent flowering towards genetic divergence is in consonance with the reports of Jayalakshmi and Ronald (2011), Pandey *et al.* (2013), Jayalakshmi *et al.* (2014), Sachin *et al.* (2014), Anita *et al.* (2015) and Jayalakshmi *et al.* (2016). For plant height, similar

Table 3. Relative contribution of 11 characters for genetic diversity in chickpea

Character	Contribution	(%)
Days to 50 per cent flowering (days)	239	54.94%
Days to maturity (days)	12	2.76%
Plant height (cm)	38	8.74%
Number of branches plant^{-1}	2	0.46%
Number of pods plant^{-1}	6	1.38%
SPAD chlorophyll meter reading	0	0.00%
Specific Leaf Area (cm^2 g $^{-1}$)	91	20.92%
Shoot biomass plot^{-1} (g plot^{-1})	8	1.84%
Harvest index (%)	5	1.15%
100-seed weight(g)	7	1.61%
Seed yield plot^{-1} (g plot^{-1})	27	6.21%

Table 4. Cluster means for different morpho-physiological characters in 30 chickpea genotypes

Cluster Number	Days to 50 % flowering (days)	Days to maturity (days)	Plant height (cm)	Number of branches per plant	Number of pods per plant	SPAD chlorophyll meter reading	Specific Leaf Area ($cm^2\ g^{-1}$)	Shoot biomass (g/plot)	Harvest index (%)	100 seed weight (g)	Seed yield (g/plot)
I	37.30	77.11	35.25	15.37	30.86	43.83	182.89	237.09	58.81	31.06	138.85
II	44.04	80.04	38.95	13.69	29.32	45.13	158.75	229.21	49.03	25.96	112.80
III	36.33	76.33	33.73	16.73	29.93	48.52	107.65	269.67	63.54	24.33	171.33
IV	55.17	82.42	38.87	14.52	29.47	45.21	175.80	216.96	44.88	24.58	97.08
V	58.33	85.67	34.13	11.20	25.59	46.04	88.70	199.33	18.49	20.00	36.67

results were reported by Jayalakshmi *et al.* (2014). For seed yield, the results are in similarity with the findings of Sreelakshmi *et al*. (2010), Babbar *et al.* (2012), Jivani *et al.* (2013) and Anita *et al*. (2015). Results of different investigators suggested that contributing characters differ in respect of their contributions to the genetic diversity. Mostly expression of these characters differs due to environmental influence on the genotypes studied, besides the nature of genetic material under investigation.

Major emphasis should be given to cluster means while selecting superior parents for crossing programme. The mean values of each cluster for all the 11 characters are given in Table 4. It was observed that clusters differ with respect to mean expression of various characters and this reflects that the clusters formed were very distinct. The cluster I showed the highest value for number of pods per plant (30.86), SLA (182.89 cm^2 g^{-1}) and 100 seed weight (31.06 g). The cluster II showed high mean value for plant height (38.95 cm). The traits such as number of branches (16.73), SCMR (48.52), shoot biomass (269.67 g), seed yield (171.33 g) and HI (63.54%) had higher cluster means in cluster III. The higher cluster means for days to 50% flowering (58.33 days) and days to maturity (85.67 days) were registered in cluster V.

CONCLUSION

Promising genotypes with high *per se* performance *viz.,* N BeG 49, ICCIL 01031, N BeG 510 and N BeG 119 from cluster I; N BeG 47 from cluster II; ICCV 09106 from cluster III and ICCV 97007 from cluster V identified from genetically divergent clusters characterized by high cluster means can be utilized in crossing programme to generate a wide range of variability followed by effective selection for these characters.

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RESPONSE OF *RABI* PIGEONPEA (*Cajanas cajan* (L.) Millsp) TO SOWING TIME AND IRRIGATIONS

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ABSTRACT

A field experiment was conducted to study the impact of sowing time and supplemental irrigations on growth and yield of *rabi* pigeonpea at Regional Agricultural Research Station, Lam, Guntur. The results indicated that the response to supplemental irrigation was more when three irrigations were provided than that of two or one at critical growth stages of pigeonpea with respect to growth and yield components. The first fortnight of September is identified as an optimum time of sowing during post-rainy season with provision of three supplemental irrigations at critical growth stages. The highest grain yield (1973 kg ha^{-1}) was recorded with this combination and it also gave higher net returns (Rs.73,861/-) and B:C ratio (1.29).

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] commonly known as redgram, *tur* or *arhar* is the fifth prominent legume crops in the world. India, Myammar, Malawi, Kenya, Uganda and Tanzania are the major pigeonpea producing countries. It has been recognized as a valuable source of protein for the vegetarians in their daily diet. In India, pigeonpea is second most important pulse crop of India which has diversified uses as food, feed, fodder and fuel, next to Chickpea. It is cultivated in an area of 3.88 mha with a production of 3.29 MT (Anonymous, 2013). The Indian sub-continent alone contributes nearly 92 per cent of the total pigeonpea production in the world. Although India leads the world both in area and production of pigeonpea, its productivity is lower (697 kg ha^{-1}) than the world average (775 kg ha^{-1}) (FAOSTAT, 2013). It is one of the protein rich legume crops of semi-arid and sub-tropics and requires due attention in view of large scale shortage of pulses to meet the domestic requirement. It is used in more diverse ways than any other pulse crop (Nene and Sheila, 1990).

However, *rabi* pigeonpea had a potential for maximum seed yield. The productivity of pigeonpea was found to be very low under rainfed condition. However, the demand for pigeonpea *dal* is increasing with premium price. Introduction of pigeonpea under *rabi* situation is compelled to initiate an experiment on pigeonpea to study the feasibility of pigeonpea cultivation during *rabi*. Several workers reported that the yields of *rabi* pigeonpea are high as compared to *kharif* pigeonpea. Govinda Reddy *et al*. (1991) realised 31.8 and 66.8 per cent less seed yield of pigeonpea on 30th October and 14th November sown crop respectively as compared to 15th October sowing. They attributed the decline to higher temperatures at pod development stage which led to high respiration rate and there by reduced amount of photosynthates to be translocated for developing grain. Panse and Jana (1990) from West Bengal reported similar results that delayed sowing from September to November resulted in lowest growth attributes as well as seed yield of pigeonpea. However, the flowering in pigeonpea should not coincide with hot weather as it may lead to severe

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flower drop resulting in low yields. Hence, the present study is envisaged to find out optimum time of sowing. Moreover, to know if supply of one or two supplemental irrigations at critical stages of crop growth results in higher yields.

MATERIAL AND METHODS

Field experiment was conducted during *rabi* season, 2014 at RARS, Lam, Guntur, A.P. The soil of the experimental site was clay loam in texture with soil pH neutral (7.4) and electrical conductivity of 0.22 dSm^{-1}. The soil organic carbon content was low (0.51%). The soil was low in available nitrogen (223 kg ha^{-1}), medium in available phosphorus (23.4 kg ha^{-1}) and available potassium (312 kg ha^{-1}). The treatments consisted of three dates of sowing *viz.*, D_1-September 1st, D_2- September 15th and D_3-October 1st and three supplemental irrigations *viz.*, I_1-One irrigation at 50 DAS, I_2-Two irrigations at flowering initiation and pod development stages and I_3-Three irrigations at 50 DAS, flowering initiation and pod development stages. The experiment was laid out in randomised block design with factorial concept and replicated thrice.

Prior to sowing the field was prepared with the onset of monsoon rains at proper moisture conditions and cultivating twice followed by planking. The spacing adopted was 120 cm X 20 cm. For the control of weeds, pendimethalin was sprayed on the same day after sowing and the spay fluid was 500 litres per ha. Imazathapyr @100 g ha^{-1} was sprayed as post emergence application at 10-15 DAS with a spray volume of 500 litres ha^{-1} followed by intercultivation operation at 50 DAS. The crop was grown with standard packages of practices for the region. Prophylactic plant protection measures were taken as against the leaf webber and leaf eating caterpillars and crop was harvested when 95% of pods are matured.

Plant height at harvest was recorded for randomly selected five plants. Grain yield was recorded on whole plot basis and then converted in to kg ha^{-1}. Data on yield components *viz.*, branches $plant^{-1}$, pods $plant^{-1}$ and test weight (100 grain) was also recorded. The data was subjected to analysis of variance as per standard procedures.

RESULTS AND DISCUSSION

Growth

The plant height and number of branches $plant^{-1}$ was influenced by time of sowing (Table1). The early sown crop resulted in significantly more plant height than later sown crop, irrespective of supplemental irrigation. Significant reduction in number of branches $plant^{-1}$ was also observed when the crop was sown on 1st October than September (1st and 15th) sown crops. These findings are in accordance with those of Panse and Jana (1990). Significantly increased plant height was recorded when the crop was provided with three supplemental irrigations at critical stages of crop growth stages (50 DAS, flowering initiation and pod development stage). Influence of one (50 DAS) or two irrigations (flowering initiation and pod development) on branching was not comparable but, a significant difference was observed between two (flowering initiation and pod development) and three irrigations (50 DAS, flowering initiation and pod development),

irrespective of time of sowing. Adequate and timely supply of nourishment and enhanced the metabolic processes in the plant might have resulted in better growth. The results are in confirmity with those of Kumbhar *et al*. (2015).

Yield attributes and Yield

The yield components (pods plant^{-1} and test weight) and yield was significantly influenced by time of sowing and supplemental irrigations (Table1). The maximum number of pods plant^{-1}(293) was recorded when the crop was sown on 1st September and beyond that significant reduction was noticed among all other treatments. Test weight (100 grain weight) not influenced when the crop was sown on either 1st or 15th September, however, comparable difference was observed in September and October sown crop.

Table1. Growth and yield of *rabi* pigeonpea as influenced by time of sowing and supplemental irrigations

Treatments	Plant height (cm)	Branches Plant^{-1}	Pods Plant^{-1}	Test wt. (g)	Grain yield (kg ha^{-1})
Factor A: Date of sowing					
D_1- 1st September	163	18.1	293	9.8	1708
D_2- 15th September	149	17.1	235	9.7	1539
D_3- 1st October	137	15.1	226	9.2	1218
Sem±	3.2	0.61	8.5	0.15	40
CD @ 5 %	9.7	1.8	26	0.44	119
Factor B: Supplemental irrigation					
I_1-One supplemental irrigation at 50DAS	139	15.3	212	9.2	1275
I_2-Two supplemental irrigations at flowering initiation and pod development stage	151	16.7	259	9.5	1489
I_3-Three supplemental irrigations at 50 DAS, flowering initiation and pod development stage	161	18.5	284	10.1	1701
Sem±	3.2	0.61	8.5	0.15	40
CD @ 5 %	9.7	1.8	26	0.44	119
Interaction	NS	NS	NS	NS	NS
CV (%)	6.4	10.8	10.1	4.6	8.0

Influence of one (50 DAS) or two irrigations (flowering initiation and pod development) on test weight was statistically not comparable, however, the difference was significant between two (at flowering initiation and pod development) and three irrigations (at 50 DAS, flowering initiation and pod development), irrespective of time of sowing. Among the number of supplemental irrigations, three supplemental irrigations significantly increased the yield components *viz*. Number of pods plant^{-1} and test weight of pigeonpea as compared to one irrigation (50 DAS) and two irrigations (flowering initiation and pod development stage). Improvement in soil moisture storage due to irrigation helped the plant to absorb

more nutrients from the soil which resulted in increased seed weight. Similar favourable effect of irrigation on yield components of pigeonpea was reported by Basu and Bandyopadhyay (2009).

Grain yield was also drastically influenced by time of sowing, irrespective of supplemental irrigations. Early sown (1st September) crop recorded the maximum grain yield (1708 kg ha^{-1}) and beyond that 9.9% and 28.7% reduction in yield was recorded as compared to 15th September and 1st October sown crops, respectively. With delay in sowing, flowering was induced earlier resulting in less vegetative growth and earliness in maturity resulting in low seed yield. These results are in close conformity with those of Krishna Reddy *et al*. (2015) and Nene and Sheila (1990). Similar results also reported by Laxminarayana (2003) indicated that September 15th sown pigeonpea had recorded the highest seed yield compared to later dates of sowing. Irrespective of time of sowing, the maximum grain yield (1701 kg ha^{-1}) was recorded when the crop received three supplemental irrigations (at 50 DAS, flowering initiation and pod development) and it was significantly superior to two irrigations (at flowering initiation and pod development) (1489 kg ha^{-1}) and single irrigation (50 DAS) (1275 kg ha^{-1}). Increasing the soil moisture availability/storage through supplemental irrigations significantly improved the number of pods $plant^{-1}$ and test weight. As a result, seed yield was maximum with three irrigations than that of one or two irrigations. It indicated that irrigations at flowering initiation stage and pod development stages were necessary for higher seed production of pigeonpea during *rabi* season. Devoid of irrigation at later stages reduced the seed yield to a greater extent (16.8%). This might be due to fact that the moisture stress affects translocation of photosynthates from leaves to grain thus resulting in small grains. The decrease in these attributes might have affected in decreased grain yield and it might be also due to moisture stress at critical crop growth stages results in pre mature closure of stomata to reduce water loss, but it also decreases

Table 2. Yield and economics of *rabi* pigeonpea as influenced by time of sowing and supplemental irrigations

Treatment combinations	Grain yield (kg ha^{-1})	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	B:C Ratio
D_1I_1	1445	96093	49844	46249	0.93
D_1I_2	1707	113516	53594	59922	1.12
D_1I_3	1973	131205	57344	73861	1.29
D_2I_1	1303	86783	49844	36939	0.74
D_2I_2	1552	103208	53594	49614	0.93
D_2I_3	1762	117173	57344	59829	1.04
D_3I_1	1076	71554	49844	21710	0.44
D_3I_2	1208	80332	53594	26738	0.50
D_3I_3	1369	91039	57344	33695	0.59

carbon dioxide diffusion in to leaves, there by affecting photosynthesis. These findings are also supported by the results of Basu and Bandyopadhyay (2009), Pramod *et al*. (2010) and Saritha *et al*. (2012).

Economics

Among all the treatment combinations, D_1I_3 showed the highest net returns (Rs.73,861/-) and B:C ratio (1.29) of *rabi* pigeonpea followed by D_1I_2 (1.12) and D_1I_1(0.93) (Table2). This might be due to higher grain yield obtained with higher number of irrigations at critical growth stages. Sowing beyond the end of September was not economically viable. The results were in agreement with the findings of Islam *et al*.(2008). Among the supplemental irrigations, three irrigations recorded higher cost of cultivation when compared to one irrigation at 50DAS and two irrigations at flowering initiation and pod development as it required more labour for irrigations. Inspite of this, it recorded higher gross returns (Rs.1, 13,117/-), net returns (Rs.55,773/-) and B:C ratio (0.97) due to its higher grain yield. Saritha *et al*. (2012) also obtained similar results.

CONCLUSION

It was concluded that the first fortnight of September was identified as an optimum time of sowing during post-rainy season with provision of three supplemental irrigations at critical growth stages (at 50 DAS, flowering initiation and pod development). It was also found to be economically viable with higher net returns and B:C ratio.

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EFFECT OF FREEZE DRYING PROCESS FOR RETAINING PHYSICAL CHARACTERISTICS OF ORCHID FLOWER

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ABSTRACT

Flowers are a means of expression, their fragrance and colour brings a sense of freshness and beauty and plays a significant role in human life. In order to protect the inherent qualities of orchid flower through freeze drying technique this study was taken up to polymer pre and post treatments to provide shatter and water resistance, durability, antioxidants, colour setting agents and ultra-violet inhibitors explore the impact of post treatments which protects the flowers from environmental damage. Different preservatives were identified and tested for hydration, pre and post treatments to retain the physical characteristics of flowers. Among the different methods, the flower treated with preservative**(**a blend of Sprite and Bleach) in luke warm water(43-45^{o}c) during hydration process, followed by pre-treatment with Base composition III and post treatment by application of Dried Material Preservative (DMP) as sealant as post treatment was found to be effective for retaining inherent qualities of the flowers.

INTRODUCTION

Flowers and plants add that extra special touch to gardens, homes, and occasions - weddings, celebrations, banquets, as well as solemn occasions. The gifts presented in the form of flowers are the best gifts ever given to someone and one feels a sense of contentment and compassionate, which in turn leads to reduction of worries and anxiety. The Orchidaceae family is a diverse and widespread family of flowering plants with colourful and fragrant blooms. The outer whorl of orchid has three sepals and the inner whorl has three petals. The sepals are usually very similar to the petals and comes in most popular colour in orchid is blue purple. Others include white, green, red, orange, burgundy, yellow and brown.

The most effective method of flower preservation is freeze drying used to preserve a perishable material which removes moisture from flowers to maintain their original shape, texture and colour better than the other drying techniques. In order to protect the inherent qualities of orchid flower through freeze drying technique this study was taken up to polymer pre and post treatments to provide shatter and water resistance, durability, antioxidants, colour setting agents and ultra-violet inhibitors explore the impact of post treatments which protects the flowers from environmental damage.

MATERIAL AND METHODS

The study was conducted at College of Home Science, Professor Jayasankar Telangana State Agricultural University (PJTSAU), Hyderabad during the year 2012 with Floral Freeze Dryer equipment by adopting experimental research design. Each of these flowers had different formation in terms of colour, form, texture and appearance. Fresh and partially bloomed flowers suitable for freeze drying process were selected for the study. Treated flowers were analyzed quantitatively and qualitatively to explore the effect of these treatments on the following physical characteristics (colour, form, texture and appearance) of selected Orchid flower (Table 1).

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Table 1. Physical Characteristics

Colour	Blue purple petal with white, lavender combination of the two colours.
Form	Flat-faced petals and sepals of equal size and strap or cylinder shaped leaves
Texture	Stiff, velvety and glossy petal
Appearance	Five pointed petals that form the shape of a star

The treatments were identified and evaluated for suitability for hydration, pre and post treatments listed below during the freeze drying process

Hydration Treatments	
T_1:	5 ml of Silver thiosulphate to a litre water
T_2:	Sprite 50 ml, Bleach 1.5g to a litre of Luke warm water 43-45^{0}c.
T_3:	150 mg of Aspirin powdered and added to a litre Luke warm water 43-45^{0}c.
T_4:	Lemon soda 50 ml, Bleach 0.7gms to a litre of water.
T_5:	Sugar 2 g, Bleach 1.5g, Listerine Mouth Wash 6 ml to a litre of water.
T_6:	Epsom Salt 2 g, chlorine bleach 2 g, Lemon Soda 50 ml to a litre of water
Pre treatments	
Basic compositions*	T_1 – Base 1 T_2 - Base 2 T_3 – Base 3
Improved composition**	T_4 – Base 1 + Polymer I in 50: 50 T_5 – Base 2 + Polymer I in 50: 50 T_6– Base 3 + Polymer I in 50: 50
Advanced composition***	T_7– Base 1 + Polymer I + Polymer II in 50: 45: 5 T_8– Base2 + Polymer I + Polymer II in 50: 45: 5 T_9– Base3 + Polymer I + Polymer II in 50: 45: 5

*- Basic three compositions : There were the blend of tertiary butyl alcohol, 1-propanol and 2-propanol, dibasic sodium phosphate, sodium formaldehyde sulfoxylate, citric acid, thiourea, aluminum sulphate, sodium citrate, cupric sulphate, propionic acid, phenol and silicone resin in different proportions. (T1, T2 & T3) in different qualities ** - Improved Composition: It is an improvement to basic treatments to improve shatter resistance with a polymer I- Ethyl Vinyl Acetate (EVA) (T4, T5, and T6). *** - Advanced composition: Further modified to improve pliability of the flower with polymer II- Poly Ethylene Glycol (PEG) (softening agent) (T7, T8 & T9).

A set of fourteen different chemicals cited in US free Patent 4349459, which fall into the category of exchange medium, biological fixatives, preservatives, environmental fixers, buffers, mordant's, pH modifiers, were used in this study and were tested on the flower individually and in combination. Florets of the flower were immersed in each solution for five seconds to study the effect of these chemicals. Each of these chemical solvents was found to play a crucial role on colour, texture, form and appearance of flower. These chemical solvents were blended into different compositions in the on-going Freeze dried flowers research project of the department (Reddy and Kumari, 2010).

Composition III and 6 -7 solvents consisting of blend of harsh and mild dehydrant, pigment fixative, colour preservative and pH buffers with pH value between 5.5 – 6.0.

Post – Treatment

T_1 – Acrylic Clear Spray (ACS)

T_2 – Picture Varnish (PC)

T_3 – Glazing Medium (GM)

T_4 – Gloss Lustre (GL)

T_5 – Dried Material Preservative (DMP)

T_6 – Glazing Dip (GD)

The four distinct variables were selected for assessing physical characteristics of lower such as change in colour, change in form, change in texture and change in appearance. In addition moisture loss in flower was also assessed to explore the extent of evaporation. Effect of hydration treatments, pre treatments and post treatments were carried out by qualitative and quantitative analysis, respectively. Three point scale was used for scoring the variation in each of these qualities for evaluation by a panel of three experts. The scores obtained for each of these variables were subjected to analysis of variance-one way classification to study the effect of treatments on keeping quality of flower.

RESULTS AND DISCUSSION

Effect of hydration treatments on Orchid

Freshness of the orchid was observed for 10 days and the effect of the selected preservative treatments on this flower is presented in Table 2.

Table 2. Effect of hydration treatment on physical observation scores on Orchid

Days/Treatments	C	T1	T2	T3	T4	T5	T6
Day 1	12	12	12	12	12	12	12
Day 2	12	12	12	12	12	12	12
Day 3	12	12	12	12	12	12	12
Day 4	11	9	12	10	12	11	12
Day 5	10	9	12	10	11	9	9
Day 6	8	9	12	9	9	8	9
Day 7	8	8	12	8	9	8	9
Day 8	8	8	12	8	9	8	9
Day 9	8	8	11	8	9	8	8
Day 10	5	5	11	8	8	8	5

Treatments: C: Control; T1: STS ; T2: SBW; T3:AW; T4:LSBW;T5:SBLW; T6:EBSW

Observation of scores reported in Table 2 revealed the influence of treatment on the exotic flower Orchid. An interesting observation in the Table is that flowers remained fresh for three days with and without treatments and gradually started deteriorating in quality in all treatments except T_2. As noticed in the Table 2, even the flower Orchid remained almost fresh upto 10 days when treated with T_2 *i.e.*, blend of

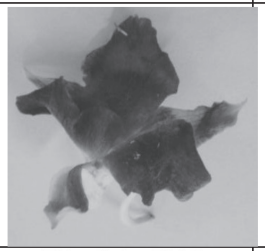
Reference	Treatment of Orchid Flower with Different Pre-treatment Compositions				
					
Fresh flower	T1 – B 1	T2 – B 2	T3 – B 3	T4 – B 1 + PI	T5 – B 2 + PI
H 371 S 82% B 60%	H 310 S 75% B 30%	H 312 S 54% B 18%	H 354 S 46% B27%	H 328 S 46% B 33%	H 309 S 52% B 44%
Violet(Dark Purple)	Violet (Pompadour)	Red (Castro)	Violet(Palatinate Purple)	Red (Wine Berry)	Violet(Palatinate Purple)
	Moisture -92%	Moisture -92%	Moisture -91%	Moisture -89%	Moisture -97%
					
Freeze Dried	T6 – B 3 + PI	T7 – B 1 + PI&II	T8 – B 2 + PI&II	T9 – B 3 + PI&II	
Violet (Mardi Gras)	H 306 S 62% B 47%	H 325 S 62 B 38%	H 342 S 68% B 35%	H 325 S 54% B 51%	
H 302 S 43% B24%	Violet(Palatinate Purple)	Red (Siren)	Red (Castro)	Red(Camelot)	
Moisture - 90%	Moisture -91%	Moisture -83%	Moisture -92%	Moisture -91%	

Fig. 1. Effect of selected pre-treatments on Orchid

sprite and bleach in water, highlighting the effect of treatment on shelf-life of flowers.

Effect of selected pre treatments on Orchid

Fresh flowers were selected for the study and the illustrations are shown in Fig. 1. Flower treated with $T_3$was more close to natural flower, though the hue changed into darker shade. All the flowers dried in freeze dryer resulted in darker shade. In all the treatments the moisture loss percentage varied between 89%-93% in all the flowers and it remained consistent between experiments.

Experts panel scores (Table 3) on qualitative parameters of Orchid treated and freeze dried with nine treatments revealed that scores for T_3 was maximum for form, texture and appearance. It can be noted from this observation that the base composition was more effective on this flower than others and addition of polymers did not work on this flower and it may be concluded that flower type and its physiological characteristics influence the choice of treatment. **Colour:** Comparision of colour values in terms of HSB of reference flower (H-371 S-82% B-60%) to all treatments, T_3 was more nearer (H-354 S-46% B-27%) to values except for brightness (B). This proved that freeze dried flowers retained colour more closer to nature (Thomas, 1999 and Wilkins and Desborough, 1986). **Form:** The freeze dried control flower was shrunk and crispy when compared with reference flower. There was a marked change in the shape and form of the flowers with T_3, T_6 and T_8. This proved that chemicals blended to prepare in different compositions had strong influence on the quality of flower.

Table 3. Physical Observation score on Orchid

Characteristics	Control	Basic compositions			Improved compositions			Advanced compositions		
		T1	T2	T3	T4	T5	T6	T7	T8	T9
Colour	2	2	2	2	2	2	2	2	2	2
Form	2	3	2	3	2	3	3	2	2	2
Texture	1	2	2	3	1	2	2	2	2	1
Appearance	1	2	2	3	2	2	3	2	3	2
Total	6	9	8	**11**	7	9	10	8	9	7

Texture: The freeze dried control flower was over dried and brittle when compared with reference flower and had the least score. Similar to form, there was a distinct change in the texture of flowers among the treatments and T_3 received maximum score points without gloss and sheen, though it retained form.

Appearance: The freeze dried control flower was over dried and brittle when compared with reference flower and had the least score. Beauty of flower is with glossy and stiff petals. Though T_3, T_6 and T_8 scores for appearance were high and this may be due to stiffness of the petals.

Moisture: This was measured quantitatively and it was found that in all the treatments the moisture loss percentage varied between 83%-97% in all the flowers and it did not remain consistent between experiments and found that the highest moisture loss was observed in T_5. This may be due to variations in chemicals between treatments which influenced the weight of flower.

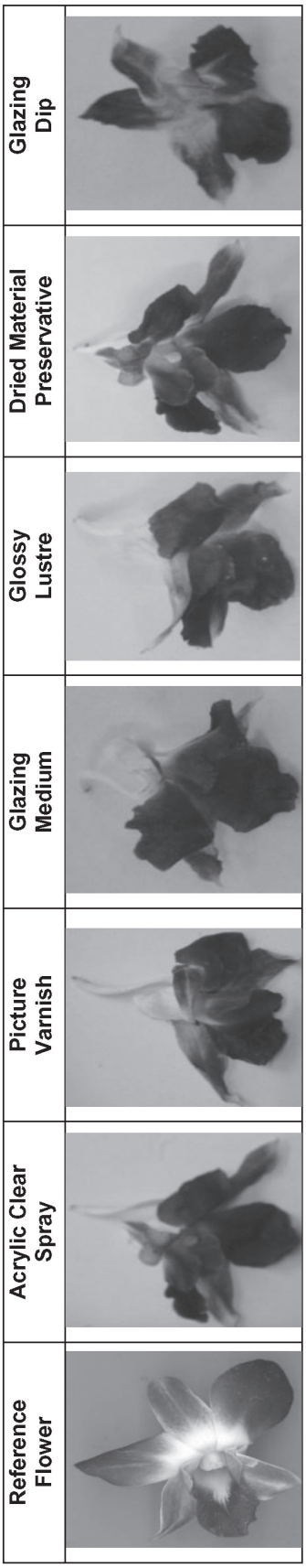


Fig. 2. Effect of selected Post treatments on Orchid

Table 4. ANOVA - One way Classification Table on Orchid

Source of Variation	SS	df	MS	F	P-value	F Critical
Between Groups	8.225	9	0.913889	4.061728	0.001734	2.210697
Within Groups	6.75	30	0.225			
Total	14.975	39				

* - Significant difference at 5% level

Effect of post treatments on Orchid

The effect of post-treatment on freeze dried Orchid flower is depicted in Fig. 2 and Physical observation scores are presented Table 5.

Table 5. Physical observation score on Orchid

Characteristics	T1	T2	T3	T4	T5	T6
Colour	2	2	3	2	3	2
Form	2	2	2	1	2	1
Texture	2	2	2	1	2	1
Appearance	2	2	2	2	3	1
Total	8	8	9	6	**10**	5

From the physical observation scores it can be noted that the flower coated with T_5 (dried material preservative) had highest score and the second best score was for glazing medium. The detailed observation of the score revealed that the form and texture were less natural, but colour and glossy appearance were close to natural flower.

Table 6. ANOVA - One way Classification Table on Orchid

Source of Variation	SS	df	MS	F	P-value	F Critical
Between Groups	4.375	5	0.875	3.7058	0.017581	2.7728
Within Groups	4.25	18	0.236111			
Total	8.625	23				

These scores were statistically analysed to establish the influence of treatments on overall quality of flowers (Table 6). (Anova one-way classification table) on Orchid revealed that post-treatments has significant difference on the overall quality of freeze-dried exotic flowers. Since calculated value of F is greater than the table value of F, null hypothesis is rejected at 5% level of significance. These results coincided with views of Brian (2009) who stated that commercial sealant and colour-enhanced floral sprays enhance the quality of flowers.

CONCLUSIONS

Flower quality is adversely affected due to inadequate postharvest care facilities and procedures. From the above research it was found

that to retain the freshness and physical characteristics of the natural flower for a longer period it is essential to follow sequence of procedure in freeze drying process to preserve the flower. Hydration treatment with Sprite 50 ml, Bleach 1.5 g to a litre of luke warm water (43-45^{0}c), pre-treatment with Basic Composition III and post treatment with Dried Material Preservative (DMP) retained physical characteristics for longer period. Choice of treatments for flowers in hydration process, pre-treatments, freeze drying, post treatments differs for each flower due to their physical quality. Careful selection of treatment ensures good quality flowers. Hydration enhances freshness of the flowers quality to get better freeze dried flowers, whereas, pre-treatments help to retain the natural colour and form of the flower in the natural state. Post treatments help to seal the flowers to improve the quality of flower and protect from environment. Freeze Dried flower products retains their aesthetic value. Package of practices helps as a guide to practice the method of freeze drying process in order to get the best quality of freeze dried flowers.

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ASSESSING THE LEVEL OF AWARENESS AND EXTENT OF PARTICIPATION OF WOMEN IN NGO ACTIVITIES IN UNITED ANDHRA PRADESH

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ABSTRACT

The study was conducted in the three regions of Andhra Pradesh *i.e.*, coastal Andhra, Telangana and Rayalaseema with a sample size of 150 women beneficiaries of 15 selected NGOs. Exploratory research design was adopted. For the purpose of this study, the level of awareness of women on different developmental programmes of NGOs and the extent of participation of women in these activities was assessed. The findings are presented region wise and activity wise. The salient findings of the study are that for all the NGO activities, majority of the women had fallen under medium category in the three regions with respect to level of awareness on different NGO programmes. The overall findings also revealed that with regard to participation in NGO activities in coastal Andhra region majority fell under medium(52%) followed by high(32%) and low(16%) category. In Telangana, similar trend was observed with majority falling under medium(50%) followed by high(28%) and low(22%) category. In Rayalaseema, majority fell under medium (51%) followed by high (30%) and low (19%) category with regard to participation in NGO activities.

INTRODUCTION

Women have a central role to play in the developmental process as they constitute 48.5 percent of the total population of the country.Women development is a complex phenomenon which has many dimensions such as social, economic, cultural, educational, environmental and political. In this connection, the role of non-governmental organizations in women development has been recognized and considered vital. Despite womens' involvement and contribution, their level of awareness and extent of participation in developmental activities is often undervalued and largely ignored.

Non- governmental organizations, since the end of second world war, become increasingly more important to global development. They often hold an interesting role in socio-economic rural upliftment. The involvement of NGOs in women development is more essential for the development of communities and also for the benefit of the weaker sections in the rural societies. The role of NGOs in women development has been recognized and considered vital mainly because of their first hand experience and knowledge of local needs, problems and resources of local level. Despite six and a half decades of independence, the intended results in women development could not reach the needy people. At the same time the developmental plans do not reflect the needs of the women because of incorrect and inadequate information and remote contact. Altogether, a different kind of expertise is required. Innovative strategies are to be mobilized in order to reach the poorer strata, this offers vast scope for intervention by alternative institutions, particularly NGOs because of their proximity to the people. (Srinivasan, 2011). Under this backdrop, the present investigation was designed to study the level of awareness and extent of

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participation of women in NGO activities of women development.

MATERIAL AND METHODS

For the present study exploratory research design was used. The state of Andhra Pradesh was purposively selected. The study was conducted in the three regions of Andhra Pradesh *i.e.*, Coastal Andhra, Telangana and Rayalaseema during the years 2012-13. One district from each region and five NGOs from each selected district were randomly chosen making a sample of 15 NGOs for the study. Regarding selection of respondents, ten beneficiaries from each selected adopted village of each NGO were chosen thus making a total of 150 beneficiaries from 15 NGOs. Interview schedule was developed and standardized based on the objectives of the study. The data was collected, coded, processed and subjected to appropriate statistical analysis.

RESULTS AND DISCUSSION

Level of awareness of the respondents in women development activities of the NGO

The level of awareness of women in this study has been operationalised as the extent of consciousness/knowing things created by the NGOs about various developmental activities, issues and problems. The data collected on the overall participation of the women respondents was categorized into Low, Medium and High based on class interval range and has been presented in Table 1.

Table 1. Level of awareness of the respondents in women development activities of the NGO

N=150

S.No	Level of awareness	Coastal Andhra		Telangana		Rayalaseema		Total	
		F	%	F	%	F	%	F	%
1.	Low (45-90)	12	24.00	10	20.00	11	22.00	33	22.00
2.	Medium (90-135)	18	36.00	22	44.00	23	46.00	63	42.00
3.	High (135-180)	20	40.00	18	36.00	16	32.00	54	36.00
	Total	50	100	50	100	50	100	150	100

An overview of the findings in Table 1 revealed that forty two percent(42%) of beneficiaries fall under medium level of awareness category followed by high (36%) and low(22%) level of awareness (Padmini, 2004). The reasons might be that the concerned NGOs were concentrating primarily on awareness generation on different developmental programmes, activities and related issues and performing street plays and have sufficient practical experience and skills in using different methods such as implanting success stories, conducting film shows, field trips, cycle rallies, door to door campaigns etc which

Table 2. Distribution of target women according to their level of awareness on different development activities of the NGO (N=150)

S. No	Level of awareness on different aspects	Three regions of A.P							
		Coastal Andhra		Telangana		Rayalasee-ma		Total (N=150)	
		F	%	F	%	F	%	F	%
1. Rural development programmes									
a.	Low(6-12)	6	12.00	10	20.00	9	18.00	25	16.00
b.	Medium(12-18)	32	64.00	31	62.00	30	60.00	90	62.00
c.	High(18-24)	12	24.00	9	18.00	11	22.00	32	21.00
		50	100	50	100	50	100	150	100
2. Women development programmes									
a.	Low(5-10)	3	6.00	8	16.00	9	18.00	20	13.00
b.	Medium(10-15)	25	50.00	22	44.00	20	40.00	67	45.00
c.	High(15-20)	22	44.00	20	40.00	21	42.00	63	42.00
		50	100	50	100	50	100	150	100
3. Legal rights and laws									
a.	Low(3-6)	4	8.00	8	16.00	9	18.00	21	14.00
b.	Medium(6-9)	34	68.00	32	64.00	30	60.00	96	64.00
c.	High(9-12)	12	24.00	10	20.00	11	22.00	33	22.00
		50	100	50	100	50	100	150	100
4. Political factors									
a.	Low(8-16)	10	20.00	14	28.00	15	30.00	39	26.00
b.	Medium(16-24)	28	56.00	25	15.00	24	48.00	77	51.00
c.	High(24-32)	12	24.00	11	22.00	11	22.00	34	23.00
		50	100	50	100	50	100	150	100
5. Health and nutritional aspects									
a.	Low(5-10)	4	8.00	6	12.00	7	14.00	24	16.00
b.	Medium(10-15)	30	60.00	28	56.00	28	56.00	86	58.00
c.	High(15-20)	16	32.00	16	32.00	15	30.00	47	26.00
		50	100	50	100	50	100	150	100
6. Environmental education									
a.	Low(3-6)	7	14.00	9	18.00	7	14.00	23	16.00
b.	Medium(6-9)	29	58.00	29	58.00	28	56.00	86	57.00
c.	High(9-12)	14	28.00	12	24.00	15	30.00	41	27.00
		50	100	50	100	50	100	150	100
7. Adult literacy and non formal education for children									
a.	Low(2-4)	12	24.00	15	30.00	16	32.00	43	28.00
b.	Medium(4-6)	32	64.00	30	60.00	29	58.00	91	61.00
c.	High(6-8)	6	12.00	5	10.00	5	10.00	16	11.00
		50	100	50	100	50	100	150	100
8. Family counseling									
a.	Low(5-10)	13	26.00	15	30.00	16	32.00	44	29.00
b.	Medium(10-15)	25	50.00	24	48.00	23	46.00	72	48.00
c.	High(15-20)	12	24.00	11	22.00	11	22.00	34	23.00
		50	100	50	100	50	100	150	100
9. Crisis management and support									
a.	Low(4-8)	3	6.00	6	12.00	6	12.00	15	10.00
b.	Medium(8-12)	30	60.00	29	58.00	28	56.00	87	58.00
c.	High(12-16)	17	34.00	15	30.00	16	32.00	48	32.00
		50	100	50	100	50	100	150	100
10. Consumer education									
a.	Low(4-8)	12	24.00	16	32.00	15	30.00	43	29.00
b.	Medium(8-12)	23	46.00	20	40.00	20	40.00	63	42.00
c.	High(12-16)	15	30.00	14	28.00	15	30.00	44	29.00
		50	100	50	100	50	100	150	100

(F: Frequency)

Table 2. Distribution of women respondents based on their activity-wise level of awareness

S.No	Activity / Programmes	Mean scores	Rank
1.	Rural development programmes	3.10	1
2.	Women development programmes	2.70	2
3.	Legal rights and laws	1.67	7
4.	Political factors	1.92	5
5.	Health and nutritional aspects	1.44	8
6.	Environmental education	1.24	9
7.	Adult literacy and non formal education for children	1.69	6
8.	Family counseling	1.22	10
9.	Crisis management and support	2.15	3
10.	Consumer education	2.07	4

Overall mean score=1.92

proved to be the most effective methods of awareness creation.

Activity wise level of awareness of beneficiaries

A spectrum of ten activities/programmes undertaken by the NGOs with respect to the activities has been assessed. The results are presented in Table 2. The responses were collected on a three point continuum as fully aware (3), partially aware (2) and not aware (1) with scoring of 3, 2 and 1, respectively. Total scores and mean scores have been calculated to find out the level of awareness with respect to different activities

Based on the total scores and mean scores the findings revealed that among all the activities, rural development activities ranked 1(mean score=3.10) followed by women development activities (mean score=2.70 , crisis management and support(mean score=2.15),consumer education(mean score=2.07),and political factor(mean score=1.92) which were above the overall mean score and remaining activities scored scored below the overall mean score. The findings were according to Padmini and Reddy (2005).

Extent of participation in development activities of the NGO

The extent of participation in developmental activities for the study was operationalised as the extent of involvement of beneficiaries at all stages *i.e.*, from planning to implementation and evaluation of activities of NGOs. The data pertaining to the

Table 3. Distribution of target women according to their extent of participation in development activities of the NGO

N=150

S. No	Extent of participation	Coastal Andhra		Telangana		Rayalseema		Total	
		F	%	F	%	F	%	F	%
1.	Low (upto 16)	8	16.00	11	22.00	10	20.00	29	19.00
2.	Medium (17-32)	26	52.00	25	50.00	25	50.00	76	51.00
3.	High (33-48)	16	32.00	14	28.00	15	30.00	45	30.00
	Total	50	100	50	100	50	100	150	100

overall participation of women in NGO activities in three regions is presented in Table 3. The overall findings indicated that majority(51%) of the beneficiaries had medium level of participation followed by high(30%) and low level of participation(19%).the probable reason might be due to the partial participation in extension activities like crop demonstrations, *melas*, exhibitions and trainings followed by participation in identifying the right beneficiaries and sharing of benefits among people. The reason for low participation might be the poor participation in activities such as organizing field visits, PRA techniques and in discussions to identify village problems and technical options for those problems which require additional time. The findings were according to Padmini and Reddy(2006) and Mangasri (1999).

The overall findings indicated that the participation was high in Telangana region when compared to coastal Andhra and Rayalaseema regions as more number of developmental activities is being taken up in Telangana due to more donors in and around the capital city Hyderabad.

CONCLUSION

The findings revealed that in all the three regions most of the respondents exhibited moderate to high level of awareness and participation in NGO activities. This was because most of the NGOs were developing location specific strategies to enhance awareness and motivated deprived women to participate in their activities. Among all activities, awareness on rural development programmes ranked first followed by women development programmes. Regarding the activity wise awareness, results indicated that the first three ranks were scored for Rural development programmes, Women development programmes followed by Crisis management and support which are the most important areas to be focused on for sustainable development (Mamata , 2011). The findings of the study, therefore, implied that in all the three regions the credibility of NGOs was well established and the

government was using NGOs as parallel pillars for extending their programmes for rural empowerment.

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Research Note
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EFFECT OF IPM MODULE ON INFESTATION OF *OKRA* SHOOT AND FRUIT BORER (*Earias* spp.)

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Okra (*Abelmoschus esculentus* L. Moench) is a member of the family malvaceae and is said to be native of Africa possibly Ethiopia (Singh and Bhagchandani, 1967). *Okra* is one of the most important fruit vegetable grown throughout the tropics and warm temperate zones. It is widely cultivated as a summer season crop in North India and as a *Kharif* and summer season crop in Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu.

Okra is susceptible to the attack of various insects from seedling to fruiting stage such as *Okra* shoot and fruit borer, *Okra* jassids, cut worm, white fly, aphids etc. Among these *Okra* shoot and fruit borer (OSFB), *Earias* spp. is the most serious pest which cause direct damage to tender shoots and fruits.

Conventionally farmers are using various types of synthetic chemical insecticides to control *Okra* shoot and fruit borer. However, the unconscious and unjustified use of synthetic pesticides creates several problems in agro-ecosystem such as direct toxicity to beneficial insects, fishes, and man. Therefore, it is now desirable to use safe and effective biodegradable pesticides with less toxic effects on non-target organisms. The biologically active natural products such as botanicals, microbial pesticides and pheromones may play a significant role in this regard. Among these, botanical and microbial insecticides are broad spectrum in pest management and many are safe to apply, unique in action and can easily be processed and used. Among the recognized plants, the neem tree (*Azadirachta indica* A. Juss) proved its unique source for numerous active ingredients of insecticidal properties. Neem ingredients affect insects in various ways including repellent, antifeedant, toxic, growth regulatory effects and effect on fecundity. Similarly, *Bacillus thuringiensis* var. *kurstaki* based formulations are specially recommended for lepidopteran pests because of their quick knockdown effect. Apart from this, pheromone traps are now a days commonly used in different crops against different insects and were reported by earlier workers. (Singh and Sachan, 1991 and Patil *et al*., 1992).

In view of the conservation of natural biological system and thereby management of *Okra* shoot and fruit borer, the present research work was undertaken.

Effect of IPM module on infestation of *Okra* shoot and fruit borer

A statistically designed field experiment was conducted during *Rabi* season of 2014-15 at ASPEE Agricultural Research and Development Farm, Village

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Nare, Taluk Wada, Palghar District. Paired t-test design was applied in an area of Plot-1:- 100m^2 (1 R) and Plot-2:- 100m^2 (1 R). **Plot 1-** Seed treatment with thiamethoxam @ 5 g kg^{-1} seed + pheromone traps (two traps of *Earias* and two traps of *Helicoverpa*) + two spray *Btk* (*Bacillus thuringiensis* var. *Kurstki*) @ 15 g 10 lit $^{-1}$water (1st spray at 50% flowering and 2nd spray 15 days after neem) + one spray with *Azadirachtin* 10,000 ppm @ 0.004% (15 days alternate with *Btk* spray).**Plot 2-** Only recommended dose of fertilizer (RDF) was given. **RDF-** 100:50:50 kg NPK ha^{-1}.

Percent fruit damage on number basis at the time of harvest

For recording the observations on percent fruit damage, the number of healthy and infested fruits from each plot were counted at the time of harvest and on the basis of that percent fruit damage was calculated by using following formula;

$$\text{Percent fruit damage (\%)} = \frac{\text{No. of infested fruits}}{\text{Total number of fruits}} \times 100$$

Effect of IPM module on percent fruit infestation by *Okra* shoot and fruit borer

The effect of IPM module was evaluated under field condition for the management of *Okra* shoot and fruit borer, *Earias* spp. during *Rabi* season of 2014-15 and is presented herewith. During present investigation shoot borer incidence was not observed up to fruit setting. Non occurrence of shoot borer incidence might be due to lack of favorable environmental conditions. The data on per cent fruit infestation are presented in Table 1.

The results indicated that *Okra* shoot and fruit borer infestation during early fruiting phase of crop was ranging from 7.35 to 21.52 percent in IPM and 20.53 to 27.16 in non-IPM plot. While after 24th Dec., percent fruit infestation was ranging from 3.08 to 10.00 in IPM and 15.35 to 40.80 in non-IPM plot. IPM plot recorded significantly minimum fruit infestation than non-IPM plot from 27th Dec. to 21st Jan, 2015. The infestation of *Okra* shoot and fruit borer was observed less in IPM plot as compared to non-IPM plot which, may be because of the cumulative effects of the module during present study.

The results on yield revealed that, the IPM plot recorded about 121.82 kg fruits plot^{-1} whereas, the Non-IPM plot recorded about 92.42 kg fruits plot^{-1}. IPM plot recorded significantly more yield as compared to the Non-IPM plot.

Mishra and Mishra (2002) revealed lowest fruit borer incidence (8.6% on weight basis) in Biotox (*Bacillus thuringiensis* sub sp. *Thuringiensis* Serotype) applied twice on *Okra* crop, alternated with one malathion application. Further, Multineem and Neem max combined with malathion (11.70%) was better than sole malathion application (13.3%) and untreated control (16.9%). The results of the present finding are also more or less similar. Ajanta *et al*. (2010) observed that fruit damage by *E. vittella* was significantly less in all the modules as compared to

Table 1. Effect of IPM module on percent fruit infestation of *Okra* shoot and fruit borer

Date	Mean percent fruit infestation		Cal. T	Significance
	IPM	Non-IPM		
18 Dec	21.52	25.09	0.75	NS
21 Dec	14.00	20.53	1.70	NS
24 Dec	7.35	27.16	1.20	NS
27 Dec	10.00	25.34	7.88	*
30 Dec	9.73	40.80	3.79	*
1 Jan	6.60	28.66	4.73	*
4 Jan	3.08	15.35	3.99	*
6 Jan	4.32	26.87	3.12	*
8 Jan	7.38	36.49	2.83	*
10 Jan	7.29	30.41	2.93	*
12 Jan	4.73	31.10	3.00	*
14 Jan	6.73	33.95	2.89	*
18 Jan	6.02	33.08	2.85	*
21 Jan	8.46	38.36	2.83	*

Tabulated T: 2.77, *- Significant, NS- Non-significant

control at each picking as well as in pooled analysis. Integrated module (M3) which included seed treatment with thiamethoxam @ 3 g kg^{-1} seed + foliar spray of neem (Neembaan) @ 3 ml l^{-1} at 40 days after sowing + foliar spray of endosulfan (1 ml l^{-1}) + neem @ 3.0 ml l^{-1} at 50 days after sowing + foliar spray of spinosad @ 3.0 ml l^{-1} at 60 days after sowing recorded less incidence of shoot and fruit borer (4.8%) and more fruit yield (81.33 q ha^{-1}) as compared to untreated control (13.6% incidence and fruit yield 52.22 q ha^{-1}). The increase in yield over control in this module was 55.7 percent.From the present study it can be concluded that the integrated management techniques such as seed treatment with thiamethoxam @ 5 g kg^{-1} seed, use of pheromone traps, two sprays of *Bt* and one spray of neem oil can manage the pest successfully.

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Research Note
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MONITORING OF GRAM POD BORER, *Helicoverpa armigera* THROUGH PHEROMONE TRAPS ON PIGEONPEA (*Cajanus cajan* (L) Millsp.) AND IMPACT OF WEATHER PARAMETERS ON TRAP CATCH

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Pigeonpea (*Cajanus cajan* (L) Millsp.) is a tropical grain legume mainly grown in India and ranks second in area and production and contributes about 90% in the world's pulse production. In India during 2014-15, the crop is cultivated in an area of 3.55 million ha with 2.78 million ton of production and 783 kg ha^{-1} of productivity. In Andhra Pradesh during 2015-16, it is cultivated in an area of 2.2 lakh ha with 1.32 lakh ton of production and 600 kg ha^{-1} of productivity (AICRP Report, 2015). Though the area under redgram is increasing both in *kharif* and *rabi* seasons, the yields have remained stagnant (500-700 kg/ha) for the past 3-4 decades, largely due to insect pest damage (Sharma and Pampapathy, 2004). More than 300 species of insect pests were reported infesting the crop (Lal and Singh, 1998) of which gram pod borer, *Helicoverpa armigera* Hubner is the most dreaded and polyphagous pest worldwide (Shanower *et al*., 1999). Its preference for flowering and fruiting parts, results in heavy loss up to 60 % or more under subsistence agriculture in the tropics. The annual loss due to this pest was estimated to be US $ 400 million worldwide in pigeonpea (ICRISAT, 2007). Management of *H. armigera* relies heavily on insecticides, often to the exclusion of other methods of management. However, indiscriminate use of insecticides has resulted in the development of resistance and resurgence. In order to optimize the application of insecticides, proper monitoring of the pest is very essential.

Further, various weather parametres influencing the population build up and suppression of the pest are to be studied for planning an effective pest management strategy that will help farmers financially without the risk of resurgence. Hence, an attempt was made to monitor the pest through pheromone trap catches and to correlate with weather parameters.

The population buildup and seasonal abundance of *H. armigera* on pigeonpea (cv. ICPL 85063) was ascertained by raising the crop in 1000 m^2 area during *kharif,* 2012-13 at Regional Agricultural Research Station, Lam, Guntur by following all the recommended package of practices except for plant protection measures. In order to know the population build up and seasonal abundance of *Helicoverpa*, the pheromone traps @ 10 ha^{-1} consisting of lures for *H. armigera viz*., Heli detector (developed with new silicon technology for extra long life) by M/s Pheromone Chemicals Ltd., Hyderabad were erected 60 cm above the plant canopy. The male moth catches were recorded once in each standard meteorological week (SMW) starting from flower bud initiation to pod maturity stage of the crop and expressed as number of moths/trap/week. The lures

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were changed at 30 days interval. The larval population was recorded at weekly intervals on 10 randomly selected tagged plants from three locations in the plot and expressed as number of larvae plant^{-1}. Simultaneously, abiotic factors such as temperature (maximum, minimum, mean), relative humidity (morning and evening), sunshine hours and rainfall were also recorded from meteorological observatory, RARS, Lam, Guntur. The meteorological data thus collected was subjected to simple correlation with larval population and male moth catches to know the influence of abiotic factors on the occurrence of gram pod borer, *H. armigera* (Gomez and Gomez, 1984).

The larval population and pheromone trap catches of *H. armigera* on pigeonpea (cv. ICPL 85063) during each standard meteorological week (SMW) starting from flower bud initiation to harvesting stage of the crop has been depicted in Fig.1. The larvae of *H. armigera* were observed from the 46th SMW (Nov. 12 -18, 2012) to 3rd SMW (Jan 15-21, 2013). The pest reached its peak twice *i.e.,* at 48th SMW (26-02 Dec. 2012) and 1st SMW (01-07 Jan, 2013) with 1.8 and 2.0 larvae plant^{-1}, respectively. Similarly, the activity of male moths commenced from 44th SMW (29 Oct. – 4 Nov., 2012) and remained active up to 3rd SMW (Jan.15-21, 2013). The moth catches were more during 48th SMW (Nov. 26 – 02 Dec, 2012) and 2nd SMW (Jan 8-14, 2013) with 2.5 and 2.7 moths per trap per week, respectively (Table 1). The results were almost in conformity with the findings of Srivastava and Vaish (2000), who observed peak male moth catches of *H. armigera* from 43 to 45th SMW in pigeonpea at Sriganganagar (Rajasthan). The larval and adult population of *H. armigera* correlated with different meteorological parameters has been presented in Table 2. The correlation was not notable except with mean temperature with correlation coefficient (r) being 0.460 and 0.381, respectively.

Several studies have documented the pest weather relationship from time to time as short-term model based on simple correlation with some abiotic factors on different crops. The findings were in contrary to the observations of Kumar *et al.* (2003), who reported that larval population of *H. armigera* remained unaffected with weather parametres. Similarly, Vishwa Dhar *et al*. (2008) reported that minimum and maximum temperature and relative humidity greatly influence the moth population of *H. armigera* at Kanpur. Yadav *et al.* (2009) also found that relatively cooler pre-monsoon period, lower amount of monsoon rainfall, rain free post monsoon period with higher evening relative humidity have been found to be congenial for build-up of higher population and subsequently resulting higher moth catches of *H. armigera* in pheromone traps during rainy season on pigeonpea. The population buildup of *H. armigera* varied remarkably in different parts of the country probably due to difference in agroclimatic conditions and crop types (Akhauri, 1992). The rain free weeks after rainy weeks were found to be congenial for population buildup. Similarly, during post monsoon period host plants, including cotton and pigeonpea were available in abundance resulting build up of population. However, the gaps in knowledge remain to be filled by concentrating on migration, survival and carry over of this dreaded pest in different agro-eco-regions of the country.

From the present findings it can be inferred that 50 per cent flowering and pod development stage was more vulnerable to adults and full bloom to pod

Table 1. Population of gram pod borer, *Helicoverpa armigera* and the weather parameters during 2012-13

SMW	Period	Temp. (°c)		R. H. (%)		Rain-fall (mm)	Sun-shine (h)	Mean temp. (°c)	Larvae plant^{-1} (No.)	Adults per trap per week (No.)
		MAX.	MIN.	I	II					
44	29 – 4 NOV., 2012	31.8	19.0	93.0	80.7	210.6	3.2	25.4	0.0	0.3
45	5 – 11 NOV., 2012	31.5	18.9	95.7	61.4	0.0	5.8	25.2	0.0	0.8
46	12 – 18 NOV., 2012	30.6	14.5	90.4	47.0	0.0	8.8	22.6	0.3	1.2
47	19 – 25 NOV., 2012	32.2	16.5	88.0	62.0	0.0	5.7	24.4	0.7	1.7
48	26 - 02 DEC., 2012	31.5	17.2	94.9	57.9	0.0	5.6	31.5	1.8	2.5
49	03-09 DEC., 2012	33.2	18.6	90.0	56.7	0.0	3.4	25.9	1.2	1.8
50	10-16 DEC., 2012	32.4	17.8	98.3	54.8	0.0	8.0	25.1	0.3	0.5
51	17-23 DEC., 2012	31.2	16.0	96.8	48.5	0.0	6.7	23.6	1.3	1.2
52	24-31 DEC., 2012	30.0	15.5	93.4	62.3	0.0	5.7	22.8	1.5	1.3
1	01-07 JAN., 2013	32.6	24.3	98.3	58.6	0.0	4.6	28.5	2.0	1.5
2	08-14 JAN., 2013	31.5	16.8	92.1	42.1	0.0	6.9	24.2	1.3	2.7
3	15-21 JAN., 2013	31.0	17.1	83.7	49.7	0.0	8.1	24.1	0.8	0.3
4	22-28 JAN., 2013	30.9	18.0	98.0	52.4	0.0	6.3	24.5	0.0	0.0

SMW: Standard Meteorological Week

Table 2. Correlation between weather parameters and larva population and pheromone trap catch of *H. armigera* during *kharif*, 2012-13

Variable	Correlation coefficients (r)	
	Larval population	Trap catches
X_1 Max T (°C)	0.124	0.206
X_2 Min T (°C)	0.216	-0.077
X_3 RH-I (%)	0.042	-0.091
X_4 RH-II (%)	-0.222	-0.283
X_5 RF (mm)	-0.367	-0.330
X_6 Sunshine (h)	-0.194	-0.141
X_7 Mean Temp. (°C)	0.460*	0.381*

initiation stage and pod maturity stage was more vulnerable to larvae of *H. armigera*. Hence, farmers should be vigilant on stage of the crop and weather parameters so as to predict the pest early and optimize the application of insecticides in order to check the pest population from reaching the economic threshold level.

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Research Note
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INFLUENCE OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHOROUS ON GROWTH AND YIELD OF CARROT IN HIGH ALTITUDE AND TRIBAL ZONE OF ANDHRA PRADESH

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Nutrient management is one of the most important aspects of modern vegetable cultivation. Plant nutrients play an important role in the productivity and development and it vary according to the soil characteristics of various regions. The use of chemical fertilizers has contributed a lot in nutrient management. However, imbalanced, irregular and excessive application of chemical fertilizers deteriorates the physio-chemical properties of the soil. Fertilizer is an important input that can help farmers in exploiting the potential of crops. The yield and yield contributing characters of carrot are influenced by the application of NPK fertilizers. Application of nitrogen is essential for vegetative growth of the plant and phosphorus affects the maturity of the crop. The nutritional requirement varies with the genotypes, agro-climatic condition, soil fertility and availability of irrigation water. The demand for additional nitrogen fertilizer in carrot varies between 0-110 kg ha^{-1} (Salo, 2000). Phosphorus is one of the important essential macro elements for the normal growth and development of plant. The phosphorus requirements vary depending upon the nutrient content of the soil. A deficiency of phosphorus affects not only the plant growth, development and crop yield, but also the quality of the produce. The climatic conditions in high altitude and tribal zone are different from that of plains of Andhra Pradesh and quite well suited for raising cool season crops such as carrot. The tribal farmers are practicing adhoc management methods and not much regard is given to the use of optimum fertilization resulting in low yields. The management practices are not standardized for this crop as there is negligible research work carried out under the agro-climatic conditions in high altitude and tribal zone in Andhra Pradesh. Keeping this in view, the present investigation was carried out during *Rabi*, 2011-12 and 2012-13 at Horticultural Research Station, Pandirimamidi, East Godavari District with the objective to ascertain the optimum N and P levels which can give high yield.

The experimental location comes under high altitude tribal zone of Andhra Pradesh. The soil is sandy loam with good drainage and moderate water holding capacity. The experimental site receives an annual rainfall of 1186 mm. Besides rainfall, irrigation is made with ground water tapped through filter points. The pH of irrigation water is 6.0 and EC is 1.66 dS m^{-1}. The experiment comprised of four levels of Nitrogen *i.e.*, N1(0 kg ha^{-1}) , N2(25 kg ha^{-1}), N3(50 kg ha^{-1}) and N4(75 kg ha^{-1}) and four levels of phosphorous *i.e.*, P1(0 kg ha^{-1}) , P2(20 kg ha^{-1}), P3(

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40 kg ha^{-1}) and P4(60 kg ha^{-1}) and their combinations. The experiment was laid out in Factorial Randomized Block Design with three replications. Nitrogen was given as urea and phosphorus as single super phosphate. In all the treatments, the total amounts of SSP and MOP @ 83 kg ha^{-1}, and 50% urea were applied as basal dose during final land preparation. The remaining N as urea was applied as top dressing. The first top dressing was done at 30 days after seed sowing and the remaining at 30days after the application of first dose. Before sowing, seeds were soaked in water for 24 hours and then wrapped in a cloth for 5 hours. Three thinning operations were done at 15, 23 and 31 days after sowing of seed to maintain 30 cm x 10 cm spacing. The experiment plot was kept free from weed infestation. Irrigation and other intercultural operations were done when required. The carrots were harvested at 90 days from seed sowing when the leaves became pale yellow. Data on different parameters were recorded from five randomly selected plants in each plot.

Effect of Nitrogen on Growth Parameters

Different nitrogen levels had shown significant influence on the plant growth. From the results (Table 1) it was observed that there was a positive relation observed between the increasing nitrogen levels with the plant height and number of leaves. The maximum plant height and number of leaves was recorded with an application of 75 kg N ha^{-1}. This might be due to the adequate amounts of nitrogen obtained from higher levels of N source applied to the soil and was directly responsible for vegetative growth of carrot plants. Nitrogen functions in plants by being part of chlorophyll which is responsible for photosynthesis, helps plants with rapid growth, and improves the plant height. Moniruzzaman *et al*. (2013) reported that application of different levels of nitrogen significantly influenced plant height at 45, 60, 75 and 90 days after sowing. Ali *et al.* (2006) found significant increase in number of leaves of carrots due to increase in N rate.

Significant differences in fresh weight of root, dry weight of root, root diameter, root length and root yield per hectare was observed due to influence of different levels of nitrogen. Treatment N3 recorded significantly higher values for fresh and dry weight of roots, root diameter and root length followed by N2 and N1 and significantly lowest values for all these parameters was recorded in N0 (No N fertilizer). Adequate supply of N is probably associated with greater photosynthetic activity and optimum vegetative growth which accounted for higher fresh weight of root in carrot. This result indicated that the application of 75 kg of N significantly contributed for proper growth and development of root through optimum nutrient uptake by the carrot plants. The lowest performance of yield attributes was recorded for 0 kg N as it did not fulfill the nitrogen requirement of the crops resulting in poor growth and development of the root. It was also evident that nitrogen nutrition played an important role on growth, yield and yield contributing characters. Havlin *et al*. (1993) reported that N uptake by the plants is assimilated into amino acids that are subsequently incorporated into proteins

Table 1. Effect of nitrogen on growth and yield of Carrot

N levels	Plant height (cm)	Number of leaves	Fresh weight of aerial parts (g plant^{-1})	Dry weight of aerial parts (g plant^{-1})	Fresh weight of root (g plant^{-1})	Root dry weight (g plant^{-1})	Root length (cm)	Root diameter (cm)	Core diameter (cm)	Yield (t ha^{-1})
N0: (0 kg ha^{-1})	31.15	9.04	42.72	7.04	41.23	6.03	7.63	2.53	1.00	10.88
N1: (25 kg ha^{-1})	40.07	10.71	63.78	11.06	60.94	7.80	9.20	3.94	1.15	13.12
N2: (50 kg ha^{-1})	48.83	12.38	97.74	11.76	85.34	10.36	12.55	4.11	1.70	18.23
N3: (75 kg ha^{-1})	51.02	13.51	103.33	12.29	91.53	11.21	13.16	4.27	1.86	20.00
S.Em±	0.206	0.115	0.547	0.069	0.617	0.089	0.090	0.028	0.051	0.150
CD at 5%	0.595	0.331	1.581	0.200	1.782	0.258	0.261	0.080	0.146	0.434

Table 2. Effect of phosphorus on growth and yield of carrot

P levels	Plant height (cm)	Number of leaves	Fresh weight of aerial parts (g plant^{-1})	Dry weight of aerial parts (g plant^{-1})	Fresh weight of root (g plant^{-1})	Root dry weight (g plant^{-1})	Root length (cm)	Root diameter (cm)	Core diameter (cm)	Yield (t ha-^{1})
P0: (0 kg ha^{-1})	40.33	10.89	70.90	9.78	63.97	8.29	9.77	3.50	1.18	14.46
P1: (20 kg ha^{-1})	42.08	11.29	76.02	10.29	68.68	8.62	10.56	3.68	1.44	14.97
P2: (40 kg ha^{-1})	43.85	11.52	78.41	10.87	71.66	9.18	10.91	3.81	1.52	15.86
P3: (60 kg ha^{-1})	44.81	11.95	82.24	11.22	74.73	9.30	11.29	3.88	1.57	16.94
S.Em±	0.206	0.115`	0.547	0.069	0.617	0.089	0.090	0.028	0.051	0.150
CD at 5%	0.595	0.331	1.581	0.200	1.782	0.258	0.261	0.080	0.146	0.434

and nucleic acids to enhance plant growth and yield. Mehedi *et al*. (2012) revealed that the maximum fresh weight of roots and maximum length of root was achieved with the application of 150 kg N ha^{-1}. The fresh and dry weight of root, root length gross yield of carrot was significantly influenced due to the application of different levels of nitrogen. (Ali *et al*., 2006; Moniruzzaman *et al*., 2013).

Effect of Phosphorus

With regard to the influence of different levels of phosphorus soil application on growth parameters such as plant height, number of leaves, fresh weight of aerial parts and dry weight of aerial parts there was a significant increase with increasing rate of P application(Table 2). The increase in fresh weight of root by single super phosphate application might be due to the role of phosphorus in improving soil fertility and increasing the nutrient availability which in turn results in increasing the growth and yield parameters. The most important chemical reaction in nature is photosynthesis, where the phosphorus utilizes light energy in the presence of chlorophyll to combine carbon dioxide and water into simple sugars, with the energy being captured in ATP. The ATP is then available as an energy source for the many other reactions that occur within the plant and the sugars are used as building blocks to produce other cell structural and storage components. Mohammad Ilyas *et al*. (2013) and Batra and Kalloo, (1990) reported that significantly highest value in terms of fresh weight of roots, dry weight of roots, root length and root diameter was recorded with increasing P fertilizer rate. The effect of P on root length was significantly positive (Lyngdoh, 2001). Sadia *et al.* (2013) observed that different level of phosphorus showed statistically significant differences for root diameter in turnip. The root yield (16.94 t ha^{-1}) was recorded significantly highest in P3 treatment *i.e*., application of 60 Kg P ha^{-1}. The increase in yield of carrot by phosphorus application might be due to the role of phosphorus in improving soil fertility and increasing the phosphorus availability which resulted in increased growth and yield parameters. These results are in consonance with Balooch *et al.* (1993) who reported that root yields were highest (29.79 t ha^{-1}) at the highest P rate.

Combined Effect of Nitrogen and Phosphorus

The combined influence of nitrogen and phosphorus was found to be significant for all the parameters studied except for number of leaves (Table 3). The highest rate of N and P had given the maximum plant height, fresh and dry weight of aerial parts, root length, root diameter and per hectare yield. The treatment combination N3P3 (75 kg N ha^{-1} and 60 kg P ha^{-1}) recorded significantly highest value plant height, fresh and dry weight of aerial parts, root length, root diameter and per hectare yield followed by N3P2 (75 kg N ha^{-1} and 40 kg P ha^{-1}). The reason for the maximum fresh weight of root with N3P3 may be due to the N and P fertilizer supplied readily available nutrients that helped in maximum fresh weight of root per plant. Rani and Mallareddy (2007) also found that the average root weight, root length, total plant fresh weight and yield increased with increasing fertilizer

Table 3. Combined effect of nitrogen & phosphorus on growth and yield of carrot

Treatment combinations	Plant height (cm)	Number of leaves	Fresh weight of aerial parts (g plant^{-1})	Dry weight of aerial parts (g plant^{-1})	Fresh weight of root (g plant^{-1})	Root dry weight (g plant^{-1})	Root length (cm)	Root diameter (cm)	Core diameter (cm)	Yield (t/ha)
N0 P0	29.43	8.53	39.53	6.32	40.03	5.83	7.07	2.46	0.94	9.66
N0 P1	31.00	8.93	43.06	6.76	40.47	5.93	7.60	2.52	1.00	10.21
N0 P2	31.80	9.60	42.63	7.46	41.90	6.27	7.77	2.56	1.01	11.51
N0 P3	32.37	9.20	45.66	7.62	42.53	6.10	8.07	2.60	1.03	12.12
N1 P0	37.93	8.7	60.43	9.74	53.45	7.45	8.75	3.72	1.11	12.82
N1 P1	39.07	7.60	61.80	10.72	60.73	7.52	9.08	3.92	1.15	12.91
N1 P2	41.30	8.06	65.33	11.47	62.08	8.08	9.42	4.06	1.16	13.25
N1 P3	41.97	10.06	67.56	12.32	67.50	8.15	9.55	4.10	1.20	13.53
N2P0	45.73	9.60	90.50	11.35	78.90	9.33	11.45	3.90	1.16	16.92
N2 P1	48.57	9.26	96.73	11.53	82.73	10.07	12.45	4.00	1.78	17.59
N2 P2	49.43	9.73	98.36	11.95	87.85	10.90	12.78	4.23	1.90	18.07
N2 P3	51.60	8.60	105.36	12.19	91.87	11.13	13.50	4.33	1.98	20.35
N3 P0	48.23	9.13	93.13	11.70	83.50	10.55	11.82	3.92	1.53	18.45
N3 P1	49.67	9.10	102.5	12.13	90.80	10.95	13.12	4.26	1.82	19.18
N3 P2	52.87	9.30	107.33	12.62	94.80	11.48	13.67	4.40	2.02	20.60
N3 P3	53.33	9.43	110.36	12.72	97.00	11.83	14.03	4.51	2.08	21.77
S.Em±	0.412	0.229	1.094	0.139	1.234	0.178	0.181	0.055	0.101	0.300
CD at 5%	1.190	NS	3.163	0.401	3.564	0.515	0.522	0.159	0.293	0.868

application rates in carrot. The root fresh weight had significantly increased with increase in N application rate in carrot (Agyako *et al*., 2006). Significantly highest yield was recorded in N3P3 (21.77 t ha^{-1}) and it was followed by N3P2 (20.60 t ha^{-1}). The increase in yield of carrot root might be attributed to higher individual root weight, higher number of leaves per plant, higher dry matter content of root. These parameters improve in relation with rising levels of fertilizers and tend to be affected by increasing soil nutrients. Hochmuth *et al*. (1999) stated that unless and until the crop receive adequate nutrition, all its metabolic functions would be impaired or inhibited resulting in poor accumulation of photosynthates. It can be concluded that under high altitude and tribal zone conditions of Andhra Pradesh application of 75 Kg N and 60 Kg P ha^{-1} can give the maximum root yield in carrot.

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Research Note
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INFLUENCE OF SOWING DATES AND VARIETIES ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* L. Merrill)

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Soybean (*Glycine max*. L. Merrill) has a prominent position among the legumes that supplement nearly one-third of the world population and popularly known as “Miracle Bean” because of its versatility. Soybean is a highly nutritive and energy rich monocarpic legume crop with proteins (40%) and edible oil (20%). Soybean now established as number one crop among oilseeds and contributes more than 50 per cent oilseed production and 30 per cent of vegetable oil production in India (Anonymous, 2008). Besides its main use for oil extraction, it can be used as *dal* after some heat treatment, soya milk, tofu etc. Soya flour is an important ingredient in the bakery products. Soybean isoflavones have beneficial effects on human health due to their antiatherosclerotic, antioxidative, antitumoral, and antiestrogenic activities (Davis *et al.,* 1999). In 2015, it occupied an area of 11 m ha in India with an average seed yield of about 1000 kg ha^{-1}. It is mainly grown in Madhya Pradesh, Maharashtra and Rajasthan (Anonymous, 2008). The productivity of soybean is low due to various constraints. The time of sowing has a considerable influence on growth and yield of soybean. Early sowing in the season may encourage higher vegetative growth which may invite various diseases and insects pests. However, delayed sowing may shrink the vegetative phase, which in turn reduces dry matter accumulation leading to poor partitioning to reproductive parts and ultimately poor realization of the potential yield. The varieties are equally important for realization of the potential yield of this crop. The short duration genotypes may vacate the field in time for the sowing of the succeeding *rabi* season crop. There was a need to study the optimum sowing window of newly developed soybean varieties.

The experiment was conducted at S.V Agricultural College, Tirupati (Andhra Pradesh) during *rabi* 2015-16. It was comprised of 16 treatments with four sowing dates (16th September (D_1), first October ($D_{2)}$, 16th October (D_3) and 1st November (D_4) and four varieties (Basar, JS-93-05, Bheem and JS-335) replicated thrice. The soil of the experimental field was sand clay loam, low in nitrogen (213 kg ha^{-1}) and medium in available phosphorus (24.2 kg ha^{-1}) and potassium (254 kg ha^{-1}). The maximum temperature during September-January was 30.0°C and 31.5°C. Total rainfall recorded during crop season was 1147.1 mm. A pre-sowing irrigation was given one day prior to sowing of the seed to ensure good germination and establishment of the seedlings and subsequently need based irrigations were given to the crop. The crop was raised using seed rate of 75 kg ha^{-1} with line-to-line spacing of 30 cm. The seed was treated with Dithane M-45@ 3 g kg^{-1} seed to control seed rot

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and seedling blight. The nutrient dose @ 30 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare was applied at the time of sowing. Nitrogen was applied in two equal splits, one at the time of sowing and another at 30 days after sowing (DAS). Method of application adopted was basal placement of 5 cm below the soil and 5cm away from seed rows. Pendimethalin @ 1.0 kg *a.i.* ha^{-1} was sprayed as a pre-emergence application on the second day after sowing to control the weeds. Hand weeding was done twice at 15 and 30 DAS of each sowing date to keep the plots free from weeds. Minor incidence of tobacco cutworm was observed at flowering. Monocrotophos @ 2 ml l^{-1} and Chlorpyriphos @ 2.5 ml l^{-1} was used for effective control of the tobacco cutworm with an interval of one week. The data on various phenological stages were collected from each plot. The data on plant height, leaf area index (LAI), dry matter production and number of pods $plant^{-1}$ were collected from randomly selected five plants per plot at harvest. From the total produce of each plot, 100 seeds were counted and weighed to express hundred seed weight. The crop was harvested when the pods were matured; the bundles were sun dried for few days and then threshed manually. The data on seed yield was collected at the time of harvest.

Effect of Sowing Date

Plant height (Table 1) progressively increased with advancement in age of the crop up to harvest. Plant height significantly differed due to times of sowing from 16th September to 16th October (D_1, D_2 and D_3). Difference in plant height due to first and second times of sowing was not significant. However, the difference in plant height due to 16th October and 1st November (D_3 and D_4) sowings was not significant. Earliest sown crop (16th September) resulted in significantly taller plants. Plant height decreased with delay in sowings from D_1 to D_4. This can also be attributed to decrease in bright sunshine hours per day and more number of rainy days during the crop period. Leaf area index at harvest significantly varied due to each date of sowing from 16th September to 16th October (D_1, D_2 and D_3). However, the difference in leaf area index due to 16th October and 1st November (D_3 and D_4) was not significant. Earliest sown crop (16th September) resulted in significantly maximum leaf area index (LAI). Decrease in leaf area index with delayed sowing can be attributed due to progressive decrease in bright sunshine hours and leaf senescence. At harvest, the highest drymatter accumulation was with early date of sowing on 16th September (D_1) which was significantly superior to that due to 1st October (D_2), 16th October (D_3) and 1st November (D_4). Latest sown crop 1st November (D_4) produced least dry matter production. The increase in drymatter production can also be attributed to taller plants and higher LAI due to early sowings can be attributed to favourable weather for growth and development of soybean with early seeding. Earliest sown crop during 16th September (D_1) resulted in significantly more number of pods $plant^{-1}$ compared with 1st October (D_2) and 16th October (D_3), which were at par. The 16th September (D_1) sown crop recorded highest hundred seed weight, which was significantly higher than 16th October and 1st November sowings,

Table 1. Influence of sowing dates and varieties on growth and yield components of soybean

Treatment	Plant height (cm)	Leaf area index (LAI)	Dry matter (kg ha^{-1})	Number of pods plant^{-1}	Hundred seed weight (g)	Seed yield (kg ha^{-1})
Sowing time						
16th September	38.2	3.5	4798.3	37.9	11.2	1417.0
1st October	36.1	3.3	4316.0	33.2	11.3	1319.0
16th October	33.1	3.1	3360.8	30.7	9.8	840.0
1st November	32.4	3.0	3003.8	28.5	9.5	787.0
SEm±	0.3	0.06	85.0	0.9	0.3	44.0
CD @ 5%	1.0	0.2	246.6	2.6	0.9	128.0
Variety						
Basar	34.9	3.3	4155.3	32.9	10.3	1158.0
JS-93-05	35.1	3.1	3264.8	30.0	9.8	942.0
Bheem	34.1	3.2	3643.6	32.0	11.2	1058.0
JS-335	36.2	3.5	4415.2	35.4	10.5	1204.0
SEm±	0.3	0.1	85.0	0.9	0.3	44.0
CD @ 5%	1.0	0.2	246.6	2.6	0.9	128.0

but, 1st October (D_2) was statistically at par with 16th September sowing. These are in conformity with the results reported by Wafaa *et al.* (2002). The seed yield in 16th September (D_1) and 1st October (D_2) sown crop was at par however, significantly higher than 16th October (D_3) and 1st November (D_4) sowings. The higher seed yield in 16th September (D_1) and 1st October (D_2) sowings might be due to ideal weather for crop growth and development leading to improvement in yield attributes such as number of pods plant^{-1} and hundred seed weight.

Effect of Varieties

Tallest plants were obtained with JS-335 (V_4) variety which was however, on par with Basar (V_1) which were at par. Bheem (V_3) and JS-93-05 (V_2), which were at par, recorded the shortest plants (Table 1). Variety JS-335 (V_4) recorded significantly higher leaf area index compared with other varieties. Difference in LAI between Basar (V_1) and JS-93-05 (V_2) was not significant. Keeping the crop management practices constant, variation in LAI due to varieties can be ascribed to their morphological characteristics, higher plant height, varietal difference in leaf area and delayed senescence of leaves. JS-335 (V_4) produced significantly higher drymatter production followed by Basar (V_1), Bheem (V_3) and JS-93-05 (V_2). Difference in drymatter production between any two varieties was significant. Highest number of pods plant^{-1} were recorded with the variety JS-335 which were statistically at par with Basr (V_1) but significantly higher than Bheem (V_3) and JS-93-05 (V_2). Kumar *et al.,* (2005) also reported genotypic differences with respect to number of pods plant^{-1} plant. Highest hundred seed weight was recorded with the variety Bheem (V_3), which was statistically at par with JS-335 (V_4), but significantly higher than Basar (V_1) and JS-93-05 (V_2). Highest seed yield was recorded with the variety JS-335 (V_4), which was statistically at par with Basar (V_1), but significantly higher than Bheem (V_3) and JS-93-05 (V_2). High soybean yields of the varieties JS-335 (V_4) and Basar (V_1) might be due to better growth, higher tolerance to insect pests and diseases, adequate crop duration. Varieties of soybean do differ in seed yields (El Douby *et al.*, 2002; Veni *et al.,* 2003; Billore *et al.,* 2009; De Bruin and Pedersen, 2009). Varieties having better leaf area, crop growth rate and net assimilation rate are expected to yield higher.

Early sowings during 16th September (D_1) is optimum for higher seed yield of soybean. Irrespective of the times of sowing, JS-335 is an ideal soybean variety suitable for *rabi* season on sandy clay loam soils of Tirupati.

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PROBLEMS AND SUGGESTIONS AS PERCEIVED BY THE TRIBAL FARMERS TOWARDS THEIR LIVELIHOOD SECURITY

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Tribal people are children of nature and their lifestyle is conditioned by the ecosystem. They have followed the ways of life for many generations that are largely self-sufficient and are clearly different from the mainstream and dominant society. There are approximately 200 million tribal people in the entire globe accounting for about 4 per cent of the global population. With more than 84.4 million constituting 8.6 per cent of the total population, India has the largest population of the tribal people in the world and the government has identified more than 697 tribal communities in the country. Tribal communities live in about 15 per cent of the country's area, in various ecological and geo climatic conditions ranging from plains, forests, hills and inaccessible areas.

The regular and continuous research in analyzing the problems as perceived by the tribal farmers towards their livelihood security and their suggestions to overcome the problems is having paramount importance to design the strategies for improving the livelihood security of the tribal farmers. Hence, the present study was taken up with the objective of analysing the problems perceived by the tribal farmers towards their livelihood security and their suggestions to overcome the problems in high altitude tribal zone of Karnataka state.

Ex- post facto research design was followed for the study. The Chamaraja Nagara district was purposively selected since it is having highest number of tribal farmers in Karnataka state.

All the four ranges *viz*., Yelandur, Kollegal, ChamarajaNagara and Punjur of High Altitude Tribal Zone located in Biligiri Rangana hills (B R Hills) of Chamaraja Nagara district were selected for the study. Two villages from each range were selected by following simple random sampling procedure, thus making a total of eight villages (Banglepodu, Yarakanagadde podu, Keredimba, Gombegallu, Boodipadaga, Kulluru, Kanneri colony and Muruti paalya) for the study. From each of the eight selected villages, 15 respondents were selected by following simple random sampling procedure, thus making a total of 120 respondents.

For the present study the 'Problem' was operationalized as the unsatisfactory situations with respect to livelihood security as perceived by the tribal farmers. The respondents were asked to give their problems as perceived by them with respect to their livelihood security. 'Suggestion' was operationally defined as the requirements expressed by the tribal farmers in order to fulfill their livelihood security needs.

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The respondents were asked to give their suggestions to overcome the problems as perceived by them with respect to their livelihood security. The tribal farmers were asked through an open ended questionnaire about their problems and suggestions.

The problems perceived and the suggestions given by the tribal farmers to overcome their problems were recorded and depicted in such a way that a suitable strategy can be arrived out of the perceived problems and suggestions.

The major problems as perceived by tribal farmers were listed up and ranks were given based on the frequency and percentage. The results indicated that ninety per cent of the tribal farmers perceived landlessness/ small land holdings as the major problem and ranked first. Followed by the stringent laws, acts, rules and regulations pertaining to Non- Timber Forest Products (NTFPs) collection and improper functioning of Public Distribution System(PDS) were perceived as critical problems by large majority (87.50%) and (75.00%) of respondents securing second and third respectively.

More than half of the tribals perceived that irregular/ seasonal availability of jobs (65.00%) ranked fourth, erratic weather conditions (64.17%) ranked fifth, inadequate financial support to take up livelihood enterprises (62.50%) ranked sixth, insecurity to family members due to migration (61.67%) ranked seventh, exploitation by middlemen (58.33%) ranked eighth and unorganized functioning of Mahatma Gandhi National Rural Employment Guarantee Act-MGNREGA (50.00%) with ninth rank, as their major problems.

Poor transportation/ less access to plains (41.67%), electricity problem (35.83%), lack of safe drinking water (31.67%), exploitation by moneylenders (30.00%), lack of effective extension networking (29.17%), exploitation by landlords by way of giving meager land rent (26.67%), improper health facilities (25.00%), lack of encouragement to preserve tribal heritage (20.83%) and land encroachments (16.67%) occupied tenth to eighteenth ranks, respectively. These were perceived as major problems by slight majority of tribals for their livelihood security.

Lack of sufficient land to cultivate the crops might be forcing the tribal farmers to be under highly in secured condition resulted in low economic security. On the other side, the NTFP collection also might be becoming a tough task due to stringent rules and regulations by the Government. Subsequently, the irregularities in supply of domestic and food items by the Government and lack of proper wage employment might be still forcing them towards low food and nutritional security. Erratic weather, inadequate support from Government, migration, exploitation by middle men, poor functioning of MGNREGA and exploitation by money lenders and land lords might be creating highly un-conducive environment for the tribal farmers. Lack of transport, electricity problems, lack of safe drinking water, improper health might have contributed for poor living environment among the tribal farmers. The research

findings were in correspondence with the studies of Kiran (2011), Singh and Yadav (2013), Dhanasree *et al.* (2014) and Patel *et al.* (2015).

By virtue of livelihood security, tribal farmers might be expecting the necessary resources and explore different opportunities which pave the way for their development. In this context they have given some important suggestions in order to improvise the current livelihood security status.

The findings also indicated that majority (90.00%) of the tribal farmers felt that 'Allotment of land for the landless tribals' as one of the major suggestions and it was ranked first among all the suggestions given by the tribals. 'Strengthening of wage employment avenues' was suggested by second majority (87.50%) of the tribals. 'Subsidies and loans to establish on farm/ off farm enterprises' was suggested by 85.00 per cent of the tribals and ranked third. It was followed by 'direct marketing of NTFPs from tribals to cooperative societies' (64.17%) ranked fourth, 'regular supply and distribution of food items through PDS' (62.50%) ranked fifth, 'establishing road connectivity to the remote village' (41.67%) ranked sixth. 'Electricity connectivity to the remote village' was also felt as one of the major problems by a slight majority (35.83%) of the tribal farmers and ranked seventh. This was followed by 'constructing water tanks and supply channels' (31.67%), 'authentic/ advanced sources of credit' (30.00%), 'proper extension support (26.67%), 'establishing health centres in remote tribal clusters' (25.00%) and 'protection of tribal lands' (16.67%) which were ranked eighth, ninth tenth, eleventh and twelfth rank, respectively.

The tribal farmers might have felt the need of land to cultivate the crops to earn sufficient income to meet their family needs. They also felt the exploitation by middle men in NTFPs sales and suggestions for direct marketing by the Government. To provide financial support, they expressed the need for subsidies and loans to establish different farm enterprises. They might be thinking that regular supply of domestic and food items and enhancing wage employment avenues, providing health facilities will help in protecting the tribal farmers towards their livelihood security. They also might be in the opinion that good road connectivity, electricity, water supply will bring security to the tribal livelihood. The findings of Kiran (2011), Marcus (2013), Subramanyam and Veerabhadrudu (2013), Dhanasree *et al.* (2014) and Patel *et al.* (2015) were in line with the present study.

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Research Note
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CONSTRAINTS FACED BY THE RICE FARMERS IN ADOPTION OF RECOMMENDED TECHNOLOGIES IN EAST GODAVARI DISTRICT OF ANDHRA PRADESH

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Rice is one of the most important food crop in India and stood second position in the world. It feeds more than 50 per cent of the world population. It is the staple food for most of the people of South-East Asia. Asia accounts for about 90 per cent of world's rice area and production, respectively. Among the rice growing countries, India is having the largest area (44.11 Mha) under rice in the world and in case of production (105 MMT) it is next to China. (Source : www. ricestat.irri.org) . Rice in India is planted over an area of about 43 million ha and produces around 125 million tonnes of rice with yield level still remaining low around 2.85 t ha^{-1}(source: www. indiastat.com). In India, Andhra Pradesh is one of the leading states in rice production in area of 16,35,000 ha with productivity of 3022 kg ha^{-1}. Rice is mostly grown in the districts of East Godavari, West Godavari, Krishna, Nellore and Guntur. In East Godavari district rice is the main crop. Though the area under rice is constantly increasing in the district, productivity levels are not increasing and hence there is a need to address this problem. Small farmers are facing many constraints in adoption of rice production technologies which need to be addressed. Keeping these in view, the present study was undertaken to study the constraints faced by the rice farmers and suggestions to overcome them in East Godavari district of Andhra Pradesh.

The study was carried out in East Godavari district of Andhra Pradesh during the year 2014. *Ex post-facto* research design was followed for the study. East Godavari district was purposively selected because of its largest area and productivity under rice crop in coastal districts of Andhra Pradesh. Out of sixty mandals in district, four mandals are selected purposively having highest acreage of rice crop in the district. From each of the selected mandal, two villages each were selected based on random sampling. The respondents were selected based on proportionate random sampling thus constituting a sample size of 120 respondents.

The perusal of the data given in Table 1 reveals that the major constraint in following the recommended seed rate/acre is lack of technical knowledge (71.66%) which was followed by lack of technical guidance (28.33%). The Seed treatment with chemicals was another constraint it was mainly due to lack of knowledge (80.83%) in case of planting of seedlings as per the recommendation, disease and pest attack was the only problem (35.83%) they are planting more no of seedlings to compensate it. With respect to FYM and fertilizer management, lack of

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Table1. Constraints in adoption of recommended technologies as perceived by farmers

S. No.		Constraints	Respondents		Rank
			Frequency	Percentage	
1. Recommended seed rate acre^{-1}					
	a	Lack of knowledge	34	28.33	II
	b	Lack of technical guidance	86	71.66	I
1. Seed treatment with chemicals					
	a	Lack of awareness of practice	97	80.83	I
	b	Lack of knowledge	12	10.00	III
	c	High cost involved	63	52.50	II
3. Planting of seedlings as per the recommendation					
	a	Disease and pest attack	43	35.83	I
4. Farm Yard Manure and Fertilizer Management					
	a	Non availability of FYM and fertilizers	112	93.33	I
	b	Lack of knowledge on fertilizer recommendation	42	35.00	V
	c	Lack of technical guidance	47	39.16	IV
	d	High cost of fertilizers	74	61.66	III
	e	Lack of money at the time of fertilizer application	98	81.66	II
5. Weed control with herbicides					
	a	Labour problem	42	35.00	III
	b	Lack of knowledge	37	30.83	IV
	c	High cost involved	63	52.50	II
	d	Ineffectiveness of chemical weeding	83	69.16	I
6. Plant protection measures					
	a	Lack of knowledge in identification of symptoms of pests and diseases	35	29.16	III
	b	Lack of knowledge in application of chemicals	75	62.50	I
	c	Lack of technical guidance	24	20.00	IV
	d	High cost of chemicals	13	10.83	V
	e	No faith in recommendation	74	61.66	II

7. Use of micronutrients					
	a	Lack of awareness of practice	15	12.50	III
	b	Lack of knowledge	29	24.16	II
	c	High cost involved	56	46.66	I
8. Harvesting of the crop					
	a	Labour shortage	77	64.16	I
9. Marketing					
	a	Lack of support price to quality produce	81	67.50	II
	b	High transport cost	93	77.50	I
	c	Lack of marketing facilities in rural area	67	55.83	III
10. Rodent management					
	a	Ineffectiveness of chemicals	82	68.33	II
	b	Lack of knowledge	57	47.50	III
	c	Lack of communal approach	105	87.50	I
11. Difficulty in remembering ETLs					
	a	Lack of knowledge	29	24.16	II
	b	Difficult to understand	83	69.16	I

knowledge on fertilizer recommendation (93.33%) was the major constraint this might be due to farmers are not aware of the recommended dosages followed by non availability of FYM and fertilizers (81.66%). FYM is not available because most of the FYM is used as manure for coconut plants as this district is having dense populous growth of coconut plantation more and more FYM is required. these results are in line with the findings of Karamjit *et al.* (2015) and Hadush Hagos (2015).

A vivid inference that could further be divulged from the Table 1 is that the weed control with herbicides is ineffective (69.16%) was the major constraint followed by high cost of herbicide chemicals (52.50%). in case of plant protection measures, lack of knowledge in identification of symptoms of pests and diseases (62.50%) was the major constraint followed by high cost of chemicals (61.66%). Similar findings were observed by Jayasankar and Thyagarajan (2010). Whereas, in harvesting of the crop labour shortage (64.16%) was the major constraint. The plausible reason is most of the labour have migrated to gulf countries and nearest towns for employment. In marketing the produce, high transport cost (77.50%) was the major constraint followed by lack of support price to quality produce (67.50%). The rice fields are distantly located from

the market. Hence, they use tractors for transportation and they are not available at peak harvesting stage. Farmers are not getting the Minimum Support Prices (MSP) in some areas as their produce is purchased by local merchants (because the farmers already took credit from them). In case of following Economic Threshold Level (ETL), complexity in understanding (69.16%) was the major constraint followed by lack of knowledge (24.16%).Most of them do not remember the Economic Threshold Level (ETL) for each pest as it was very complex for them to understand many have a belief that following ETL will get low yields.

It can be observed from the Table 2 that the majority of the respondents suggested providing good quality of seed and fertilizers at subsidized rate (80.83%), followed by strengthening rodent management as mass approach (77.50%), wide publicity on seed treatment uses (65.00%), organizing more field visits by extension personnel

Table 2. Suggestions given by the farmers for better adoption of recommended technologies

S. No	Suggestions	Respondents		
		Frequency	Percentage	Rank
1.	Providing good quality of seeds fertilizers at subsidized rates	97	80.83	1
2.	Wide publicity on seed treatment uses	78	65.00	3
3.	Develop pest and disease resistant varieties	67	55.83	5
4.	More demonstrations organized on green manure and farm yard manure	65	54.16	6
5.	Organize more field visits by A.O.	75	62.50	4
6.	Strengthening rodent management as mass approach	93	77.50	2
7.	Availability of bio-control agents at village level	57	47.50	8
8.	Create awareness about bio fertilizers	12	10.00	12
9.	Supply of pheromone traps on subsidy	39	32.50	10
10.	Simple procedure to remember ETL	61	50.83	7
11.	Easy ways to solve pesticide doses	48	40.00	9
12	Farmers should be protected by crop insurance scheme in case of failure of season	36	30.00	11

(62.50%), development of pest and disease resistant varieties (55.83%), more demonstrations should be organized on green manure and FYM (54.16%), simple procedure to remember ETL (50.83%), availability of bio-control agents at village level (47.50%) and easy ways to solve pesticide doses (40.00%), Supply of pheromone traps on subsidy (32.50%), providing crop insurance (30.00%) and create awareness about bio fertilizers (10.00%) are in order of magnitude. These results corroborate with the findings of Sriharinarayana *et al*. (2014)

Agricultural officers should organize more number of field visits to educate the farmers for easy identification of different symptoms of pests and diseases. Scientists have to develop pest and disease resistant varieties specific to area. Crop insurance scheme should be provided to all farmers and demonstrations must be organized on farm yard manures. Similar findings are observed by Maheriya *et al*. (2015).

More number of extension personnel per Mandal is required to educate the large number of farmers simultaneously to create awareness among the rice farmers about bio-fertilizers and mass media such as news papers, T.V and Radio can be used. The responsibility of State Department of Agriculture, State Agricultural Universities and Government of India is to see that the above suggested facilities are provided to the respondents to overcome the constraints in adoption of recommended practices in rice cultivation.

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Research Note
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EFFECT OF SOIL TEST BASED APPLICATION OF PHOSPHORUS FERTILIZERS ON YIELD AND ECONOMICS OF RICE

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Green revolution enabled to increase the crop production several folds but with heavy usage of external inputs. This phenomenon led to several problems *viz.,* decrease in factor productivity, stagnation in yields, increase in deficiency of several micronutrients and imbalance in the soil fertility and health. By 2050, we need to produce about 349 million tonnes of food grains from the same cultivated area of 1428 million hectares. Hence, the challenge for agriculture over the coming decades will be to meet the increasing demand for food in a sustainable way.

Declining soil fertility and mismanagement of plant nutrients have made this task more difficult. It is observed that as long as agriculture remains a soil-based industry, major increases in productivity are unlikely to be attained without ensuring that plants have an adequate and balanced supply of nutrients. Fertilizer is one of the costliest inputs in agriculture and the use of right amount of fertilizer is fundamental for farm profitability and environmental protection (Kimetu *et al*., 2004). Dumping of fertilizers by the farmers in the fields without information on soil fertility status and nutrient requirement by crop causes adverse effects on soil and crop regarding both nutrient toxicity and deficiency either by overuse or inadequate use (Ray *et al*., 2000). Kumar *et al.* (2007) observed that the declining factor productivity is largely due to imbalanced fertiliser use.Hence, in order to enhance farm profitability under different soil climate conditions, it is inevitable to have information on optimum dose for fertilizer use. Soil fertility management for intensive cropping system is a major component of sustainable agricultural development. Balanced fertilization of major crops should be based on soil testing. (Rajan Bhatt, 2013). Traditionally, to determine the optimum fertilizer dose, the most appropriate method is to apply fertilizer on the basis of soil test and crop response studies. Fertilizers recommendation in crops are developed over a period of time based on the soil test results and crop needs and were developed through All India Coordinated Research Project for investigation on Soil test crop response correlation (STCRC). Soil testing of field aids in taking scientifically valid decisions about fertilizer requirement of crops after assessing the nutrient status in soil.

Ramamurthy *et al.* (2009) suggested that soil-based fertilizer recommendations should be preferred to achieve precision in farming and to maximize crop production with minimized fertilizer misapplication for maintaining soil health. However, with continuous and higher application of complex and other phosphatic fertilizers, larger areas of cultivated lands of Andhra Pradesh are being reported to contain higher available P in soils resulting in adverse effects on the availability of other nutrients particularly micronutrients (Zn) besides increasing the cost of cultivation in different crops.

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High soil phosphate levels are one of the most common causes of zinc deficiency in crops (Alloway, 2008). One of the reasons for lower production of rice is imbalanced fertilization of N, P and K nutrients (Reddy and Ahmed, 2000). Out of 4,00,070 soil samples analysed during 2010- 11 by state soil testing laboratories in Andhra Pradesh, 1,22,471 samples constituting 31% were found to register high Phosphorus levels in soils (Anand Kumar *et al.,* 2015). The research reports of Acharya N.G. Ranga Agricultural University, Guntur indicate that with applicability of targeted yield equations for soils having high Phosphorus, there is a possibility of saving of Phosphorus fertilizers to an extent of 25 to 50 per cent from currently used phosphorus fertilizer doses in selected crops on such high phosphorus soils. In the light of above, Acharya N.G. Ranga Agricultural University, initiated "Bhuchetana Project" during *kharif,* 2013 under RKVY Scheme through its extension institutes in 10 selected Districts of Andhra Pradesh. Keeping this in view, the present investigation was carried out to study the effect of soil test based phosphatic fertilizer application on crop yield and cost of production.

Twenty-one soil samples from six villages belonging to five mandals were collected, analysed for nutrient content, NPK in *kharif,* 2013 "Bhuchetana Project" at soil testing lab of KCP Sugars, Lakshmipuram, Challapalli. Among the 21 samples, 10 samples with high level of available soil phosphorus (Olsens *et al*., 1954) content from five villages of five mandals were selected in the present study. On farm demonstrations in the selected 10 locations were conducted with an objective to demonstrate to farming community and to popularize the use of soil test based phosphorus fertilizer in crops for reducing the input cost and to sustain the soil health.

Each demonstration consisted of three treatments namely

T_1: Soil test based NPK with 25% reduction in P fertilizers input

T_2: NPK with 50% reduction in P fertilizer input

T_3: Farmers practices (unbalanced use of N, P and K fertilizers)

Each treatment was imposed in 0.40 ha with same variety (BPT-5204).The recommended dose of N, P and K per hectare for *kharif* rice in Krishna Zone of A.P. is 120, 60 and 40 kg ha^{-1}, respectively. Phosphorus was applied as single super phosphate, nitrogen as urea and potassium as murate of potash. To avoid zinc deficiency, zinc sulphate was sprayed twice on the main crop @ 400 g/each spray (15 days after transplanting) in weekly interval. Full dose of P along with 1/3rd N and half dose of K were applied during last puddling in both treatments (T_1 & T_2). The remaining 1/3rd N along with half dose of potash were applied at panicle initiation stage in both the treatments. Similar plant protection measures were adopted throughout the crop growth period in both the treatments. Grain yield data $acre^{-1}$ was recorded, per hectare yield was computed and subjected to analysis of variance.

Average figures for grain yield (kg ha^{-1}) were recorded based on the yields recorded in the experimental fields after harvesting the rice BPT 5204 variety. It was observed that grain yield obtained in T_1, T_2 and T_3 were 5147 kg ha^{-1}, 4978 kg ha^{-1} and

5100 kg ha^{-1}, respectively. The quantity of phosphatic fertilizers applied also recorded along with the costs. The benefit-cost ratios were calculated and observed that highest benefit was recorded in 25% phosphatic fertilizer reduced treatment.

On perusal of the data recorded for grain yield, no significant difference was observed between the soil test based fertilizer use treatments *viz.*, 25% & 50% reduction on phosphatic fertilizers use and farmers practice. However, there exists a significant difference among the treatments in 25% and 50% reduction in phosphatic fertilizer use. This indicates that even 25% - 50% reduction in recommended phosphatic fertilizers will give yields on par with farmers practice.

The quantity of phosphatic fertilizers applied indicates that farmers used excess amounts irrespective of the soil test results leading to several problems. In farmers practice each hectare received on an average 90.375 kgs of phosphatic fertilizer which is 50% higher than the recommended dose. The average cost of phosphatic fertilizers applied (Rs. ha^{-1}) in T_1, T_2 and T_3 were Rs. 2109/-, Rs. 1406/- and 4026, respectively. This indicates that there is a significant difference in the cost of P fertilizers applied in T1, T2 and T3 to the extent of Rs.1917/- to Rs. 2620/- per hectare. This clearly indicates that if the farmers follow the soil test results and reduce the P fertilizers usage by 25-50% they can substantially reduce the cost of cultivation without compromising the yields.

The present study supports the earlier research reports of Prasada Rao and Bhupal Raj (2001) and Reddy and Ahmed (2000) stating that there is a possibility of saving of phosphatic fertilizers to the extent of 25 to 75 per cent on soils having high status of available P. This suggests that the use of excess P fertilizers does not result in significant marginal increase in the yield besides increasing the cost of cultivation and adverse effects on other nutrients.

Application of fertilizers based on soil test results holds key to achieve the higher yields with optimum use of fertilizers. This is a key decision making aspect in rice production ultimately ensures productivity and profitability. Bijay Singh and John Ryan (2015) also indicated that fertilizer management is one of the management objective associated with practical farm level operations leading to fulfilment of the objectives *viz.,* productivity, profitability, cropping system sustainability, and a favourable biophysical and social environment. Rao and Srivastava (2000) observed that soil test based application of plant nutrient helps to realize higher response ratio and B:C ratio as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient and the correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization.The higher use of P fertilizers often associates with deficiency of key micro nutrients resulting in reduction in productivity. High soil phosphate levels are one of the most common causes of zinc deficiency in crops (Alloway, 2008).

The results achieved through the demonstrations clearly showed that approximately Rs. 1900/- to Rs. 2600/- could be saved per hectare following the soil test based recommendations of NPK and Zn in rice along with other stated benefits. Hence, it can be concluded that the judicious use of phosphorus fertilizers saves cost of cultivation and

also saves soil from the ill effects resulted due to imbalance of nutrients.

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GUIDELINES FOR THE PREPARATION OF MANUSCRIPT

1. Title of the article should be short, specific, phrased to identify the content and indicate the nature of study.

2. Names should be in capitals prefixed with initials and separated by commas. For more than two authors the names should be followed by 'and' in small letters before the end of last name. Full address of the place of research in small letters should be typed below the names.E-mail ID of the author may be given as foot note.

3. The full length paper should have the sub heads ABSTRACT, INTRODUCTION, MATERIAL AND METHODS, RESULTS AND DISCUSSION, CONCLUSIONS and REFERENCES-all typed in capitals and bold font - 12. The research note will have only one sub head REFERENCES.

4. **ABSTRACT**: The content should include the year, purpose, methodology and salient findings of the experiment in brief not exceeding 200 words. It should be so framed that the reader need not refer to the article except for details.

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Books

AOAC. 1990. Official methods of analysis. Association of official analytical chemists. 15th Ed. Washington DC. USA. pp. 256

Federer, W.T. 1993. Statistical design and analysis for intercropping experiments. Volume I: two crops. Springer – Verlag, Cornell University, Ithaca, New York, USA. pp. 298-305

Thesis

Ibrahim, F. 2007. Genetic variability for resistance to sorghum aphid (*Melanaphis sacchari,* Zentner) in sorghum. Ph.D. Thesis submitted to Acharya N.G. Ranga Agricultural University, Hyderabad.

Seminars / Symposia / Workshops

Naveen Kumar, P.G and Shaik Mohammad. 2007. Farming Systems approach – A way towards organic farming. Paper presented at the National symposium on integrated farming systems and its role towards livelihood improvement. Jaipur, 26 – 28 October 2007. pp.43-46

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