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ROOT ACTIVITY OF RICE CROP UNDER NORMAL (FLOODED) AND SRI METHOD OF CULTIVATION

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ABSTRACT

A field experiment was conducted during 2007-08 and 2008-09 at Agricultural Research Institute, Rajendranagar to determine whether there is any difference in the active root distribution of rice crop under normal and SRI method of cultivation by using ^{32}P radioisotope. The results indicated that normal method of planting under flooded conditions resulted in higher root activity of rice plant by about 10 per cent at lateral distance of 6 cm and 11 per cent at 12 cm of lateral distance when compared to that of SRI method. It was observed that at 18 cm lateral distance the root activity of rice plant under normal method of planting was negligible. However, in SRI method, the root activity of rice plant was significantly high and has contributed 34 per cent to its total lateral root activity. As a whole, SRI method of planting resulted in 38 per cent mean higher total lateral root activity than that of normal method. The vertical distribution of root activity of rice plants under these methods of planting indicated that SRI method of planting resulted in about 48, 34 and 30 per cent higher root activity than that of normal method at 7.5, 15 and 22.5 cm vertical depth, respectively. Despite variations in root activity, the mean grain yield of rice was higher by 11 per cent in SRI system (6750 kg ha^{-1}) when compared to that of normal method (6081 kg ha^{-1}).

System of Rice Intensification (SRI) is considered as an option to enhance the water productivity and to save the water in rice cultivation. It is being advocated in many states of India directly in farmers' fields without considerable research on many aspects of this method of rice cultivation. This system of rice cultivation is also reported to be resulting in higher yields than that of normal (flooded) method of rice planting in farmers' fields. Higher root mass and there by better nutrient uptake is one of the reasons attributed for such increased grain yield of rice crop in this method of cultivation. Enhanced root activity of rice crop under SRI method of cultivation, if existing, will have bearing on soil nutrient depletion pattern, quantity of external nutrient supply to be made to the existing crop and the fertilization requirement to the subsequent crops. Therefore, it is essential to determine the root activity of the crop under SRI method which can further help in understanding the other aspects of nutrient management and fertility sustenance of rice fields.The present investigation was to determine whether there is any difference in the active root distribution (lateral and vertical distances) of rice crop under normal and SRI method of cultivation by using ^{32}P radioisotope.

MATERIAL AND METHODS

A two year field investigation was carried out to determine whether there is any difference in the active root distribution of rice crop under normal and SRI method of cultivation. Rice cv. M-7 was raised on vertisol during kharif 2007-08 and 2008-09 under normal (15 x 15 cm) and SRI method (25 x 25 cm) of cultivation (with same dates of transplanting in spite of difference in the age of the seedlings) on separate large bulk plots following standard field operations for each system. Carrier free ^{32}P radioisotope @ 3.7 MBq (100 µCi) in 0.5 ml volume per plant was injected into rice plant at panicle initiation stage so as to obtain the soil samples for counting from the combinations of 3 lateral distances (6, 12 and 18 cm) and 3 vertical depths (7.5, 15 and 22.5 cm) in both the systems of rice cultivation replicated four times.^{32}P-plant injection technique (Racz *et al.,*1964) is mostly used for root distribution pattern of the crop. Counts were recorded from soil samples collected one week after ^{32}P injection using radiation counting system (IAEA,1976). During recording of data, it was observed that there were negligible or only background counts in the samples of soil collected from third lateral distance i.e. 18 cm away from plant in normal method of planting. Thus, statistical analysis and results are presented accordingly. Yield was recorded from both the bulk plots at harvest.

RESULTS AND DISCUSSION

The pooled data presented in Table 1 indicates that normal method of planting under flooded

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conditions resulted in higher root activity of rice plant by about 10 per cent at lateral distance of 6 cm and 11 per cent at 12 cm of lateral distance when compared to that of SRI method. It was observed that there were negligible counts in the samples of soil collected from third lateral distance i.e. 18 cm away from plant in normal method of planting. Absence of counts at 18 cm lateral distance indicates that the root activity of rice plant under flooding with 15 x 15 cm spacing does not extend up to this distance and beyond 18cm. However, in SRI method of planting, the root activity of rice plant was significantly high at 18 cm and has contributed 34 per cent to its total lateral root activity. Such increased lateral root activity in this method of rice cultivation is due to constant disturbance to roots by way of regular inter cultivation with cono / rotary weeder which often damages roots inducing its proliferation. Consequently, as a whole, SRI method of planting resulted in 38 per cent mean higher total lateral root activity than that of normal method. The higher concentration of active roots beyond 12 cm lateral distance can be additional opportunity for better utilization of top dressed nitrogen and potassium.

The vertical distribution of root activity of rice plants under these methods of planting (Table 2) indicated that SRI method of planting resulted in about 48, 34 and 30 per cent higher root activity than that of normal method at 7.5, 15, and 22.5 cm vertical depth, respectively, mainly due to possibility of third lateral distance advantage to this system. Active root distribution of groundnut at different vertical depths was reported by Jayasree *et al*.,(2005) by using ^{32}P radioisotope.

However, when only two lateral distances (6 and 12 cm) are considered in both the systems of planting, it is observed that normal method of planting results in better spread of roots vertically when compared to that of SRI system because of limited lateral space availability in the former method. In addition to this observation, it is also evident that the root activity of rice plant reported here under normal system is only that of one plant where as two seedlings are planted per hill in this method when compared to one in SRI method. An estimate of pooled root activity per unit volume of soil under normal method (15 x 15 x 22.5cm x Bulk Density of soil) and SRI method (25 x 25 x 22.5 x Bulk Density of soil) indicated that it is higher by 9.6 per cent in normal method (78833 counts kg^{-1} soil) than that of SRI system (71933 counts).

The investigation suggests that under SRI method, because of exclusive agronomic practices and interventions in the form of frequent use of rotary cultivators in the field, rice plant appears to be getting trained or inclining for surface feeding in contrast to a different and intense feeding in normal method. This situation can be exploited for better nutrient efficiency of applied fertilizers, particularly, nitrogen and potassium through innovative fertilizer application strategies along with the benefit that is gained in water saving under SRI method. However, from the soil nutrient exploration ability point of view, normal method of planting appears to be better than that of

Table1. Root activity* of rice crop at different lateral distances under normal and SRI method of planting (Counts / 5 gm of soil / 200 sec) during *kharif* (monsoon) seasons of 2007-08 and 2008-09

Details	Normal Method			SRI Method		
	K-07-08	K-08-09	Mean	K-07-08	K-08-09	Mean
L_1 – 6 cm	1233	1317	1275[a]	1128	1189	1159[b]
L_2 – 12 cm	1033	1106	1070[c]	942	987	965[d]
L_3 – 18 cm	--	--	--	1000	1228	1114[b]
Total Counts	**2266**	**2423**	**2345**	**3070**	**3404**	**3237**

***** The total counts are equivalent to 100 per cent of recordable root activity of the plant for which isotope injection was made. F-test is significant for 5 treatments viz L-1 and L2 of normal method and 3 laterals of SRI method. Figures followed by different alphabets are statistically significant at p=0.05.

SRI method as it makes the plant to go deep into the soil due to restriction on the lateral front. Thus, there is a need to find out the reasons for reported enhanced rice yields under SRI system of management.

This study indicated that the SRI method of planting resulted in mean higher total lateral root activity than that of normal method. The vertical distribution of root activity of rice plants was higher in normal method when compared to SRI method. The mean grain yield of rice was higher by 11 per cent in SRI system when compared to that of normal method of planting.

Table 2. Root activity* of rice crop at different vertical depths under normal (Flooded) and SRI method of planting (Counts / 5 gm of soil / 200 sec) during *kharif* (monsoon) seasons of 2007-08 and 2008-09

Details	Normal Method			SRI Method		
	K-07-08	K-08-09	Mean	K-07-08	K-08-09	Mean
V_1 – 7.5 cm	858	931	895^{c}	1246	1405	1326^{a}
V_2 – 15 cm	683	728	706^{d}	918	969	944^{bc}
V_3 – 22.5 cm	725	764	745^{d}	906	1030	968^{b}
Total Counts	**2266**	**2423**	**2346**	**3070**	**3404**	**3237**

***** The total counts are equivalent to 100 per cent of recordable root activity of the plant for which isotope injection was made. F-test is significant for 6 treatments. Figures followed by different alphabets are statistically significant at p=0.05

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SAFETY OF CHLORANTRANILIPROLE 18.5 SC TO *Cotesia plutellae* (Kurudjumov) A LARVAL ENDOPARASITOID OF *Plutella xylostella L.*

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ABSTRACT

The safety of chlorantraniliprole, spinosad, and indoxacarb was tested against *Cotesia plutellae* (Kurudjumov) a larval endoparasitoid of *Plutella xylostella* L. under laboratory conditions. Toxicity on *C. plutellae* adults tested by dry film method revealed that chlorantraniliprole 18.5 SC 10 g a.i. ha^{-1}, indoxacarb 14.5 SC 20 g a.i. ha^{-1}, and spinosad 2.5 SC 8.75 g a.i. ha^{-1} recorded less than 50 per cent mortality and were harmless, whereas, indoxacarb 40 g a.i.ha^{-1}, spinosad 17.5 g a.i.ha^{-1} and quinalphos 500 g a.i.ha^{-1}, recorded 63.33, 63.33 and 73.33 per cent mortality, respectively and were slightly harmful after 48 hours of exposure. Contact toxicity on pupae and surviving adults revealed that chlorantraniliprole at 5 and 2.5 g a.i. ha^{-1}, and indoxacarb at 20 g a.i. ha^{-1} were harmless with less than 50 per cent mortality, whereas chlorantraniliprole at 18.5 SC 10 g a.i. ha^{-1}, indoxacarb at 40 g a.i. ha^{-1}, spinosad at 17.5 and 8.75 g a.i. ha^{-1} and quinalphos at 500 g a.i. ha^{-1} recorded mortality in the range of 52.22 to 71.83 per cent and were slightly harmful. Higher per cent reduction in parasitisation of *P. xylostella* was recorded with quinqlphos 500 g a.i.ha^{-1}, and spinosad at 17.5 g a.i.ha^{-1}, and were toxic to *C. plutellae*. Chlorantraniliprole at 5 and 2.5 g a.i. ha^{-1}, spinosad at 8.75 a.i.ha^{-1}, and indoxacarb at 20, 40 g a.i.ha^{-1}, were found to be relatively safe to the *C. plutellae* with respect to parasitisation.

The diamond back moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) is one of the most destructive pests of cruciferous crops throughout the world. In Southeast Asia, major outbreaks of *P. xylostella* were reported to cause more than 90 per cent crop losses (Verkerk and Wright, 1996). *Cotesia plutellae* (Kurudjumov) a solitary larval endoparasitoid of *P. xylostella*, has been reported to be host-specific to *P. xylostella* (Verkerk and Wright, 1996). *C. plutellae* is the predominant larval parasitoid of diamondback moth in almost all the tracts of India (Chelliah and Srinivasan, 1986). It exhibited clear density dependent relationship between parasitized and host in KarnatÎka (Nagarkatti and Jayanth, 1982) with high level of parasitism ranging from 46.9 per cent in Bangalore to 77.1 per cent in Gujarat (Chelliah and Srinivasan, 1986); 1.69 to 85.71 per cent in Nilgiris of Tamil Nadu (Chandramohan, 1994) and 5.4 to 28.92 per cent in major cauliflower growing tracts of Tamil Nadu (Kalyanasundaram, 1995).

The effects of insecticides on *C. plutellae* varied significantly depending on the stages of parasitoid treated and the insecticides tested (Miyata *et al.,* 2001). Among the 17 commonly used insecticides tested for toxicity to *C. plutellae*, seven insecticides were harmful (mortality >99%), (Kao and Tzeng, 1992). Haseeb and Amano (2002) recorded reduction in parasitism when some insect growth regulators (chlorfluazuron, flufenoxuron and tefludenzuron) were ingested by *C. plutellae* adults. Sheeba *et al.,* (2008) reported that abamectin was relatively safer to *C. plutellae*. Haseeb *et al.,* (2004) reported that indoxacarb (53 mg a.i.litre-$^{1)}$, λ-cyhalothrin (28 mg a.i.litre-^{1}) and spinosad (53 mg a.i.litre-^{1}) caused 100, 88.5 and 50 per cent adult mortalities respectively.

Chlorantraniliprole is a novel anthranilic diamide insecticide registered for use in vegetables, fruits, grains and turf against a variety of insect pests. Acute toxicity of chlorantraniliprole on seven species of parasitic wasps evaluated under laboratory conditions revealed that according to IOBC classification criteria, there was no significant effects (< 30%) on adult survival, percentage parasitism or emergence (Brugger *et al.,* 2010). The information on safety of newer insecticides on *C.plutellae* on cabbage and cauliflower is lacking. Hence, the present study on safety of chlorantraniliprole 18.5 SC on *C.plutellae* was carried out along with widely used insecticides spinosad 2.5 SC, indoxacarb 14.5 SC and quinalphos 25 EC.

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MATERIAL AND METHODS

Laboratory studies were carried out in the Insecticide Resistance Laboratory, Department of Agricultural Entomology, Tamil Nadu Agricultural University. The *P.xylostella* larvae collected from cauliflower growing areas of Coimbatore (Narsipuram village), which received minimum number of insecticidal sprays. Mass culturing of *P.xylosella* was carried out by following the method described by Liu and Sun (1984) with little modifications. Mustard seedlings were used for egg collection in oviposition cage and same cage was used for larval rearing on cauliflower maintained in pot culture without exposure to insecticides. Raising of mustard seedlings and rearing of *P. xylostella* was done under the laboratory conditions at 12:12 (L:D) and at prevailing room temperature 28 ± 2ºC.

C. plutellae reared under similar laboratory conditions as those used for rearing *P. xylostella*. A potted cauliflower plant with 100 second instar larvae of diamondback moth was placed inside the oviposition cage along with 50 pupae (cocoons) of *C. plutellae* collected from fields as done for the host. After emergence of adults, 10 per cent honey was provided as food and allowed to mate for parasitisation of *P.xylostella* larvae.The parasitized larvae turned to pale yellow initially and later black and parasitoids emerged from the body of the larvae and pupated near the dead larvae of diamondback moth. The cocoons of parasitoids were collected for further mass culturing.

Insecticides used for toxicity tests on *C. plutellae* were chlorantraniliprole 18.5 SC (Coragen), indoxacarb 14.5 SC (Avaunt), spinosad 2.5 SC (Success) and quinalphos 25 EC (Ekalux).

For evaluating toxicity to adults the dry film method described by McCutchen and Plapp (1988) was followed. The commercial formulations of the test insecticides, chlorantraniliprole 18.5 SC, spinosad 2.5 SC, indoxacarb 14.5 SC and quinalphos 25 EC were diluted with distilled water and acetone in the 20:80 ratio. Water and acetone treated test tube was provided as a control. A solution of 0.5 ml was added to a test tube of 3.5 cm diameter and 15 cm in height. The insecticide solution was distributed evenly around the inner wall of the test tubes and allowed to air dry. Ten unsexed adult parasitoids (1-2 day old) were released into each test tube and fed with honey soaked cotton wool. All the treatments were replicated three times. Mortality of the emerged adults was recorded at 24 and 48 hours after treatment. The effect of insecticides on *C. plutellae* and their selectivity was categorized according to Hassan *et al.* (1985).

For studying adult emergence, the test insecticides were diluted with distilled water at required concentrations and 2 ml of each insecticide solution was sprayed with atomizer onto cocoons and cocoons treated with water were provided as control. Each treatment consists of 10 cocoons and replicated three times. Observations were made on the adult emergence and subsequent adult moralities at 24 hours interval. The surviving adults were transferred to transparent plastic bins (30 cm height and 15 cm in diameter) and were fed with 10 per cent honey-solution. One hundred second instar larvae of *P.xylostella* were provided per five pairs of *C.pluellae* for parasitization. Per cent parasitisation and per cent reduction in parasitisation over control was calculated. The experiments were conducted at 25ºC and 80 per cent RH with 16 L: 8 D photo period. The mortality data were recorded and calculated by Abbott's formula (Abbott, 1925). The data obtained were statistically analysed by ANOVA and DMRT.

RESULTS AND DISCUSSION

Toxicity of test insecticides on adults of *C.plutellae* showed that, the test insecticides recorded a mortality up to 50 per cent at 24 hours after treatment (HAT) except quinalphos 500 g a.i. ha^{-1} which recorded 63.33 per cent and was slightly harmful (Table1). At 48 HAT chlorantraniliprole at 10, 5 and 2.5 g a.i. ha^{-1}, indoxacarb at 20 g a.i. ha^{-1} and spinosad 8.75 g a.i. ha^{-1} recorded mortality of 40.00, 3.33, 0, 43.33 and 46.67 per cent respectively and were harmless, whereas indoxacarb at 40 g a.i. ha^{-1}, spinosad at 17.5 g a.i. ha^{-1} and quinalphos at 500 g a.i. ha^{-1} recorded 63.33, 63.33 and 73.33 per cent mortality and were slightly harmful based on the categorization by Hassan *et al.* (1985).

Toxicity of test insecticides to cocoons of *C. plutellae*, was recorded and per cent adult emergence, mortality of emerged adults, per cent parasitisation per cent reduction in parasitisation are presented in Table 2. There was no significant difference in adult emergence from the treated cocoons. Mortality of the adults that emerged from

treated cocoons, recorded at 24 HAT was in the range of 23.33 to 71.83 per cent. Chlorantraniliprole at 10, 5 and 2.5 g a.i. ha^{-1}, indoxacarb at 20 g a.i. ha^{-1} and spinosad at 17.5 g a.i. ha^{-1} recorded mortality of 48.89, 26.67, 23.33, 38.15 and 48.15 per cent respectively and were harmless, while , indoxacarb at 40 g a.i. ha^{-1} spinosad at 8.75 g a.i. ha^{-1} and quinalphos at 500 g a.i. ha^{-1} recorded 56.85, 55.56 and 71.83 percent mortality respectively and were slightly harmful. Mortality recorded at 48 HAT was in the range of 30.00 to 71.83 per cent. Chlorantraniliprole at 5 and 2.5 g a.i. ha^{-1} and indoxacarb at 20 g a.i. ha^{-1} recorded 33.33, 30.00 and 48.89 per cent mortality and were harmless, while chlorantraniliprole 10 g a.i. ha^{-1} indoxacarb 40 g a.i. ha^{-1}, spinosad 17.5 and 8.75 g a.i. ha^{-1} and quinalphos 500 g a.i. ha^{-1} recorded 52.22, 63.89, 63.06, 58.89 and 71.83 per cent mortality and were slightly harmful according to the categorization of Hassan *et al.,*(1985). Fresh foliar residues of spinosad (Tracer) caused up to 50 per cent mortality of *C. plutellae* and were slightly harmful (Pietrantonio and Benedict, 1999). Cartap 75 SG, chlorfenapyr 10 F, emamectin benzoate 1 EC, permethrin 20 EC, chlorfluazuron 5 EC, flufenoxuron 10 EC and teflubenzuron 5 EC found to be selective (Haseeb and Amano, 2002) against the cocoon stage are supportive to this study.

There was no significant difference in per cent parasitisation among insecticides tested. However, higher per cent reduction in parasitisation of *P. xylostella* was recorded with quinalphos 500 g a.i ha^{-1} and spinosad 17.5 g a.i. ha^{-1} and were toxic. Chlorantraniliprole 5, 2.5 g a.i. ha^{-1} spinosad 8.75 g a.i. ha^{-1} and indoxacarb 20, 40 g a.i. ha^{-1} were relatively safe to *C. plutellae* with respect to parasitisation. Present finding on the toxicity of quinalphos on parasitism agrees with that of Mani and Krishnamoorthy, (1984) who reported that quinalphos (0.05%) was highly toxic to all the stages of *C. plutellae* and Kao and Tzeng, (1992) (quinalphos 0.5% caused more than 99% adult mortality).

Table 1. Toxicity of chlorantraniliprole 18.5 SC to adults of *Cotesia plutellae* (Kurudjumov)

Treatments	Dose (g a.i. ha^{-1})	% Mortality after treatment	
		24 HAT	48 HAT
T1 Chlorantraniliprole 18.5 SC	10	40.00^{c} (39.23)	40.00^{b} (39.23)
T2 Chlorantraniliprole 18.5 SC	5	3.33^{a} (10.52)	3.33^{a} (10.52)
T3 Chlorantraniliprole 18.5 SC	2.5	0.00^{a} (0.00)	0.00^{a} (0.00)
T4 Indoxacarb 14.5 SC	40	50.00^{cd} (45.00)	63.33^{c} (52.73)
T5 Indoxacarb 14.5 SC	20	23.33^{b} (28.88)	43.33^{b} (41.17)
T6 Spinosad 2.5 SC	17.5	43.33^{c} (41.17)	63.33^{c} (52.73)
T7 Spinosad 2.5 SC	8.75	23.33^{b} (28.88)	46.67^{b} (43.09)
T8 Quinalphos 25 EC	500	63.33^{e} (52.73)	73.33^{c} (58.91)
T9 Control (Water : Acetone) 20 80		0.00^{a} (0.00	0.00^{a} (0.00)
CD @ 5 %		8.82	11.36

*HAT – Hours after treatment, Figures in the parenthesis are arcsine transformed values, (Mean of three observations)

Mortality	Category(Hasan *et al.,* 1985)
< 50	Harmless
50-79	Slightly harmful
80-99	Moderately Harmful
> 99	Harmful

Chlorantraniliprole reported as harmless to the parasitoid wasp species tested according to IOBC classification criteria (<30% effects) (Brugger *et al.,* 2010) is in supporting the present study.

The present study clearly revealed that chlorantraniliprole 10 g a.i. ha^{-1}, followed by indoxacarb 20 g a.i. ha^{-1} and spinosad 8.75 g a.i. ha^{-1} were selective to adult parasitoid *C. plutellae* in terms of toxicity to adults, cocoons, adult emergence and parasitism.

Table 2. Toxicity of chlorantraniliprole 18. 5 SC to cocoons of *Cotesia plutellae* (Kurudjumov)

Treatments	Dose (g a.i. ha^{-1})	Adult emergence (%)	Mortality of adults after emergence (%)		Parasitisation after emergence (%)	Reduction in parasitisation (%)
			24 HAT*	48 HAT*		
T_1 Chlorantraniliprole 18.5 SC	10	96.67[a] (79.48)	48.89[d] (44.36)	52.22[c] (46.27)	56.44[b] (48.70)	9.02
T_2 Chlorantraniliprole 18.5 SC	5	100.00[a] (90.00)	26.67[b] (31.09)	33.33[b] (35.26)	56.67[b] (48.83)	8.78
T_3 Chlorantraniliprole 18.5 SC	2.5	100.00[a] (90.00)	23.33[b] (28.88)	30.00[b] (33.21)	58.10[b] (49.66)	7.23
T_4 Indoxacarb 14.5 SC	40	90.00[a] (71.57)	56.85[d] (48.94)	63.89[cd] (53.06)	56.22[b] (48.57)	9.26
T_5 Indoxacarb 14.5 SC	20	96.67[a] (79.48)	38.15[bc] (38.14)	48.89[c] (44.36)	56.67[b] (48.83)	8.78
T_6 Spinosad 2.5 SC	17.5	90.00[a] (71.57)	55.56[d] (48.19)	63.06[cd] (52.57)	44.44[b] (41.81)	21.89
T_7 Spinosad 2.5 SC	8.75	96.67[a] (79.48)	48.15[c] (43.94)	58.89[c] (50.12)	61.33[b] (51.55)	3.70
T_8 Quinalphos 25 EC	500	70.00[b] (56.79)	71.83[e] (57.94)	71.83[de] (57.94)	44.44[b] (41.81)	21.89
T_9 Control		100.00[a] (90.00)	0.00[a] (0.00)	0.00[a] (0.00)	64.67[a] (53.53)	-
CD @ 5%		15.8065	10.72	10.19	16.75386	0

* HAT – Hours after treatment, Figures in the parenthesis are arcsine transformed values, Mean of three observations

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EFFECT OF MECHANIZED TRANSPLANTING ON YIELD, YIELD ATTRIBUTES AND ECONOMICS OF RICE *(Oryza sativa)*

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ABSTRACT

On farm trials (OFTs) were conducted in seventeen locations by RASS – Krishi Vigyan Kendra during *rabi* 2009, 2010 and 2011 to assess the performance of mechanized transplanting using Yanji rice transplanter for yield, yield attributes and economics. The field capacity of Yanzi rice transplanter was 0.16 ha per hour and time taken to cover one hectare area was 6 hours and 25 minutes. Results of the trials indicated that the yield parameters viz., number of productive tillers per hill^{-1}, panicle length, number of grains panicle^{-1} and yield were higher in mechanized transplanting than manual transplanting. Mechanized transplanting recorded more grain yield (6359 kg ha^{-1}) and net returns (Rs. 31870/- ha^{-1}) with less cost of cultivation (Rs. 29796/- ha^{-1}) compared to manual transplanting. Mechanized transplanting recorded benefit cost ratio of 2.3, but it was only 1.76 in the case of manual transplanting. Mechanized transplanting with Yanji rice transplanter can be used successfully as an economic, viable and alternative option for obtaining higher yield and reducing cost of cultivation as the manual transplanting involves more labour and drudgery.

Rice is the most important food grain crop and plays a vital role in food security in India and grown in an area of 48.29 lakh ha with a production of 153.28 lakh tonnes during *Rabi* season (Source:www.rkmp.co.in). In Andhra Pradesh, it is grown in an area of 18.29 lakh ha during *Rabi* with a production of 69.08 lakh tonnes and an average productivity of 3777 Kg ha^{-1} (Source: www.rkmp.co.in). Manual transplanting is the most popular method of rice cultivation. Though, it is an effective means of rice cultivation, however it is tedious, laborious, time consuming and involve drudgery, including shortage and high cost of labour during peak periods of agricultural operations. It also results in increased cost of transplanting and delay in transplanting due to non availability of labour in time. Further, it is very difficult to cover larger area within a short span by using manual labour. Delay in transplanting from normal date causes reduction in rice yield by nine per cent. (Islam *et al.*, 2008). Ved Prakash Chaudhary and Varshney (2003) reported that transplanting takes about 250-300 man hours per ha which is roughly 25 per cent of the total labour requirement of the crop. Under such situation, a less expensive and labour saving method of rice transplanting without reduction in grain yield is the need of the hour. The mechanical rice transplanting is an alternate and promising option, as it saves labour, ensures timely transplanting and also contributes to higher grain yield. Keeping this in view, Rasthriya Seva Samithi Krishi Vigyan Kendra (RASS KVK), Tirupati has undertaken a study on VST Shakti Yanji Rice Transplanter in Chittoor district and assessed its performance for yield attributes and economic parameters for three consecutive years from 2009.

MATERIAL AND METHODS

The mechanized transplanting was evaluated in seventeen locations during *rabi* 2009, 2010 and 2011 in Yerpedu mandal of Chittoor district which is geographically located at 13.6°N and 79.6°E. The soil texture of the experimental fields was sandy clay loam with soil pH ranging from neutral to slightly alkaline (7.1 - 8.2), normal electrical conductivity (0.2 – 0.9 m mhos cm^{-1}), low in available nitrogen (212 - 255 Kg ha^{-1}), high in available phosphorus (88 – 145 Kg ha^{-1}) and medium to high in potassium (195 – 355 Kg ha^{-1}). The test variety ADT-37, a short duration (120 days), blast resistant and coarse grain quality suitable for para boiled rice was used for the study. The Yanji rice transplanter was purchased from VST Tillers and Tractors Private Limited, Bangalore with the financial support of Agricultural Technology Management Agency (ATMA), Chittoor.

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In mechanized transplanting, seedlings were raised by special method, mat method of nursery. Raised beds of 10 m length, 1.2 m width and 2.5 cm height were prepared and covered with polythene sheet of 1.2 m width and 50 micron thickness. On the plastic sheet, 21x50 cm size iron frames prepared by KVK were placed to get the uniform size of nursery mats which is suitable to feed in to the transplanter for easy planting. These frames were filled with softened wet soil free from any trash and stones and mixed with well decomposed farm yard manure for better growth. Sprouted Paddy seed (45 Kg ha^{-1}) were spread uniformly on the wet soil and covered with paddy straw, as it prevents any damage from birds and also helps in good seedling growth. These nursery beds were watered using rose cans for 4-5 days and thereafter, the paddy straw was removed and seedlings were grown normally by regular watering. Seedlings were ready for transplanting by 16 to 18 days after sowing, when the height of the plant reaches 10-15 cm height with 3-4 leaves. Yanji rice transplanter was used for mechanized transplanting. After the land preparation and levelling in the main field, the field was allowed for sedimentation for 12 hours to avoid sinking of transplanter. The machine covers 8 rows with spacing of 23.8 cm between the rows and 17 cm between the hills in a row. Rice nursery was raised by adopting the recommended package of practices for manual transplanting.

RESULTS AND DISCUSSION

Yanji rice transplanter

Based on the trials conducted during three consecutive rabi seasons 2009, 2010 and 2011, it was observed that the number of seedlings transplanted $hill^{-1}$ was 4-6 and the depth of seedlings planted was about 5 cm in case of mechanized transplanting. The field capacity of Yanzi rice transplanter was 0.16 ha $hour^{-1}$ and the time taken to cover one hectare area was 6.25 hours. The transplanter doesn't have the facility to change the row distance, but the distance between the hills in a row can be adjustable to 10 or 14 or 17 cm.

Yield attributes

The data from the Table 1 revealed that the yield attributes viz., productive tillers $hill^{-1}$, panicle length and number of grains $panicle^{-1}$ were higher in mechanized transplanting than manual transplanting during three consecutive years, though statistically there was no significant difference between manual and mechanized transplanting. This might be due to maintenance of optimum plant population per unit area and depth of planting which resulted in increased number of productive tillers $hill^{-1}$ due to efficient utilization of growth resources. Similar results were reported by Manjunatha *et al.* (2009). Increased number of panicles $hill^{-1}$ and fertile grains $panicle^{-1}$ in machine planting were also reported by Sheeja *et al.* (2012).

Table 1. Yield attributes as influenced by manual transplanting and mechanized transplanting (variety: ADT-37)

Year	Method of transplanting	No. of productive tillers $hill^{-1}$	Panicle length (cm)	No. of grains $panicle^{-1}$	Test weight (g)
2009	Manual	14.1	15.0	121	22.51
	Transplanter	16.5	16.2	128	22.30
2010	Manual	11.9	13.4	100	22.61
	Transplanter	12.7	14.9	105	22.74
2011	Manual	12.4	14.7	103	22.59
	Transplanter	13.5	15.2	111	22.64
Mean	Manual	12.8	14.4	108	22.57
	Transplanter	14.2	15.4	115	22.56
	CD at 5 % SE m±	NS 0.425	NS 0.356	NS 3.618	NS 0.183

There was no significant difference in test weight between mechanized and manual transplanting methods in all the three years. These results are in conformity with Manjunatha *et al.* (2009).From the yield data of three consecutive years presented in Table 2, it was observed that statistically there was no significant difference in grain yield of rice due to mechanized transplanting and manual transplanting methods. However, mechanized transplanting recorded higher grain yield (6359 Kg ha^{-1}) than manual transplanting (5718 Kg ha^{-1}).Mechanized transplanting recorded 10% increase in grain yield over manual transplanting which might be due to transplanting of younger seedlings with uniform spacing. This enabled better translocation of photosynthates from source to sink leading to higher number of productive tillers $hill^{-1}$ (14.2) which in turn increased the number of filled grains $panicle^{-1}$ (115) and ultimately higher grain yield. The results are in conformity with the findings of Vijay Kumar *et al*., (2012) and Sheeja *et al*., (2013).

Table 2. Yield and economics of manual transplanting and mechanized transplanting (variety: ADT-37)

Year	Method of transplanting	Grain yield (Kg ha^{-1})	Cost of cultivation (` ha^{-1})	Gross returns (` ha^{-1})	Net returns (` ha^{-1})	Benefit cost ratio
2009	Manual	6255	27338	62550	35212	2.29
	Transplanter	6819	24988	68190	43202	2.73
2010	Manual	5288	31163	51404	20241	1.65
	Transplanter	6025	29663	58643	28980	1.98
2011	Manual	5610	39238	52360	13122	1.33
	Transplanter	6232	34738	58165	23427	1.67
Mean	Manual	5718	32580	55438	22858	1.76
	Transplanter	6359	29796	61666	31870	2.13
	CD at 5 % SE m ±	NS 195.45	NS 667.98	NS 1895.80	NS 2472.36	NS 0.09

* Rs. 1000/- (2009), Rs. 973/- (2010), Rs. 933/- (2011) per quintal of grain

Economics

The study revealed that the average cost of cultivation in mechanized transplanting was reduced by Rs. 2784 ha^{-1} compared to manual transplanting. The cost of operations like field preparation for nursery rising, pulling of seedlings, transport of seedlings to main field and transplanting in manual transplanting method is higher than the cost of operations involved in mechanized transplanting. It is observed from Table 2 that the cost of cultivation in both the methods was gradually increasing from 2009 to 2011 due to increase of labour wages and prices of fertilizers. An additional benefits of Rs.9012/- was obtained in mechanized transplanting compared to manual transplanting. This was due to lower cost of labour for nursery and transplanting in mechanical transplanting. Mohapatra *et al.*, (2012) and Sheeja *et al.*, (2012) also reported that the cost of cultivation was reduced and net returns were increased by using transplanter in rice. Similarly, the highest benefit cost ratio (2.13) was obtained with mechanized transplanting compared to manual transplanting (1.76). Sajitha Rani and Jayakiran, (2010) also reported higher benefit-cost ratio in mechanical transplanting.

CONCLUSION

Mechanized transplanting was found to be the best method to obtain more number of productive tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, grain yield, net returns and benefit -cost ratio compared to manual transplanting even though statistically not significant. Cost of cultivation was reduced by Rs. 2784 ha^{-1} in mechanized transplanting than manual transplanting. It can be concluded that the rice transplanter can be used successfully as an alternative option to manual method of transplanting for obtaining higher grain yield and reducing cost of cultivation as it involves more labour and drudgery.

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EVALUATION OF DIFFERENT CROP ESTABLISHMENT TECHNIQUES IN PUDDLED RICE (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during *kharif* 2011 and 2012 at Agricultural Research Station, Kampasagar, Nalgonda, Andhra Pradesh to evaluate the different crop establishment techniques in puddled rice. Machine transplanting, broad casting and drum seeding were compared with conventional transplanting in large size plots (112 m^{-2}). Machine transplanting recorded maximum panicle length (23.61 cm) and maximum number of grains per panicle (156) in first and second year respectively. The grain yield was maximum with machine transplanting in both the years (5693 and 6751 kg ha^{-1}) and significantly superior over broadcasting (5248 and 6298 kg ha^{-1}), whereas net returns were highest with drum seeding (34060 and 79627 Rs ha^{-1}).

Rice (*Oryza sativa* L.) is the major staple food for more than half of the world's population. Among the rice growing countries, India has the largest area (44 million hectares) and it is the second largest producer (131 million tonnes) next to China (197 million tonnes) (CMIE, 2013). Urbanisation, migration of labour from agriculture to non-agriculture sector and increased labour costs are seriously threating the cultivation of crops in general and rice in particular (Yadav *etal.*, 2014).The typical system of low land rice cultivation in puddled soils discourages the labour to attend the field operations. Transplanting in rice is very labour intensive and at least 30 man days are required to transplant one hectare. Often, the peak labour demand coincides with release of water from canals leading to labour shortage (Singh *etal.,* 2005). Transplanting alone costs about 15 % of total rice production cost and delayed transplanting due to labour shortage causes substantial loss in yield (Ponnuswamy *etal.,* 1999). Therefore, there is need of alternative methods to replace transplanting to tackle the problem of high cost of production and labour scarcity in puddled rice.

Broadcasting, drum seeding, machine transplanting are some of the labour saving rice cultivation systems which are gaining popularity among the farming community in Andhra Pradesh.Though, the performance of these individual rice cultivation systems are well documented (Visalakshi and Sireesha, 2013, Singh *etal.,* 2005), comparative studies for their yield and economics are lacking. Hence the present field investigation was conducted with an objective to evaluate different crop establishment techniques in puddled soil for their yield and economics.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* 2011 and 2012, at the Agricultural Research Station, Kampasagar, Nalgonda district ($16^0$51'N Latitude $79^0$28'E Longitude and at an altitude of 136 m above mean sea level).

The soil of the experimental field was sandy loam in texture, low in organic carbon (0.28%) and available nitrogen (135 kg ha^{-1}), medium is available phosphorus (23.4 kg ha^{-1}) and potassium (270 kg ha^{-1}). Under average climatic conditions, the area receives 645 mm of total rainfall. The mean monthly temperatures during the rice growing seasons varied from 15^0c to 38^0c.

The experiment was laid out in randomised block design with five replications. Treatments comprised of four systems of rice cultivation – Conventional transplanting (CT), Machine transplanting (MT), Broad casting (BC) and Drum seeding (DS). Long duration (140-145 days) rice variety, Samba Mahsuri (BPT 5204) was used as test variety in the present study. The seeding was done on 8-7-2011 and 18-8-2012 during the two years under investigation.

The sprouted seed was either broadcasted or drumseeded on the same day as nursery sown for transplanting. The seed rate adopted was 50, 30, 30

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and 25 kg for CT, MT, BC and DS respectively. Seedlings of 17 and 30 days were used in machine and conventional transplanting during both the years of study. The size of the each experimental treatment was 112 m^2.

The experimental field was puddled, perfectly leveled and adequate drainage facility was provided. The specific recommended package of practices for each method of rice cultivation was followed and the crop was kept free from pest and diseases. At harvest, the yield and yield attributes were recorded and analysed as per the procedure outlined by Gomez and Gomez (1984).The cost economics were worked out based on actual expenditure incurred and on the prevailing market prices.

RESULTS AND DISCUSSION

Yield parameters

Certain yield parameters were significantly influenced by different crop establishment techniques in first or second year (Table 1), whereas panicle number and number of grains per panicle were significantly influenced by different crop establishment methods in both the years. In 2011, tillers as well as panicle number were significantly not influenced by different rice establishment techniques, where as in 2012, MT rice significantly recorded more number of tillers (541 per m^2) and panicles (423 per m^2). The wider row spacing (30 cm) coupled with transplanting young seedlings (17 days) may be the reason for such trend under MT. These results endorsing the earlier findings of Thakar *etal.,* (2008).

During both the years of investigation, significantly lower panicle length (20.32 and 17.90 cm) was recorded in DS over CT. Overcrowded population leads to competition and it is reflected as lower panicle length under DS.

The total (207) as well as filled grains (197) per panicle were maximum under CT in 2011 and in subsequent year these values were highest in MT rice (156 and 149) and these two systems were at par with each other and significantly superior over BC. These results are in contrast to the findings of Visalakshi and Sireesha (2013) where maximum filled grains per panicle were observed with DS and BC over conventional transplanting. Test weight was not influenced by treatments and ranged between 12.70 to 13.37 g under different crop establishment methods.

Grain and straw yield

The grain yield was significantly influenced by different crop establishment techniques (Table 2). MT and CT were at par during both the years and significantly superior over BC and DS in first year where as in second year DS was also at par with these two systems. BC method of rice cultivation recorded lower grain yield (5248 and 6298 kg ha^{-1}) in both the years. Visalakshi and Sireesha (2013) evaluated drum seeder in farmers field and inferred that DS is superior to CT and BC, whereas Sharma and Gangwar (2001) recorded similar grain yields with transplanting, sowing / dibbling sprouted seeds in puddled soil. The performance of a particular system of rice cultivation depends on soil, climate and variety and may be the reason for such differential reports in rice.Straw yield was not significantly influenced by different rice establishment methods.

Economics

Lowest cost of cultivation (Rs. 29525 and Rs. 31025 ha^{-1}) was recorded with BC closely followed by DS (Rs. 29000 and Rs. 31400 ha^{-1}). The cost of cultivation is high in conventional as well as machine transplanting due to nursery raising and more involvement of human labour. The net returns in second year are substantially higher than first year due to hike in the sale price of rice by 5 Rs. kg^{-1}. The net returns (Rs. 34060 and 79627 ha^{-1}) as well as return per rupee invested (1.14 and 2.53) were maximum with DS closely followed by BC. The less cost of cultivation incurred in these two practices was the reason for higher net returns.Similar findings were reported by Halder and Patra (2007).

Table 1.Yield attributes as influenced by different crop establishment techniques in puddled rice

Treatment	Tillers m^{-2}		Panicles m^{-2}		Panicle length (cm)		Total grains $panicle^{-1}$		Filled grains $panicle^{-1}$		1000 grain weight (g)	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Conventional transplanting	371	345	352	336	22.64	19.20	207	145	197	132	13.13	13.31
Machine transplanting	382	541	364	423	23.61	18.50	170	156	158	149	12.70	13.23
Broad casting	372	336	341	320	20.32	17.90	145	117	116	112	12.91	13.37
Drum seeding	352	427	328	413	21.53	18.50	160	145	143	137	12.77	13.20
S Em±	18	23	16	17	0.49	0.26	8.3	13	9.4	8	0.27	0.13
C.D at 5%	NS	70	NS	53	1.53	0.80	26	NS	29	24	NS	NS

Table 2. Grain yield, straw yield and economics under different crop establishment techniques in puddled rice

Treatment	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Cost of cultivation (Rs ha^{-1})		Net Returns (Rs ha^{-1})		Return per rupee invested	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Conventional transplanting	5659	6451	5873	6678	35700	37200	32208	72467	0.90	1.95
Machine transplanting	5693	6751	5978	7117	35250	36750	33066	78017	0.94	2.12
Broad casting	5248	6298	5670	6751	29525	31025	33475	76109	1.13	2.45
Drum seeding	5330	6531	5510	6725	29900	31400	34060	79627	1.14	2.53
S Em±	92	92	114	120						
C.D at 5%	287	287	NS	NS						

Rice sale price (Rs kg^{-1}): 12 (2011) and 17 (2012)

Thus, it can be concluded that alternative systems of crop establishment in puddled rice in comparision with conventional transplanting are encouraging. Machine transplanting and drum seeding of rice as an alternative to conventional transplanting are recommended for higher yield and net returns.

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EXTENSION SYSTEM AND FARMERS' LINKAGE EFFECTIVENESS IN AGRICULTURAL UNIVERSITIES OF ETHIOPIA AND INDIA

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ABSTRACT

The linkage among research, extension and farmers is important for the technologies being useful for farmers' needs and demands and to address the challenges of sustained decrease in agricultural productivity, environmental sustainability and poverty alleviation. Agricultural extension services are expected to disseminate new technologies among their clients, but due to poor linkages between research and extension, the adoption of new technologies by farmers in the developing world is often very slow and research is not focusing on the actual needs of the farmers'. The main problem is lack of clear understanding of the concept of linkage and its need in the agricultural and rural development process. This paper attempts to describe and address the issues of Research - extension - farmer linkages as perceived by scientists so that findings will benefit and contribute in socio-economic development of the farming community in India and Ethiopia. In India, Punjab Agricultural University (PAU), Ludhiana and in Ethiopia, Hawasa University were purposively selected. The data was collected from randomly selected 84 agricultural scientists in India and 87 agricultural scientists in Ethiopia in the year 2008-09. The effectiveness of linkage of agricultural universities system with extension and farmers was measured with the help of linkage effectiveness scale developed for the study. The overall effectiveness score (3.13) of linkage of agricultural universities with extension system in India was found to be 'average'.In Ethiopia the overall score of 2.61 indicates that scientists perceived the linkage as 'below average'.This is an area of concern which needs to be addressed by all stakeholders to enhance the effectiveness of university led extension system as well as research system.

The Research - Extension - Farmer linkage provides a key element in planning research and extension activities which are participatory and demand driven. Therefore, there is not only a need to recognize farm skills and knowledge as an important element in agriculture technology development and dissemination but it needs careful assessment for its strength and weakness. Various sub-systems of Agricultural Knowledge and Information System (AKIS) must work together in cooperation. There should be two way communications among research - extension and farmers and other subsystems. It is well understood that AKIS must work synergistically to fulfil the world stride of facing triple challenges of sustained decrease in agricultural productivity, environmental sustainability and poverty alleviation. This requires using linkage as an important tool of management for coordination and communication. This will result in development and dissemination of appropriate technologies. The concept of linkage implies the communication and working relationship established between two or more organisations pursuing commonly shared objectives in order to have regular contact and improved productivity. Depending on the country, linkage activities are usually managed at varying administrative levels -national, regional, state and local levels. The agricultural research and extension system identifies farm families as their target and the hub around which researchers and extensionists focus their actions. The constraints which hinder research-extension linkage potentially affect the agricultural output of farmers, whereas effective links will allow farmers to enhance their output through the availability of farming innovations.(Agbamu, 2000). Researchers and Extension officers need to work together with farmers. Various studies indicate that there are poor linkages between research and extension in many developing countries. Agricultural extension services are expected to disseminate new technologies among their clients, but due to poor linkages between research and extension the adoption of new technologies by farmers in the developing world is often very slow and research is not focusing on the actual needs of the farmers'. The main problem is lack of clear understanding of the concept of linkage and its need in the agricultural and rural development process. In Indian and Ethiopian situation, the linkages were perceived to be poor. Prasad and Singh (2004) stated that limiting factors and challenges in linkage planning are: insufficient guidance, frequent changes/ transfer of personnel assigned for linkage related responsibilities, limiting awareness among stakeholders of linkage planning approach, insufficient time to develop linkage among sub-systems at

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national, regional and district levels. They also identified other limiting factors in the process that require changes in attitudes, institutional structure and policy issues and imperfect communication among personnel of different sub-system that limit linkage and hinder the proper implementation of programmes and information flow.

This paper attempts to describe and address the issues of Research - extension - farmer linkages as perceived by scientists so that findings will benefit and contribute in socio-economic development of the farming community. In this paper, the effectiveness of research, extension and farmers' linkage refers to flow of communication among these three sub-systems and relevance of technology developed to solve the farmers' production problems and to improve the profitability of the farmers.

MATERIAL AND METHODS

The study was conducted in two countries i.e., India and Ethiopia. In India, Punjab Agricultural University (PAU), Ludhiana and in Ethiopia, Hawasa University were purposively selected. The data was collected from randomly selected 84 agricultural scientists in India and 87 agricultural scientists in Ethiopia. The effectiveness of linkage of agricultural universities system with extension and farmers was measured with the help of linkage effectiveness scale developed for the study. The validity was tested through jury opinion and reliability was done through test-retest technique.

S.No.	Score	Evaluation
1.	1 to 1.25	Poor
2.	1.26 to 2.59	Below average
3.	2.60 to 3.75	Average
4.	3.76 to 5.00	Above average

The average scores obtained for each dimension were ranked.

The scale consisted of the following eleven dimensions:

1. Reward system for understanding research projects
2. Feedback
3. Relevance of technology developed
4. Conversion of findings into practical solutions
5. Publications
6. Testing and refinement of technology
7. Development of extension models
8. Training of scientists
9. Coordination mechanism
10. Availability of high yielding variety seeds developed by University for farmers

Table 1. Overall effectiveness of linkage as perceived by Indian scientists ***On a scale of 1-5**

(n=84)

S.No.	Dimensions	Mean Score*	Rank
1.	Testing and refinement of technology	3.60	I
2.	Publication	3.58	II
3.	Conversion of findings into practical solutions	3.44	III
4.	Development of extension models	3.29	IV
5.	Coordination mechanism	3.29	IV
6.	Feedback	3.20	V
7.	Availability of high yielding variety seeds developed by University to farmers	3.12	VI
8	Relevance of technology developed	3.09	VII
9.	Reaching marginalized group with emphasis on reaching rural women and marginal farmers and laborers.	3.08	VIII
10.	Reward system for understanding research projects	2.55	IX
11.	Training of scientists	2.25	X
Overall Score		**3.13**	

Table 2. Effectiveness of linkage in India as perceived by Indian scientists ***On a scale of 1-5***
(n=84)

S.No	Dimensions	Mean Score*	Evaluation
1	**Testing and refinement of technology**	**3.60**	
	• Testing and refinement of technology in farmers' fields	*3.49*	*Average*
	• Conducting demonstrations	*3.72*	*Average*
2	**Publications**	**3.58**	
	• Publication of findings of research in research journals and books	*3.06*	*Average*
	• Conversion of research findings into popular articles	*3.75*	*Average*
	• Production of extension literature and mass media for diffusion of technology	*3.93*	*Above Average*
3	**Conversion of findings into practical solutions**	**3.44**	
4	**Development of extension models**	**3.29**	
5	**Coordination mechanism**	**3.29**	
	• Coordination mechanism between university and state departments	*3.41*	*Average*
	• Mechanism for constant improvement in present linkage	*3.81*	*Average*
6	**Feedback**	**3.20**	
	• Receiving feedback from extension functionaries and farmers	*3.04*	*Average*
	• Utilization of innovative ideas received from farmers	*3.25*	*Average*
	• Influence of farmers and extension workers on research agenda of university	*3.02*	*Average*
	• Utilization of indigenous technologies	*3.50*	*Average*
7	**Availability of high yielding variety seeds developed by university to farmers**	**3.12**	
8	**Relevance of technology developed**	**3.09**	
	• Relevance of technology developed to solve small and marginal farmers' problems.	*3.43*	*Average*
	• Research systems oriented towards field problems	*2.76*	*Average*
9	**Reward system for understanding research projects**	**2.55**	
10	**Reaching marginalized group with emphasis on reaching rural women and marginal farmers and laborers**	**3.08**	
11	**Training of scientists**	**2.25**	
	• Training of scientists to improve linkages	*1.66*	*Below average*
	• Proper attitude for better linkage	*2.85*	*Average*

11. Reaching marginalized group with emphasis on reaching rural women and marginal farmers and laborers.

It was decided to evaluate the score on each dimension. For the purpose the following evaluation criteria was used.

RESULTS AND DISCUSSION

Evaluation of linkage effectiveness in India

The overall effectiveness score (3.13) of linkage of agricultural universities with extension system in India was found to be 'average' and the detail is provided in Table 1. The nine dimensions viz; 'testing and refinement of technology' followed by 'publications' (3.58), 'conversion of findings into practical solutions (3.44), 'development of extension models' and 'coordination mechanism'(3.29), 'feedback' (3.20) 'availability of high yielding variety seeds developed by university to farmers' (3.12), 'relevance of technology developed' (3.09), 'reaching marginalized group with emphasis on reaching rural women and marginal farmers and labourers' (3.08) were evaluated as av-

erage. However, it was below average in areas of 'reward system for understanding research projects' (2.55) and 'training of scientists' (2.25).

Evaluation of sub-items of major dimension

The data in Table 2 shows the evaluation of sub-items of major dimension such as 'testing and refinement of technology', 'publications', 'coordination mechanism', 'feedback', 'relevance of technology developed' and 'training of scientists' were rated as 'average' or below average.

Overall effectiveness of linkage as perceived by Ethiopian scientists.

The overall effectiveness of linkage among research, extension and farmers as perceived by scientists in Ethiopia was studied in terms of the identified eleven major dimensions. The overall score of 2.61 indicates that scientists perceived the linkage as below average and the detail is provided in Table 3.

Table 3. Overall effectiveness of linkage among research-extension and farmers in Ethiopia as perceived by Ethiopian scientists.

On a scale of 1-5
(n=87)

S.No.	Dimension	Mean Score*	Rank
1.	Coordination mechanism	3.78	I
2.	Conversion of research findings into practical solutions	2.89	II
3	Reward system for understanding research projects	2.79	III
4.	Testing and refinement of technology on farmers fields	2.70	IV
5.	Publications	2.66	V
6.	Reaching marginalized group with emphasis on reaching rural women and marginal farmers and laborers	2.57	VI
7.	Feedback	2.49	VII
8.	Development of extension models	2.46	VIII
9.	Relevance of technology developed	2.43	IX
10.	Training scientists	2.00	X
11.	Availability of high yielding variety seeds	2.00	X
	Overall Score	**2.61**	

The rank ordering of dimensions as per Table 3 shows that the dimension of 'coordination mechanism' as the best dimension with the score of 3.78 followed by 'conversion of research finding into practical solutions' (2.89), 'reward system for understanding research projects' (2.79), 'testing and refinement of technology on farmers fields' (2.70), 'publications' (2.66), 'reaching marginalized group with emphasis on reaching rural women and marginal farmers and labourers (2.57), 'feedback (2.49), 'development of extension models' (2.46), 'relevance of technology developed' (2.43), 'training of scientists' (2.00) and 'availability of high yielding variety seeds' (2.00).

The Effectiveness of linkage in terms of various sub-divisions among research, extension and farmers as perceived by scientists of Ethiopia are presented in Table 4.

Table 4. Effectiveness of linkage among research, extension and farmers in Ethiopia as perceived by Ethiopian scientists ***On a scale of 1-5**

(n=87)

S.No.	Dimensions	Mean Score*	Evaluation
1.	**Testing and refinement of technology**	**2.70**	**Average**
	• Testing and refinement of technology in farmers' fields	*2.59*	*Below Average*
	• Conducting demonstrations	*2.82*	*Average*
2.	**Publications**	2.66	Average
	• Publication of findings of research in research journals and books	*2.48*	*Below Average*
	• Conversion of research findings into popular articles	*2.88*	*Average*
	• Production of extension literature and mass media for diffusion of technology	*2.64*	*Average*
3.	**Conversion of findings into practical solutions**	2.89	Average
4.	**Development of extension models**	**2.46**	**Below Average**
5.	**Coordination mechanism**	3.78	Above Average
	• Coordination mechanism between university and state departments	*2.93*	*Average*
	• Mechanism for constant improvement in present linkage	*2.63*	*Average*
6.	**Feedback**	2.49	Below average
	• Receiving feedback from extension functionaries and farmers	*2.61*	*Average*
	• Utilization of innovative ideas received from farmers	*2.23*	*Below Average*
	• Influence of farmers and extension workers on research agenda of university	*2.43*	*Below Average*
	• Utilization of indigenous technologies	*2.70*	*Average*
7.	**Availability of high yielding variety seeds developed by university to farmers**	**2.00**	**Below Average**
8.	**Relevance of technology developed**	2.43	Below Average
	• Relevance of technology developed to solve small and marginal farmers' problems.	*2.79*	*Average*
	• Research systems oriented towards field problems	*2.08*	*Below Average*
9.	**Reward system for understanding research projects**	**2.79**	**Average**
10.	**Reaching marginalized group with emphasis on reaching rural women and marginal farmers and laborers**	**2.57**	**Below Average**
11	**Training of scientists**	**2.00**	**Below average**
	• Training of scientists to improve linkages	*1.64*	*Poor*
	• Proper attitude for better linkage	*2.36*	*Below Average*

It can be observed from Table 4 that none of the dimensions were rated as above average. The dimensions were rated as average was - 'Reward system for understanding research projects', 'Conversion of findings into practical solutions'. 'Publications', 'Testing and refinement of technology', and 'Coordination mechanism'.

The dimensions that were rated as 'below average' were 'Feedback', Relevance of technology developed', 'Training of scientists', 'Availability of high yielding variety seeds developed by university to farmers', and 'Reaching marginalized groups with emphasis on reaching rural women, marginal farmers and labourers'.

The major difference in case of India and Ethiopia in the effectiveness of linkage was perceived in terms of 'research system oriented towards field problem'. In India which was average whereas in case of Ethiopia the corresponding linkage was below average.

Suggestions of scientists to improve linkage between scientists and farmers

Linkages between scientists and farmers are important for improving effectiveness of universities. The suggestions given by scientists for improving linkage between scientists and farmers were analyzed. The suggestions have been categorized into four main headings:

1. Research aspects
2. Technology dissemination
3. Capacity building and administration
4. Resource allocation

India

Regarding research aspects three suggestions were given to improve linkage between research scientists and farmers. These were 'strengthening the facility in research institutions' was suggested by majority of the respondents (77.78%, Rank I) followed by 'visiting farmers fields regularly for understanding their problems and getting feedback' (70.23%, Rank II) and allowing researchers to conduct their research

Table 5. Suggestions of scientists to improve linkage between scientists and farmers in India

S.No.	a. Research Aspects	Frequency	Percentage	Rank
1.	Strengthening the Extension faculty in research institutions	65	77.38	I
2.	Visiting farmers' field regularly for understanding their problems and getting feedback	59	70.23	II
3.	Allowing researchers to conduct their research in their own specialization	51	60.71	III
	b. Technology dissemination			
1..	Arranging transportation facilities for farmers to visit the research institutions.	75	89.29	I
2.	Conducting group meetings with farmers	50	59.52	II
3.	Making farmers visit research institutions in groups for solving new problems	47	55.95	III
4.	Establishing effective communication modes like internet, T.V., radio etc.	34	40.47	IV
	c. Capacity building			
1.	Providing training to farmers	69	82.14	I
2.	Giving more opportunity for interaction among scientists and farmers.	65	77.38	II
3.	Strengthening farmers' organizations and empowering workers	61	72.61	III
4.	Reducing official meetings and report preparation for scientists.	58	69.04	IV
5.	Organizing regular meetings, workshops, forums etc for scientists and farmers	55	65.47	V
6.	Freeing scientists from unnecessary administrative works	51	60.71	VI
7.	Redistributing staff depending on the work demand	48	57.14	VII
8.	Making farmers understand the aim and purpose of *kisan* mela, KVK and university meetings	37	44.04	VIII
9.	Providing training to scientists	35	41.66	IX
	d. Resource allocation			
1.	Providing proper financial and other resources	70	83.33	I
2.	Ensuring support from government and allied agencies	35	41.66	II

With respect to "resource allocation", suggestions given by the scientists were "providing proper financial and other resources" (83.33%, Rank I) and "ensuring support from Government and other allied agencies (41.66%, Rank II).

Ethiopia

Regarding research aspects, a total of six suggestions were given by the scientists to improve effective linkage of scientists with farmers. As seen in the Table 6 majority of the scientists (74.71%, Rank I) believed that "Identifying research problems with farmers and involving them at every step" is of utmost importance to improve linkage followed by "Allocating more time for research work" (67.82%, Rank II), "Monitoring evaluation and feedback of research output" (58.62%, Rank III), "Planning research with a long term perspective" (51.72%, Rank IV), "Assigning equal importance to conducting research as well as publication of results and promotion: (49..43%, Rank V) and "Conducting research in line with community culture and tradition" (39.08%, Rank VI). It is clear from these suggestions that more emphasis should be laid on research and involving the farmers in every stage of the research work to improve the linkage.

Table 6. Suggestions by scientists to improve linkage between scientists and farmers in Ethiopia

S.No.	a. Research aspects	Frequency	Percentage	Rank
1.	Identifying research problems with farmers and involving them at every step	65	74.71	I
2.	Allocating more time for research work	59	67.82	II
3.	Monitoring, evaluation and feedback of research output	51	58.62	III
4.	Planning research with a long term perspective rather than short term	45	51.72	IV
5.	Assigning equal importance to conducting research as well as publication of those results and promotion	43	49.43	V
6.	Conducting research in line with the community culture and tradition	34	39.08	VI
	b. Technology dissemination			
1.	Establishing proper communication means	39	44.83	I
2.	Designing out-reach programme for research institutions or universities	38	43.68	II
	c. Capacity Building			
1.	Devising institutional framework and motivation of scientists	71	81.61	I
2.	Rewarding and motivating successful research work	65	74.71	II
3.	Allowing farmers to request their needs	51	58.62	III
4.	Regular meetings, forums for information exchange, learning and sharing experiences	47	54.02	IV
5.	Increasing the number of scientists	30	34.48	V
	d. Resource allocation			
1.	Allocating enough budget	50	57.47	I
2.	Ensuring support from Government and other agencies	33	37.93	II
	e. Linkage			
1.	Establishing good relationship and forming Farmers-Researchers group and facilitating participation	65	74.71	I
2.	Making researchers and farmers understand each others duty and responsibility	43	49.43	II
3.	Proper willingness and commitment of researchers for effective linkage	32	36.78	III

Under the head" Technology dissemination" the suggestions given by the scientists to improve linkage were "Establishing proper communications means" (44.83%, Rank I) and "Designing outreach programme for research institutions or universities" (43.68%, Rank II). A total of five suggestions were given to improve the capacity of scientists which will help in improving the linkage of research scientists with farmers.

As regard the dimension "capacity building", majority of the scientists (81.61%, Rank I) suggested devising institutional framework and motivation of scientists to improve linkage followed by rewarding and motivating successful research work (74.71%, Rank II) and allowing farmers to requests their needs (58.62%, Rank III). Other suggestions offered by the scientists were organizing regular meetings, forums for information exchange, learning and sharing experiences (54.02%, Rank IV) and increasing the number of scientists (34.48%, Rank V).

Under Resource allocation scientists suggested "Allocating enough budget" (57.47%, Rank I) and "Ensuring support from government and other agencies" (37.93%, Rank II). Three suggestions were given by the scientists under the heading "Linkage" which are as follows: "Establishing good relationship and forming farmers – researchers groups and facilitating participation" (74.71%), Rank I), "Making researchers and farmers understand eacha other duties and responsibilities" (49.43%, Rank II) and 'Willingness and commitment of researchers for effective linkage" (36.78%, Rank III).

The study revealed that the effectiveness of linkages between scientists, extension workers and farmers was not very effective. This is an area of concern which needs to be addressed by all stakeholders, especially in this era of public-private partnership. This will enhance the effectiveness of university led extension system as well as research system in India and Ethiopia.

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E-READINESS OF AGRICULTURAL EXTENSION PERSONNEL OF ANDHRA PRADESH

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ABSTRACT

E-learning is deciphered as an effective tool to disseminate knowledge and information and has become the boom to the end users. Indian agriculture is witnessing many changes and to meet the challenges, extension system of the country needs to look for alternate ways of learning and training opportunities. A study on e-readiness of agricultural extension personnel was carried out in Andhra Pradesh to assess the e-readiness of agricultural extension personnel with the help of an e-readiness index. A total of 100 respondents from agricultural extension field were taken as a sample from Ranga Reddy district of Andhra Pradesh. The results showed that majority of the extension personnel are having e-readiness towards use of the Information and Communication Technologies (ICTs) in the profession. On the basis of the findings, it is suggested that there is an urgent need to work towards improvement in extension professional's competency in terms of e-readiness so that in future, the agricultural extension personnel can perform better in their job area and make the technology dissemination and utilization more workable.

Information and Communication Technologies (ICTs) can help in enabling extension workers to gather, store, retrieve, adapt, localize and disseminate a broad range of information needed by farmers, thus transforming them from extension workers to knowledge workers (Meera *et al.,* 2010). Information and Communication Technologies have changed the face of agricultural extension, not only in terms of knowledge of the agricultural extension professional but also in terms of speed, accuracy, time and cost effective manners. With the advancement in Information and communication technology, Indian agriculture also improved its way of technology generation, dissemination and utilization.

At present the ICT revolution has made the extension function more efficient and effective and provides extension system with opportunities to deliver new information services to the clients. Now-a-days, it also provides new options for accessing information by providing it directly to farmers and rural households by extension agents, agribusiness, and other intermediaries. e-readiness is defined as the degree to which an economy or community is prepared to participate in the digital economy (Source: www.ecommerce.gov/apec). According to Powell (2000), e-readiness refers to the availability and access to IT infrastructure, the policies to support and to participate in the international global network. But there is a need to assess the e-readiness of agricultural extension personnel who are using the ICTs in extension services. Thus, for harnessing the power of ICTs in the field of agricultural extension, it becomes necessary to study the e-readiness of extension personnel. Keeping the above facts in consideration, the present study was undertaken to find out the e-readiness of extension personnel towards use of ICTs in agricultural extension.

MATERIAL AND METHODS

The present study was conducted during 2012 in Ranga Reddy district of Andhra Pradesh purposively as it is the one of the major state where a number of ICT projects are being implemented. A proportionate number of respondents were selected both from public and private sectors. In case of public organizations, respondents were taken from State Department of Agriculture, Ministry of Agriculture, Acharya N G Ranga Agricultural University (ANGRAU) and ICAR institutes. From private sector, respondents were selected from Nagarjuna fertilizers, ETV, TV5, e-choupal (ITC), etc. A proportionate sample of 50 respondents was selected randomly from public and private sectors thus making a total of 100 respondents for the study.

RESULTS AND DISCUSSION

Personal profile of the respondents

It could be inferred from Table 1 that in public sector, majority of the respondents (42%) belong to

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middle category of age followed by young age (34%) and old age (24%). More than 50 per cent of the respondents were male followed by 20 per cent female. With respect to educational qualification of the respondents, it is evident that 52 percent respondents were doctorate, 38 percent post graduate and remaining 10 % respondents were graduates. Majority of the respondents (40%) belonged to rural area followed by urban (32%) and semi urban area (28%). It is evident from the table that more than 50 per cent of respondents belong to young age (58%) of category followed by middle (36%) and old age (06%). With respect to gender, 82 per cent respondents were male and 18 per cent respondents were female. Majority of the respondents (94%) were post graduate followed by doctorate degree (06%). Not a single respondent from private sector was only graduate. With respect to nativity, majority of the respondents (46%) were hailing from semi urban area followed by urban (30%) and rural area (24%).

Table 1. Personal profile of the respondents

S.N.	Characteristic	Public sector			Private sector		
		Category	Frequency	Percentage	Category	Frequency	Percentage
1.	Age	Young (24 to 35)	17	34.00	Young (28 to 37)	29	58.00
		Middle (36 to 47)	21	42.00	Middle (38 to 47)	18	36.00
		Old (above 47)	12	24.00	Old (above 47)	03	06.00
2.	Gender	Male	40	80.00	Male	41	82.00
		Female	10	20.00	Female	09	18.00
3.	Education	Graduate	05	10.00	Graduate	00	00.00
		Post-graduate	19	38.00	Post-graduate	47	94.00
		Doctorate	26	52.00	Doctorate	03	06.00
4.	Nativity	Rural	20	40.00	Rural	12	24.00
		Semi-urban	14	28.00	Semi-urban	23	46.00
		Urban	16	32.00	Urban	15	30.00

Comparative analysis of e-readiness of Extension Personnel

Table 2 represents the e-readiness of the extension personnel. In the present study, e-readiness was calculated through three main domains accessibility, ability and motivation. Accessibility was again measured through two sub sections; availability and ability. Ability was measured under basic ICTs skills, internet skills and software literacy skills.

With regard to ICT availability at personal level, it can be concluded that 84 per cent respondents from the public sector and all the respondents from the public sector have ability to use the computer without any other's assistance.It shows that the public sector extension personnel have good ability to use the computer which can be utilized for updating the extension personnel from public sector. With respect to ability to use internet, only 74 per cent public sector extension personnel have readiness in comparison to 86 per cent private sector extension personnel's ability to use internet. It can also be stated from the same table that less than 50 per cent extension personnel from public sector can handle smart phone while more than 50 per cent extension personnel from private sector can handle smart phone for their work (Table 2). In brief, it can be concluded that with respect to ICT availability at individual level public sector extension personnel have sufficient availability and accessibility to use computer and internet that can be utilized far better to utilize ICTs to disseminate the agriculture technology to the beneficiaries.

ICT Access With respect to accessibility, 84 per cent public sector extension personnel have accessibility to utilize departmental available ICTs,

Table 2. Comparative analysis of e-readiness of Extension Personnel

N=100

S. N.	Statements	Frequency	
	Technology access		
	Availability at personal and individual level	**Public**	**Private**
1.	Ability to use computer/Laptop without other's assistance.	42 (84.00)	50 (100.00)
2.	Ability to use the internet properly in desktop.	37 (74.00)	43 (86.00)
3.	Ability to handle the smart phone for my work.	17 (34.00)	29(58.00)
	Accessibility		
1.	Accessibility of every employee to utilize the ICTs available in the department as per need.	42 (84.00)	50 (100.00)
2.	Accessibility of every employee to official computer/laptop during official working hours with internet facility.	33 (66.00)	50 (100.00)
3.	Use of available ICTs in the department only by technicals	20 (40.00)	24 (48.00)
	Ability		
	Basic ICTs skills		
1.	Ability to use the computers and its peripherals as per need and work.	44 (88.00)	50 (100.00)
2.	Ability to use MS windows without any assistance except in emergency.	44(88.00)	50 (100.00)
3.	Readiness to participation in online programmes several times a week.	42(84.00)	47 (94.00)
4.	Use of modern ICTs (video conferencing, Tele conferencing, online sharing, mobile learning etc.)	31(62.00)	43(86.00)
	Internet skills		
1.	Knowledge of online technologies for communication with others.	49 (98.00)	50 (100.00)
2.	Proper and safe use of the e-mail.	50 (100.00)	50 (100.00)
3.	Knowledge of internet explorer and can use it.	49(98.00)	50 (100.00)
4.	Knowledge of utilizing the group mails (Google group), online file sharing with Google doc and discussion boards, chat tools etc.	32 (64.00)	41 (82.00)
5.	Working knowledge of video chatting (Skype, Google chat etc.)	33 (66.00)	41 (82.00)
6.	Working knowledge of social networking sites (Orkut, Facebook, twitter etc.) and can use them properly.	39 (78.00)	45 (90.00)
7.	Knowledge of online surveys and use of it.	33(66.00)	42 (84.00)

	Motivational factors		
1.	I can work comfortably with ICTs even if there are various physical and psychological distractions.	38 (76.00)	41(82.00)
2.	I can work comfortably despite the online distractions (e.g., friends sending emails or Websites to surf).	39 (78.00)	45 (90.00)
3.	I can work comfortably despite distractions at my home or workplace (e.g. Television, children, guests and such).	33 (66.00)	42 (84.00)
4.	I can learn by my own without any formal training.	28 (56.00)	40 (80.00)
5.	I am not ready for the e-learning.	8 (16.00)	0 (0.00)
6.	As ICTs are highly demanding for my job, so I will be motivated by my own to utilize it in future also.	44 (88.00)	50 (100.00)
7.	I am using the ICTs as these are speedy.	43 (86.00)	50 (100.00)

while cent per cent availability of departmental ICTs is provided to private sector extension personnel. Apropos access to use official computer during working hours, only 66 per cent public sector extension personnel are utilizing whereas in private sector this accessibility is 100 per cent.

Under ability to use ICTs, again three sub-sections, basic ICT skills, internet skills and software literacy was studied. With respect to basic ICT skills, four items were asked to get information on, ability to use computer and its peripherals, ability to use MS windows, readiness to participate in online programme and use of modern ICTs tools. It can be evident from the Table2 that 88 per cent public sector extension personnel have both ability to use computer and its peripherals and use of MS windows whereas private sector extension personnel have cent per cent ability to use computer, its peripherals and MS Windows. With respect to readiness to participate in online programme,84 per cent public sector extension personnel are ready to participate in online programme while 94 per cent private sector extension personnel are ready to participate in online programme. Sixty-two per cent public sector extension personnel have ability to use modern ICTs while about fifty per cent private sector extension personnel have ability to use modern ICTs.

Internet Skills

Readiness of extension personnel in internet skills was assessed using nine statements. It was revealed that all the extension personnel (both public and private sector) possessed skills in using emails. Majority of the respondents from public sector agree that they have knowledge of online technologies and knowledge of internet explorer whereas cent per cent private sector respondents have knowledge of online technologies and internet explorer. More than three fourth (78.00%) of the public sector respondents have working knowledge of social networking sites whereas 90 per cent private sector respondents have working knowledge of social networking sites. With regard to use of online survey private sector respondents are far better (90.00%) than public sector respondents (66.00%). It is good to know that with regard to online library and other resource database, both public (70.00%) and private sector (92.00%) respondents have good command.

Apropos software literacy, about 72 per cent public sector extension personnel have the ability to use several applications at a time whereas 90 per cent private sector extension personnel have ability to use several applications at a time. The ability to use several applications at a time can be useful in agriculture technology dissemination to diverse users with diverse interests and use at the same time. 46 per cent public sector respondents have interest towards ICTs courses whereas 56 per cent private sector respondents have interests towards ICTs courses. 44 per cent public sector extension personnel know the use of Learning Management Systems (LMS) whereas 66 per cent private sector extension personnel know the use of LMS.

Motivational readiness shows a positive picture of readiness of public sector extension

personnel. It is clear from the Table 2 that 88 per cent public sector extension personnel are ready to utilize the ICTs in their job followed by 86 per cent are using due to speedy nature of ICTs, work comfortable despite online distractions (78.00%), work comfortably despite distractions at work place (66.00%).

Overall e-readiness of Extension Professionals

Table 3 categorizes the respondents based on their overall e-readiness. It can be interpreted from Table 3 that there is wide variation between public and private sector respondents. 28 per cent public sector respondents have low e-readiness whereas only four per cent private sector respondents have low e-readiness.Wider e-readiness gap among respondents shows that private sector respondents have better e-readiness than public sector respondents. Moreover,32 per cent public sector respondents are falling into medium category of e-readiness whereas 18 per cent private sector respondents have medium e-readiness. Further, 40 per cent public sector respondents belonged to high category of e-readiness whereas more three-fourth of the private sector respondents (78%) belonged to high category of e-readiness.

It shows that the percentage of public sector respondents falling in low and medium category of e-readiness is more than private sector respondents whereas more than three- fourth of private respondents (78%) belonged to high category of e-readiness, hence, it can be concluded that public sector respondents have less e-readiness than private sector respondents Further, public sector respondents e- readiness can be improved by the proper training, awareness, infrastructural development and policy matters. The findings are in line with Purnomo and Lee (2010).

Table 3. Categorization of respondents based on overall e-readiness

N=100

S.No.	Respondents	Category	Frequency	Percentage
1.	Public	Low	14	28.00
		Medium	16	32.00
		High	20	40.00
2.	Private	Low	02	4.00
		Medium	09	18.00
		High	39	78.00

It could be concluded from the findings that both private and public sector respondents have e-readiness towards use of ICTs in agricultural extension system.However, the public sector respondents have little less than e-readiness in comparision to private sector. The reason for this might be due to differences in job responsibilities and clientele. The focus should be on those areas where public sector extension personnel are lagging behind in terms of e-readiness and ways should be decide how to improve their e-readiness and work efficiency towards use of ICTs in agricultural extension system.

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A COMPARATIVE STUDY ON CONSTRAINTS IN ZERO TILLAGE AND CONVENTIONAL MAIZE CULTIVATION

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ABSTRACT

A study was carried out to know the access to credit, extension contact and constraints in maize cultivation of zero tillage and conventional maize farmers in Khammam district of Andhra Pradesh. The primary data was collected from 120 farmers randomly representing 12 villages of four mandals during the year 2013 using structured interview schedule. The study found that majority of respondents of zero tillage (73.33%) are accessing credit from commercial banks, whereas 69.20 per cent of conventional maize farmers are accessing credit from cooperative bank. Almost all the respondents of zero tillage (96.69%) and conventional tillage maize farmers (95.00%) own Television (TV) set and watch it. The major production constraint for zero tillage maize was incidence of stem borer (66.67%) and obtaining credit (75.83%) for conventional maize cultivation.

In India, Maize is an important crop next only to rice and wheat and it ranks fourth in area and sixth in production of maize. Maize in India contributes nearly nine per cent in the national food basket and more than Rs.100 billion to the agricultural GDP at current prices apart from generating employment of over 100 million man-days at the farm and downstream agricultural and industrial sectors. In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material (as an ingredient) to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc. Bulk of the maize produced in the country goes for production of poultry feed. It is estimated that the demand for maize from the poultry industry would rise by about 6 per cent. Increasing demand from poultry sector is likely to substantially increase maize consumption to go over 30 million tonnes by 2020.

In India, there has been an increase in the area coverage under maize from 7.89 million hectares in 2006-07 to 8.78 million ha in 2011-12. Productivity of maize has also increased significantly from 1912 kg per hectare in 2006-07 to 2478 kg per hectare in 2011-12. The total production of maize has increased from 15.10 million tonnes in 2006-07 to 21.76 million tonnes in 2011-12 (Source DOA, 2012-13)

The current level of maize yield in India (2.17 million tonnes/ha) is far behind the global average of 5 mt/ha and there is a huge scope for improvement in yield. It is important to understand the access to credit, extension contact and constraints in adoption of scientific maize cultivation practices for enhancing productivity as India has a huge potential to increase its market share and to make its presence felt in the global maize market. In this context, this study was undertaken with the following objectives: to compare access to credit and extension contact of Zero tillage and Conventional maize farmers and comparing constraints in Zero tillage and Conventional maize cultivation.

MATERIAL AND METHODS

The study was carried out in Khammam district of Andhra Pradesh during 2012-13. Ex-post facto research design is formulated and multi stage random sampling was followed for this study. From Khammam district, four mandals were selected and from each mandal three villages were selected based on the criteria of larger extent of zero tillage and conventional maize cropped areas during Rabi, 2011-12. From each village 10 farmers of zero tillage and 10 farmers of conventional maize were selected randomly, making a total sample size of 240. The factors which may influence the adoption of scientific maize cultivation practices viz., access to credit (Erenstein *et al*, 2007), Extension contact (Aman Djauhari *et al*, 1988) and Constraints (Joshi *et al*, 2005) were selected based on review of literature, discussions with experts and extension staff with little modifications. The data was collected from the selected sample through structured schedule and

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interview technique.The statistical tools used for analysing the collected data were frequency and percentage.

RESULTS AND DISCUSSION

Comparision of access to credit and extension contact of Zero tillage and Conventional tillage maize farmers

Access to credit of zero tillage and conventional maize farmers

About 73.33 per cent of zero tillage farmers and 66.67 per cent of conventional tillage farmers reported that they had access to credit from commercial banks, while 69.20 per cent of conventional tillage and 66.67 per cent of zero tillage farmers had access to credit from cooperative bank (Table 1).

Table 1. Access to credit of Zero tillage and Conventional maize cultivation

(n=240)

Source	Zero tillage maize (n=120)		Conventional tillage maize (n=120)	
	Frequency	Percentage	Frequency	Percentage
Commercial Bank	88	73.33	72	60.00
Cooperative bank	80	66.67	83	69.20
Money lender	32	26.67	33	27.50
Input dealer	42	35.00	64	53.30
Commission agent	8	6.67	7	5.80

It could be observed from Table 1 that 53.30 per cent of conventional tillage and 35.00 per cent of zero tillage farmers had access to input dealers for credit. Also, less percentage of farmers of zero tillage (26.67%) and conventional tillage (27.50%) were accessing credit from money lenders.

Extension contact of Zero tillage and Conventional tillage maize farmers

It could be observed from Table 2 that most of the farmers of zero tillage (96.67%) and conventional tillage (95.00%) maize own T.V set and watching it but more number of zero tillage farmers (73.33%) were watching agricultural programmes than conventional tillage (37.50 %) maize farmers.

Table 2. Extension contact of Zero tillage and Conventional tillage maize cultivation

(n=240)

Extension activities	Zero tillage maize (n=120)		Conventional tillage maize (n=120)	
	Frequency	Percentage	Frequency	Percentage
Read news paper: yes/no	72	60.00	49	40.80
Read agricultural magazine: yes/no	68	56.67	19	15.80
Observe maize demonstration plot: yes/no	8	6.67	20	16.70
Own TV set and watch: yes/no	116	96.67	114	95.00
No TV set but watch others: yes/no	4	3.33	3	2.50
Owned radio and listen: yes/no	16	13.33	16	13.30
View/listen to TV/radio programmes: Agriculture Rural programmes Others	88	73.33	45	37.50
	16	13.33	14	11.70
	120	100.00	120	100.0
Participate in training programme: yes/no	69	57.00	54	45.00
Participate in group action: Farmers group	12	10.00	15	12.50

More than half of the zero tillage farmers (56.67%) were reading agricultural magazine, whereas, only 15.80 per cent of conventional tillage farmers were reading agricultural magazine (Table 2). Also more than half (57.00%) of zero tillage and less than half (45%) of conventional tillage maize farmers participating in training programmes, while more number of conventional tillage (12.50%) maize farmers were participating in group action than zero tillage maize farmers (10.00%) (Table 2).

Comparision of constraints in Zero tillage and Conventional tillage maize cultivation

The results on comparison of constraints in Zero tillage and Conventional tillage maize cultivation were discussed as biotic and abiotic, institutional and economic and technological constraints and they were presented as below

Biotic and Abiotic constraints in Zero tillage and Conventional tillage maize cultivation

Table 3.Biotic and Abiotic constraints in Zero tillage and Conventional maize cultivation

Biotic and Abiotic constraints	Zero tillage maize (n=120)				Conventional maize (n=120)			
	Not constraint		Constraint		Not constraint		Constraint	
	f	%	*f*	%	*f*	%	*f*	%
A. Biotic constraints								
a. Insects & Nematodes								
stem borer	40	33.33	80	66.67	78	65.00	42	35.00
b. Diseases								
Wilt	108	90.00	12	10.00	111	92.50	9	7.50
Bacterial stalk rot	100	83.33	20	16.67	104	86.67	16	13.33
Maydis leaf blight	56	46.67	64	53.33	65	54.17	55	45.83
Turcicum leaf blight	64	46.67	56	46.67	66	55.00	54	45.00
Banded leaf blight	76	63.33	44	36.67	79	65.80	41	34.20
B. Abiotic constraints								
Late planting	103	85.83	17	14.17	53	44.17	67	55.83
Water stress	71	59.17	49	40.83	49	40.83	71	59.17
Hail storm	108	90.00	12	10.00	106	88.33	14	11.67
Zinc deficiency	104	86.67	16	13.33	42	35.00	78	65.00
Standing stubbles / Crop residues at time of planting	54	45.00	66	55.00	120	100	0	0.00
Dense population of weeds at the time of planting	95	79.17	25	20.83	120	100	0	0.00
Lack of appropriate soil moisture at time of planting	57	47.50	63	52.50	105	87.50	15	12.50
Risk of increased problem with insect pests and diseases	49	40.83	71	59.17	93	77.50	27	22.50
Hardening of upper soil	88	73.33	32	26.67	120	100	0	0.00
Straw burning	96	80.00	24	20.00	120	100.0	0	0.00
Lack of good irrigation water	116	96.67	4	3.33	120	100.0	0	0.00
No significant difference in yield	70	58.33	50	41.67	104	86.670	16	13.33
Increased weed problem following adoption of ZT	76	63.33	44	36.67	79	65.83	41	34.17
Increased irrigation water requirement	98	81.67	22	18.33	51	42.50	69	57.50

Table 3 indicated that among the biotic constraints, 66.67 per cent of zero tillage farmers and only 35.00 per cent of conventional tillage maize farmers reported 'stem borer' as constraint in maize cultivation. It may be due to the presence of paddy stubbles in zero tillage maize, the higher percentage of zero tillage respondents expressed 'stem borer' as constraint in maize cultivation.

The other biotic constraints were 'maydis leaf blight' reported by zero tillage farmers (53.33%) and

conventional tillage farmers (45.83%). Nearly equal per cent of zero tillage maize farmers (46.67%) and conventional tillage maize farmers (45.00 %) reported 'turcicum leaf blight' as constraint. Moreover, 'banded leaf blight' considered as constraint by 36.67 per cent of zero tillage and 34.20 per cent of conventional tillage maize farmers (Table 3).

Among the abiotic constraints, more number (65.00%) of conventional tillage farmers reported that 'Zn deficiency' as constraint than zero tillage (13.33%) farmers. Moreover, 59.17 per cent of zero tillage farmers and 22.50 per cent of conventional tillage farmers expressed the 'risk of increased problem with insect pests and diseases' as constraint.

It could be observed from Table 3 that more than half (55.83%) of the conventional tillage farmers and less per cent of (14.17%) of zero tillage farmers expressed 'late planting' as constraint. It may be due to the reason that more time is required for land preparation in conventional tillage. Similarly, 'water stress' as constraint is expressed by more number (59.17%) of conventional tillage respondents than zero tillage (40.83%) maize farmers because of late planting.

Institutional and economic constraints in Zero tillage and Conventional maize cultivation

It could be noted from Table 4 that 75.83 per cent of conventional tillage respondents and 46.67 per cent of zero tillage respondents expressed that 'constraint to obtaining credit' as constraint. Also 69.17 per cent of conventional tillage farmers and 58.33 per cent of zero tillage maize farmers expressed 'high fertilizer price' as constraint.

Table 4. Institutional & Economic constraints in Zero tillage and Conventional maize cultivation

(N=240)

Institutional & Economic constraints	Zero tillage maize (n=120)				Conventional maize (n=120)			
	Not constraint		Constraint		Not constraint		Constraint	
	f	%	*f*	%	*f*	%	*f*	%
Low maize prices	52	43.33	68	56.67	56	46.67	64	53.33
Maize marketing difficulties	42	35.00	78	65.00	85	70.83	35	29.17
Constraint to obtaining credit	64	53.33	56	46.67	29	24.17	91	75.83
Un availability of inputs	111	92.50	9	7.50	112	93.33	8	6.67
High fertilizer price	50	41.67	70	58.33	37	69.17	83	69.17
Low quality fertilizers	116	96.67	4	3.33	116	96.67	4	3.33

More than half (65.00 %) of the conventional tillage respondents reported 'maize marketing difficulties' as constraint than conventional tillage maize farmers (29.17 %). Nearly equal per cent of zero tillage maize farmers (56.67 %) and conventional tillage maize farmers (53.33 %) reported 'low maize prices' as constraint. It can be inferred that the zero tillage maize farmers recognised the low prices for maize was due to lack of adequate regulatory maize marketing facilities (Table 4).

Table 4 also indicates that 57.50 per cent of conventional tillage farmers and only 18.33 per cent of zero tillage maize farmers reported 'increased irrigation water requirement' as constraint. Due to untilled conditions, more than half of the zero tillage respondents (55.00 per cent) expressed 'standing stubbles / crop residues at time of planting' as constraint.

Technological constraints in Zero tillage and Conventional maize cultivation

It could be observed from Table 5 that 49.17 per cent of zero tillage maize farmers and 63.33 per cent of conventional tillage maize farmers expressed as 'lack of technical assistance' as constraint. Nearly, half of the respondents that is 49.17 per cent of zero tillage and 61.67 per cent of conventional maize cultivators expressed 'poor knowledge of cultivation techniques' as a constraint for adoption of maize production technology.

Table 5. Technological constraints in Zero tillage and Conventional maize cultivation

(n=240)

Technological constraints	Zero tillage maize (n=120)				Conventional maize (n=120)			
	Not constraint		Constraint		Not constraint		Constraint	
	f	%	*f*	%	*f*	%	*f*	%
Poor knowledge of cultivation techniques	61	50.83	59	49.17	46	38.33	74	61.67
Lack of technical assistance from extension worker	61	50.83	59	49.17	44	36.67	76	63.33
Non availability of extension literature on ZT cultivation	71	59.17	49	40.83	99	82.50	21	17.50
Lack of coverage of ZT method by mass media	108	90.00	12	10.00	111	92.50	9	7.50

Table 5 indicates that 40.83 per cent of zero tillage maize farmers and 17.50 per cent of conventional tillage maize farmers expressed 'non availability of extension literature on zero tillage cultivation' as constraint. It also found that less per cent of zero tillage (10.00 %) and conventional tillage (7.50 %) maize farmers reported 'lack of coverage of ZT method by mass media' as constraint.

CONCLUSION

To increase maize production, the study recommends that financial institutions viz., commercial and cooperative banks should be strengthened in the study area with simple procedure of securing loans and also strengthen the existing extension agencies.

It can be concluded that the identified major constraints of zero tillage maize were stem borer, lack of appropriate soil moisture at the time of planting, standing stubbles / crop residues at time of planting, risk of increased problem with insect pests and diseases compared to conventional tillage maize. The major constraints of conventional tillage maize were late planting, water stress, increased irrigation water requirement, Zn deficiency, poor knowledge of cultivation techniques, lack of technical assistance from extension. Hence, to avoid late planting and its consequences, the extension workers should promote zero tillage maize cultivation Further, Zero tillage farmers must be includes in capacity building training programmes with regard to package of practices of zero tillage.

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PROBIT – AS AN INDEX FOR HYBRID EVALUATION

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ABSTRACT

In any crop improvement programme, the parents for hybridization are usually chosen on the basis of breeding objective, traits to be improved and strong points of the germplasm resources available with the breeder. During the process of hybridization or inbreeding, a large number of hybrid combinations or inbred lines are generated. At each generation, the short-listing of the promising ones on the basis of numerous desirable economic traits is a most critical part of the program. The success of the program depends on elimination of inferior combinations/lines till the target to develop the most promising ones is not achieved. The modified "Probit" can be used as collective Performance Index to evaluate and shortlist the hybrids/ inbred lines on the basis of all the traits under consideration. In the present study, the modified "Probit" has been used to evaluate and select the most promising hybrid.

The Performance Index may be called as Evaluation Index, which is used to evaluate the collective performance of each hybrid combination/ inbred line for the parameters under study for the selection of promising ones at each generation and finally come out with the most promising hybrid/line. Various methods (Arunachalam and Bandopadhyay, 1984; Barreto *et al.,* 1991; Mano *et al.,* 1992 and Narain *et al.,* 1991 and 2007) are used to evaluate and compare the performance on the basis of composite index. Evaluation index (E.I) method by Mano *et al.* has been widely used by the silkworm breeders (Datta *et al.,* 2001; Mal Reddy *et al.,* 2002; Naseema Begum *et al*., 2001 & 2003; Sudhakar Rao *et al.,* 2001 and 2002; Ramesh Babu *et al.,* 2005). The breeders do face a practical problem of calculating a single composite index where as for some of the parameters higher index values and for some other parameters low index values are desirable. The present study explains a simple, easy and user friendly "Probit Performance Index (PPI)" method using "Probit" for the evaluation of hybrids/ inbred lines. Single average PPI can be calculated for low and high desirable parameters simultaneously. Further, while calculating the PPI, different weights may also be assigned to various parameters based on the importance of the parameters under study.

MATERIAL AND METHODS

From a breeding experiment conducted in full diallel with 10 inbred lines of the mulberry silkworm *(Bombyx Mori* L.), 14 hybrid combinations were shortlisted based on their phenotypic uniformity and performance index. The data on eight metric traits of economic importance *viz.,* fecundity (the average number of eggs laid by a female silk moth), hatching% (calculated from the ratio of number of larvae hatched from the total number of live eggs laid by a moth), cocoon yield (kg), pupation rate % (calculated as the ratio of number of live pupae to the total number of cocoons harvested), single cocoon weight (g), single shell weight (g), shell ratio% (calculated as ratio of single shell weight to single cocoon weight in percentage) and crop duration (hrs) were recorded. For all the traits except crop duration higher values are desirable. Silkworm rearing/ sericulture crop duration varies to 20-28 days, depending upon breeds/ hybrids. However, the hybrids with smaller crop duration is preferred. The hybrid combinations are evaluated using the Probit Performance Index as explained below.

Standard Normal Variate If 'x' is a normal variate with mean **µ** and standard deviation ó, then **(,** the standard normal variate (SNV) follows normal distribution with mean zero and standard deviation unity.

Probit Transformation It is difficult to draw statistical inferences from sigmoid curve between log dose and mortality %. As shown in the *Fig.1,* the relation between log dose and SNV follows linear relationship. Therefore, the mortality% is converted into SNV to convert the sigmoid curve into straight line. The values of SNV vary from negative to positive (-4, -3, -2, -1, 0, 1, 2, 3, 4). In order to remove negative SNV values, a constant "5" is added to all the SNV values

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and the transformed SNV values are termed as "PROBIT".

The relation between probit of response and the dose is given by

$$Y = 5 + \left(\frac{x - \mu}{\sigma}\right)$$

A suitable index is obtained by multiplication with 10 (or any constant) to change the scale of the "Probit" for magnifying the differences in performance of various hybrids or inbred lines. Thus, the Performance Index may be calculated as follows:

For the traits where higher values are desirable

$$PPI = \left\{5 + \left(\frac{x_{ij} - \mu_j}{\sigma_j}\right)\right\} \times 10$$

For the traits where lower values are desirable

$$PPI = \left\{5 - \left(\frac{x_{ij} - \mu_j}{\sigma_j}\right)\right\} \times 10$$

Where the suffixes *i* and *j* represents the number of hybrid and trait respectively. The x_{ij} is the average performance of the i^{th} hybrid for j^{th} trait. The μ_j and σ_j are the grand mean and standard deviation respectively, of the j^{th} trait. The index value; PPI was calculated for all the hybrid combinations for each of the trait separately and finally, an average or total Index value was obtained for each of the hybrid combination for comparison and selection of better ones. The PPI calculated for each of the trait may be assigned desirable weights, as per the importance of the particular trait and then weighted average may be calculated for comparison of hybrids.

RESULTS AND DISCUSSION

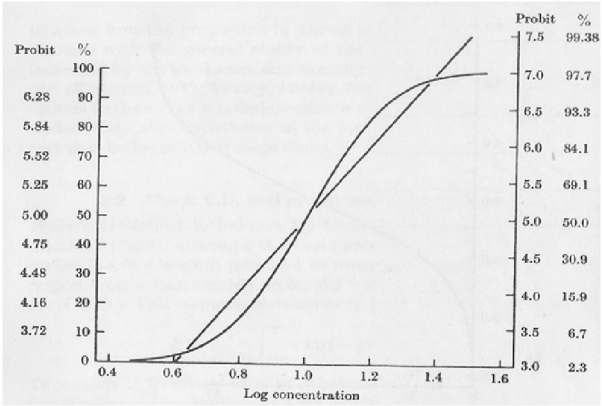

Fig 1. Probit vs Logdose

The 14 hybrid combinations of the mulberry silkworm *(Bombyx Mori* L.) were shortlisted based on their phenotypic uniformity and performance from a total 100 hybrid combinations tested under 10 x 10 full diallel experiment. Since, it is unexpected to have a hybrid which is found to be best for all the traits under study, the hybrids were evaluated on the basis of its composite performance index; "Average Probit Performance Index" to evaluate, select and recommend the most promising hybrid(s). The performance of the shortlisted hybrids on eight metric traits under study, Probit Performance Index (PPI) for all the hybrids for each of the trait and Average PPI are presented in Table1. The perusal of the data revealed good amount of variability among the hybrids as evidenced by the minimum and maximum values recorded for each of the trait. The fecundity was recorded to vary from a minimum of 490 eggs/ laying (C61) to a maximum of 620 eggs/laying (C16), the hatching (%) varied from 85.1% (C48) to 96.4 (C17), yield from 13.6 kg (C52) to 18.22 kg (C12) and the pupation rate was found to be minimum of 85% to a maximum of 95.5%. Similarly, the cocoon weight was recorded to vary between 1.548 g (C52) to 1.994 g (C26), single shell weight between 0.322 g (C61) and 0.411 g (C16) and shell ratio recorded a minimum of 19.31% to a maximum of 22.18% (C16). However, the trait of Crop Duration (hrs), which is desirable to be minimum, recorded a minimum value of 511 hrs (C61) and maximum of 584 hrs (C26). As expected none of the hybrid was found to be best in all the eight parameters. The hybrid C16 was observed to be best performer for two traits and second best for one of the traits followed by hybrid combination C17, best in one trait and second best in four traits, C12 best in two and second best for two traits. The hybrid combinations C19, C26 and C45 were observed to be best for one trait each only. Such a comparison of performance with more number of hybrid combinations and traits could very complicated confusing and tedious to select the most promising hybrid combinations.

A simple composite index method "Probit Performance Index (PPI)" was used to identify the most promising hybrids. As used in probit analysis,

the standard normal variate; Z score were added with 5 for the traits for which hybrid is preferred to have higher values but the Z score were subtracted from 5 for the traits where lower values are preferred. Arunachalam and Bandopadhyay, 1984; Maize Selection Tool (MST) by Barreto *et al.,* 1991; Mano *et al.,* 1992; Narain *et al.*(2007) also worked with standard normal variate. It provides a facility to the breeders to select the target values between -3 to +3 and intensity (weight) in the range of 0 to 10.Kalpana *et al.,* (1999) used MST for selecting the promising hybrids among 66 hybrid combinations. However, for evaluating the economic merit of the new hybrids/lines, the present Probit Performance Index (PPI) is simple and easy to calculate that a breeder can use with full understanding of logic, reasoning and process of evaluation. The method also provides a facility of assigning weights to each trait based on its importance for the breeder.

Table 1.Average rearing performance of selected hybrid combinations and their performance index

S. No.	Hybrid	Fecun -dity	Hatch	Yld/TTL	Pupa.	C Wt.	SS Wt	S R	CD
		(No.)	(%)	(kg)	Rate (%)	(g)	(g)	(%)	(hrs.)
1	C04	585	93.21	15.86	92.39	1.820	0.397	21.13	514
2	C12	583	93.04	18.22	95.50	1.931	0.401	21.41	558
3	C16	620	95.41	17.69	92.66	1.951	0.411	21.11	540
4	C17	602	96.42	18.11	93.01	1.957	0.405	21.15	520
5	C19	528	91.87	16.41	88.32	1.867	0.410	22.18	582
6	C21	526	89.45	15.21	89.44	1.723	0.359	21.32	559
7	C26	512	89.65	16.69	91.08	1.994	0.389	20.01	584
8	C30	518	92.47	16.55	91.59	1.848	0.374	20.21	540
9	C44	528	90.05	15.84	94.84	1.679	0.349	21.13	512
10	C45	534	87.82	13.67	85.36	1.627	0.344	21.29	511
11	C48	526	85.10	15.20	88.29	1.726	0.357	20.74	539
12	C52	528	87.08	13.60	88.12	1.548	0.322	20.78	561
13	C55	539	90.68	14.79	90.35	1.656	0.327	19.72	564
14	C61	490	93.20	14.08	85.09	1.670	0.322	19.31	536
Min		490	85.10	13.60	85.09	1.548	0.322	19.31	511
Max		620	96.42	18.22	95.50	1.994	0.411	22.18	584
Mean (μ)		544	91.10	15.85	90.43	1.786	0.369	20.82	544
SD (σ)		37.72	3.17	1.53	3.19	0.14	0.03	0.76	24.59
CV%		6.93	3.48	9.67	3.52	7.98	9.03	3.66	4.52

Hatch: Hatching; Yld/TTL: Yield by 10000 larvae; Pupa.: Pupation;
CWt: Cocoon Weight; SSWt: Single shell weight; SR: Shell ratio; CD: Crop duration

Table 2. Probit Performance Index (PPI)

S. No.	Hybrid	Fecundity (No.)	Hatch (%)	Yld/TTL (kg)	Pupa. Rate (%)	CW (g)	SS Wt (g)	S R (%)	CD (hrs.)	Avg. PPI
1	C04	60.83	56.64	50.06	56.15	52.40	58.38	54.06	62.31	56.35
2	C12	60.17	56.12	65.46	65.91	60.22	59.59	57.74	44.42	58.70
3	C16	70.11	63.57	62.00	57.00	61.65	62.59	53.79	51.74	60.31
4	C17	65.34	66.74	64.74	58.10	62.03	60.79	54.32	59.87	61.49
5	C19	45.84	52.42	53.65	43.37	55.71	62.29	67.77	34.66	51.96
6	C21	45.06	44.80	45.81	46.87	45.63	46.98	56.53	44.02	46.96
7	C26	41.37	45.42	55.47	52.04	64.66	55.98	39.35	33.85	48.52
8	C30	43.07	54.31	54.56	53.63	54.37	51.48	41.99	51.74	50.64
9	C44	45.72	46.68	49.93	63.83	42.50	43.97	54.10	63.13	51.23
10	C45	47.31	39.66	35.76	34.07	38.86	42.47	56.10	63.53	44.72
11	C48	45.19	31.09	45.75	43.28	45.83	46.38	48.97	52.15	44.83
12	C52	45.70	37.32	35.31	42.76	33.32	35.87	49.47	43.20	40.37
13	C55	48.62	48.66	43.07	49.74	40.91	37.37	35.61	41.98	43.25
14	C61	35.65	56.59	38.44	33.24	41.91	35.87	30.19	53.37	40.66
Min		35.65	31.09	35.31	33.24	33.32	35.87	30.19	33.85	33.57
Max		70.11	66.74	65.46	65.91	64.66	62.59	67.77	63.53	65.85
Mean (μ)		50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
SD (σ)		10	10	10	10	10	10	10	10	10.00
CV%		20	20	20	20	20	20	20	20	20

Hatch: Hatching; Yld/TTL: Yield by 10000 larvae; Pupa.: Pupation;
CWt: Cocoon Weight; SSWt: Single shell weight; SR: Shell ratio; CD: Crop duration

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Research Note
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VASE LIFE STUDIES OF TUBEROSE (*Polianthes tuberosa* L.) cv. HYDERABAD SINGLE AS INFLUENCED BY DIFFERENT HOLDING SOLUTIONS

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Tuberose (*Polianthes tuberosa* L.) is an important flower crop and much adored for its colour, elegance and fragrance. It occupies a prime position because of its popularity as cut flower, loose flower and in the perfume industry. The flower spikes are largely used for vase decoration. Export potential of cut flowers mainly depends on the quality and post harvest longevity. Normally the flower spikes lasts for 6-8 days when they are placed in vase water and only 30-40 per cent flower buds of the spike are open. The major limiting factor in the vase life of many cut flowers is water stress which creates disturbances in the water relations of cut flowers there by changes occur in physiology of cut flowers leading to senescence the ultimate phase of growth.Flower senescence is particularly related to the practical aspects of post harvest handling of cut flowers. The role of preservatives in prolonging the vase life was probably associated with the inhibition of microbial growth and maintenance of vascular conductivity (Padaganur *et al*., 2005). Bacterial proliferation is largely responsible for vascular occlusion, which shortens the vase life of cut flowers (Jacob and Kim, 2009).

Moreover, once the cut flowers are harvested, they are deprived of carbohydrates and depend on reserved food materials for respiration to continue metabolic activities. The carbohydrate status of cut flowers will decide its longevity after harvest. Hence, exogenous supply of sugars will play an important role in lengthening of vase life of cut flowers and tuberose is no exception for this. Hence, the present investigation was carried out to study the effect of different holding solutions on post harvest longevity and quality of tuberose spikes.

The field experiment was carried out with seven single cultivars of tuberose *viz*., Prajwal, Hyderabad single, Culcutta single, Rajath rekha, Sikkim selection, Phule rajani and Shringar at All India Coordinated Research Project on Floriculture, Agricultural Research Institute, Rajendranagar, Hyderabad during the year 2009-10. Experiment was laid out in randomized block design comprising of seven cultivars as seven treatments with three replications. Plots measuring 2.1m x 2.1m were prepared to accommodate 49 plants at a spacing of 30 cm x 30 cm. In the subsequent experiment spikes obtained from the cv. Hyderabad single in first experiment was used for vase life studies.

The spikes were harvested in the early morning hours when lowermost two florets were opened. Immediately after harvesting, the spikes were kept in bucket containing water and brought to the laboratory. All the spikes were placed in 500 ml conical flasks containing 300 ml of different holding solutions *viz*., Control (T_1), Sucrose 4% + Aluminium sulphate 150 ppm (T_2), Sucrose 4% + Aluminium sulphate 200 ppm (T_3), Sucrose 4% + Aluminium sulphate 250 ppm (T_4), Sucrose 4% + Citricacid 150 ppm (T_5), Sucrose 4% + Citricacid 200 ppm (T_6), Sucrose 4% + Citricacid 250 ppm (T_7).

The experiment was carried out in completely randomized design with three replications keeping 2 spikes in each replication. In the control only distilled water was used.

The difference between the weight of the container + solution + flower spike and the weight of the container + solution was recorded every day to measure the fresh weight of the flower spike on that particular day. Vase life was recorded by caluclating the number of days taken for 50% withering of flowers on the spike suggested by Padaganur *et al*. (2005). Vase life of individual florets was recorded by taking the number of florets wilted every day divided by the total number of florets per spike.

The differences between consecutive measurements of the container + solution (without flower spike) was recorded every day to measure the water uptake on that particular day. To measure the transpirational loss of water, the differences between consecutive measurements of the container + solution + flower spike recorded every day. Loss-

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Table 1. Effect of different holding solutions on post harvest behavior of tuberose cut spikes

Treatments	Fresh weight (g)		Vase life	Vase life of individual florets	Uptake of water	Loss of water	Loss-uptake ratio
	2nd day	10th day					
T_1 Control	49.27	28.10	5.13	2.52	54.13	69.38	1.30
T_2 Sucrose 4% + Aluminium sulphate 150 ppm	55.71	35.44	7.05	3.20	63.65	73.42	1.17
T_3 Sucrose 4% + Aluminium sulphate 200 ppm	52.03	32.43	7.90	3.41	67.06	76.19	1.14
T_4 Sucrose 4% + Aluminium sulphate 250 ppm	54.94	34.54	8.83	3.71	86.29	95.38	1.11
T_5 Sucrose 4% + Citric acid 150 ppm	50.37	30.30	6.78	3.30	51.39	66.42	1.27
T_6 Sucrose 4% + Citric acid 200 ppm	55.21	36.01	8.36	3.84	72.44	88.56	1.22
T_7 Sucrose 4% + Citric acid 250 ppm	60.56	44.23	10.15	4.04	95.61	105.65	1.04
SEm±	0.61	0.79	0.22	0.06	1.02	1.37	0.02
CD at 5 %	1.92	2.46	0.69	0.21	3.19	4.28	0.05

uptake ratio was calculated by using the formula Transpirational loss of water/ Water uptake.

The treatment T_7 (Sucrose 4% + Citric acid 250 ppm) performed significantly superior (44.23 g) over rest of the treatments with minimum loss of weight. Flowers held in citric acid @ 250 ppm along with sucrose 4% influenced cut flower longevity by increasing water uptake, maintaining normal levels of transpirational loss of water, improved water balance, there by increased fresh weight of the flowers. Kumar *et al.* (2007) in tuberose, Pal and Sirohi (2007) in gladiolus also reported that combination of sucrose + citric acid and sucrose + aluminium sulphate, increased the cut flower longevity by increasing water uptake and maintaining cut flower longevity.

Vase life or keeping quality of cut tuberoses denotes the total duration of cut flower longevity from the cut to the wilting of flowers. Extended period of vase life was significant for treatment T_7 (Sucrose 4% + Citric acid 250 ppm) with 10.15 days followed by treatment T_4 (Sucrose 4% + Aluminium sulphate 250 ppm) with 8.83 days. The vase life increased with increasing concentrations of both aluminium sulphate and citric acid. The increased vase life period of cv. Hyderabad single with treatment T_7 and T_4 might be due to better water relations, delay in protein degradation, maintenance of membrane integrity, leading to delay in petal senescence. The present results were in accordance with Jature *et al.,* (2009) and Kumar *et al.* (2010). Vase life of individual florets was also more for the treatments T_7 (sucrose 4% + citric acid 250 ppm) having taken 4.04 days, followed by T_6 (sucrose 4% + citric acid 200 ppm) with 3.84 which was on a par with T_4 (sucrose 4% + aluminium sulphate 250 ppm) recording 3.71 days. Sucrose in combination with either citric acid or aliminium sulphate maintains endogenous levels of soluble sugars and soluble proteins which in turn provide energy as well as required osmoticum for floret development and longevity (Hussain *et al.,* 2001). The results were in accordance with Varu and Barad (2008).

An increase in rate of water uptake was recorded by cut tuberose held in different

concentrations of sucrose + biocide compared to control. Water uptake decreased from the first day of experimentation till the end of vase life period. Maximum water uptake was recorded with cut tuberose spikes held in solution containing sucrose 4% + citric acid 250 ppm (95.61 ml) followed by sucrose 4% + aluminium sulphate 250 ppm (86.29 ml). It might be due to the reason that citric acid and aluminium sulphate acidifies the holding solution, keeps it free form microorganisms and thus helps in preventing the plugging of conducting tissue.

Loss of water was significantly more with treatment T_7 (105.65) followed by T_4 (95.38). The preservative citric acid along with sucrose not only increased water uptake by cut tuberose spikes but also increased transpirational loss of water. High transpirational loss of water by tuberose spikes held in citric acid 250 ppm might be due to higher water uptake to avoid temporary water stress. Minimum loss of water was observed in control due to decreased water uptake, there by the quantity of water retained in the flowers was meagre which led to wilting of cut flowers. According to Krishnappa and Reddy (2004), the normal rate of transpiration is essential for extending the vase life of cut flowers and any process that hinders the normal transpiration will decrease the keeping quality of cut flowers. The present results were in accordance with the findings of Rekha *et al.* (2001) in cut gladiolus.

The ratio of water loss to water uptake was lower for the spikes treated with citric acid 250 ppm (1.04) and aluminium sulphate 250 ppm (1.11) compared to control. These results were in accordance with Padaganur *et al*. (2005) and Varu and Barad (2009) in tuberose. Beneficial effect of reducing the transpiration loss of water by partial closure of stomata has also been reported for aluminium sulphate (Kumar *et al.,* 2007).

Considering all these parameters of post harvest behaviour, it was observed that Citric acid @ 250 ppm along with sucrose 4% gave best results among various holding solutions recorded in the study. Aluminium sulphate @ 250 ppm was also found to be good for improving post harvest life of cut tuberose spikes.

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INFLUENCE OF PLANTING DATES AND VASE CHEMICALS ON POST HARVEST QUALITY OF GLADIOLUS (*Gladiolus grandiflorus* L.)

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Gladiolus is an interesting flower one could choose to grow due to its florets of brilliant colours, attractive shapes and varying sizes suited to different purposes. Successful production of quality flowers depends much upon the planting time which indirectly influences the keeping quality (Usha Bala, 2002). Cut flowers once they are detached from the mother plant are deprived of metabolic supply and suffer disruption of water. Hence, the post harvest factors may influence 30% of the potential lasting quality of the cut flowers (Pratap *et al*., 2008). Besides the planting season, post harvest nurturing of cut spikes through addition of sucrose as respiratory substrate and other floral preservatives for improving fresh life of cut flowers is the common practice which has profound influence in extending the post harvest quality of cut gladiolus. In the present investigation an attempt has been made to establish optimum season of planting and holding solution to get spikes with extended period of vase life.

A field experiment was conducted at All India Coordinated Research Project on Floriculture at Agricultural Research Institute, Rajendranagar during the year 2008-09. The experiment was laid out in split-plot design comprising of 16 treatments with main treatment as varieties consisting of Advance, Spic and Span, Peter Pears and White Knight; sub treatment as dates of planting consisting of 15th September, 15th October, 15th November and 15th December plantings. The treatments were replicated thrice.

The spikes were harvested at colour break stage for vase life studies. Immediately after harvesting, the cut spikes were placed in buckets containing water. Lower two cm portion of the stem was cut and kept in solutions containing Dichlorophen @50 ppm and Aluminium Sulphate @ 300 ppm as vase chemicals and distilled water as control. All these treatments were used with 4% sucrose as base material, except for control. The experiment was laid out in completely randomized design with factorial concept and replicated thrice. Observations were recorded for number of days for basal floret opening, number of florets remained open at a time per spike, diameter of the second fully opened floret, vase life (wilting of 5th floret) and days taken for wilting (complete wilting of spike).

The data in Table 1 reveals that Aluminium sulphate @ 300 ppm along with sucrose 4% recorded less number of days taken for the basal floret to open (1.76) compared to Dichlorophen 50 ppm and sucrose 4% combination (2.11).The early opening might be due to the supply of food material in form of sucrose and reduced growth of micro organisms due to acidification of solution by aluminium sulphate (Nelofar and Paul, 2008). Planting dates has no significant influence on number of days taken for basal floret opening. Significantly less number of days recorded by the variety Advance (1.96) can be attributed to the genetical factor. The number of florets remained open at a time and diameter of the second full opened floret were maximum for the spikes obtained from the 15th September planting in the variety Advance with the treatment sucrose 4% + aluminium sulphate @ 300 ppm. Sucrose and preservatives supplied externally might have resulted in maintenance of freshness of florets and there by more number of opened florets. A variation in flower size among the varieties was also reported by Sindhu and Verma (1995) and Kalasa Reddy (1997). The spikes harvested from 15th September planting recorded maximum vase life and more number of days taken for wilting of the spikes. In the plants from late plantings, the flower initiation and development were confronted with high temperature intensities during the months of March and April. A tremendous heat along with longer day's periods might have caused a reduction in growth, quality and vase life of gladiolus drastically. Effect of planting dates on vase life was also reported by several authors

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(Sheikh and John, 2005 and Hematzadet *et al*.,2007).Variations in vase life and other quality parameters among the varieties may be attributed to the differential accumulation of carbohydrates due to varied leaf production and sensitivity of varieties to ethylene. In turn variations in these aspects might be due to genetical make up of the plants (Kamble *et al*., 2004).The sucrose in the vase solution along with aluminium sulphate maintained the water balance and osmotic potential, since sugar has been observed to decrease moisture stress in cut flowers by affecting the stomatal closure, preventing water loss (Singh and Beura, 2002).The findings of the experiment are further supported by Singh *et al*., (2006).

Table 1. Effect of planting dates and vase chemicals on post harvest quality of gladiolus varieties

Factors	Days taken for basal floret opening	Number of florets remain opened	Diameter of second fully opened floret	Vase life	Days taken for wilting
Dates of Planting (D)					
D_1- 15th September planting	2.03	3.40	9.25	10.39	16.69
D_2- 15th October planting	2.05	2.56	8.36	10.01	15.67
D_3- 15th November planting	2.06	2.50	7.90	7.54	15.01
D_4-15th December planting	2.05	2.19	7.58	8.25	13.94
CD at 5%	NS	0.06	0.50	0.12	0.39
Varieties (V)					
V_1 - Advance	1.96	2.97	9.06	10.42	17.41
V_2- Spic and span	2.01	2.64	9.06	9.99	17.32
V_3- White knight	2.11	2.35	8.58	8.14	14.50
V_4- Peter pears	2.09	2.56	8.86	7.34	12.09
CD at 5%	0.02	0.25	0.05	0.12	0.39
Vase chemicals (T)					
T_0- Control (Distilled water)	2.26	2.38	8.38	6.54	12.75
T_1- Sucrose 4% + Aluminium sulphate 300ppm	1.76	2.94	8.40	10.79	16.88
T_2- Sucrose 4% + Dichlorophen 50ppm	2.11	2.57	8.39	9.59	16.35
CD at 5%	0.25	0.36	0.01	0.10	0.33

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Research Note
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ATTRIBUTES OF BT COTTON *(Gossypium spp.)*: A FARMERS PERSPECTIVE

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Cotton crop *(Gossypium spp.)* suffers from significant yield losses due to three types of bollworms, *viz*., American bollworm (*Helicoverpa armigera*), pink bollworm (*Pectinophora gossypiella*) and spotted bollworms (*Earias vitella*). Sources of resistance to the bollworms in the germplasm of cotton, in the world over are not available. Moreover, about 10 per cent of insecticides on global basis and 45 per cent in India are used for control of insects in cotton crop alone. Insecticides have adverse effects on natural predators and parasites of bollworms, beneficial insects, human health and microorganisms such as earthworm, blue green algae and nitrogen fixing bacteria. Use of insecticides also leads to environmental pollution (soil, air and water), increase in cost of cultivation and sometimes development of resistance in insects against insecticides. Under these circumstances, Bt cotton has emerged as an attractive option before the cotton farmers.

The study was conceived using exploratory research design. Karimnagar district of Andhra Pradesh was purposively selected as it has largest area under Bt cotton cultivation (1.73 lakh ha).Out of fifty-seven mandals of the district, three mandals were selected purposively for the study. Four villages from each mandal were selected. Thus, 12 villages were selected for the study. From the list of Bt cotton cultivating farmers, ten (10) Bt cotton cultivating farmers were selected randomly from each village, thus making a sample of 120 respondents for the study. Keeping the specific objectives and variables of the study in view, interview schedule was developed and administered to respondents.

Attributes of Bt Cotton The attributes of Bt cotton as perceived by respondent farmers were documented and results were presented in Table 1. Majority of the respondents felt that Bt cotton is relatively advantageous over non Bt cotton in terms of initial cost (57.5%), net profitability (64.17%), regularity in consistency of profits (53.33%), saving of time (70%) and multiple benefits (39.17%).

Regarding the attribute of compatibility, majority of respondents perceived that Bt cotton is compatible with existing cultivation practices in terms of feasibility in present situation (48.33%), culturally acceptable (61.67%) and physically compatible (69.17%).Whereas, majority disagreed to the statements such as Bt cotton gives recognition in the society (61.67%) and it is independent of existing practices (54.17%).

With respect to attribute of complexity majority of the respondents perceived that Bt cotton is easy to understand and apply in the field as it involves cultivation of same cotton crop (but of a different variety) (100%) and less number of pesticides sprays (100%). Majority of respondents felt Bt cotton cultivation is not complex in terms of resource utilization (83.33%), reversibility (81.67%) and labour efficiency (65.83%).

Majority of respondents regarding the attribute of practicability felt that practices done in Bt cotton cultivation are easily communicable (76.67%), visibility (80.83%), demonstrability (60.83%), trialability (90.83%) and reliable point of origin (44.17%) as it was recommended by scientists and extension officers.

Finally, it can be concluded that majority (44.16 %) of the respondents had favourable perception towards attributes of Bt cotton. 41.28 per cent of the respondents had unfavourable perception where as 14.54 per cent were undecided. This is in accordance with the results of Nirmala (2012).

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Table 1. Distribution of respondents according to their perception about attributes of Bt cotton technology

S.No.	Attributes	Response categories					
		agree		Undecided		disagree	
		n	%	n	%	n	%
A.	**Bt cotton is relatively advantageous over non Bt cotton in terms of**						
1	Initial cost	69	57.5	23	19.17	28	23.33
2	Net profits	77	64.17	15	12.5	28	23.33
3	Consistency in profits	64	53.33	39	32.5	17	14.17
4	Saving of time	84	70	17	14.17	19	15.83
5	Multiple benefits (multiple use potential)	47	39.17	29	24.17	44	36.66
	Average	**68.2**	**56.83**	**24.6**	**20.50**	**27.2**	**22.66**
B	**Bt cotton is compatible with existing cultivation practices in terms of**						
1	Feasible in present situation	58	48.33	29	24.17	33	27.5
2	Cultural acceptance	74	61.67	12	10	34	28.33
3	Physical compatibility	83	69.17	20	16.67	17	14.16
4	Recognition in the society	46	38.33	-	-	74	61.67
5	Independent of existing practices	17	14.17	38	31.66	65	54.17
	Average	**55.6**	**46.33**	**19.8**	**16.5**	**44.6**	**37.16**
C.	**Bt cotton is complex when compared to non Bt cotton in terms of**						
1	Difficulty in understanding	-	-	-	-	120	100
2	Application in the field	-	-	-	-	120	100
3	Resource utilization	-	-	20	16.67	100	83.33
4	Reversibility	-	-	22	18.33	98	81.67
5	Labour efficiency	17	14.17	24	20	79	65.83
	Average	**3.4**	**2.83**	**13.2**	**11**	**103.4**	**86.16**
D.	**Bt cotton is practicable in the field in terms of**						
1	Communicability	92	76.67	-	-	28	23.3
2	Visibility	97	80.83	-	-	23	19.17
3	Demonstrability	73	60.83	18	15	29	24.17
4	Trailability	109	90.83	-	-	11	9.17
5	Reliable point of origin	53	44.17	43	35.83	24	20
	Average	**84.8**	**70.66**	**12.2**	**10.16**	**23**	**19.16**
	Average of all attributes	**53**	**44.16**	**17.45**	**14.54**	**49.55**	**41.28**

Changes occurred due to Bt Cotton cultivation

Changes occurred due to Bt cotton cultivation as perceived by respondent farmers in Table 2 reveals that majority **(**51.67%) of the respondents got higher net returns due to cultivation of Bt cotton when compared to non -Bt cotton.

More than 40 per cent of respondents expressed that number of crops cultivated and area under cultivation got increased due to Bt cotton cultivation.

55 per cent expressed that due to Bt cotton cultivation there was occurrence of new pests and diseases viz., mealy bugs, tobacco streak virus, cucumber mosaic virus, grey mildew and wilt.

Majority of respondents also indicated that there was no change in pest population, status and prestige in the society (100%) and cost of cultivation due to Bt cotton (50%). The result is in accordance with the result of Qaim and Zilberman (2003).

Table 2. Distribution of respondents according to changes occurred due to Bt cotton cultivation

S. No.	Item	Changes occurred					
		Increase		Decrease		No change	
		n	%	n	%	n	%
1	Net returns (Rs/acre)	62	51.67	0	0	58	48.33
2	Status &prestige in the society	0	0	0	0	120	100
3	Yield obtained/acre	46	38.33	0	0	74	61.67
4	Pest population (like jassids, aphids, white fly, mites and red cotton bugs)	0	0	0	0	120	100
5	Occurrence of new pest/diseases (Mealy bugs, Tobacco streak virus, cucumber mosaic virus, grey mildew, wilt.)	66	55	0	0	54	45
6	No. of sprays (3 to 4)	0	0	120	100	0	0
7	No. of crops cultivated (2to 3 crops)	57	47.5	0	0	63	52.5
8	Area under cultivation	58	48.33	0	0	62	51.67
9	Cost of cultivation	19	15.83	41	34.17	60	50

Sources of Information utilised by Bt Cotton farmers

The result shown in the Table 3 revealed that under personal localite sources majority (85%) of the respondents contacted friends frequently whereas 90.83 per cent of them contacted other farmers sometimes (once in a month or more than that). Under personal cosmopolite sources majority (76.67%) of the respondents contacted input dealers, whereas 96.67 per cent of them contacted scientists some times. Under mass media sources, majority (43.33%) of the respondents got information frequently about Bt cotton cultivation through television, whereas 35.83 per cent of the respondents depended on cell phones for information on Bt cotton and 90 per cent of the respondents never used radio for information followed by Agricultural Magazines.

It could be concluded from the results that primary localite sources were frequently utilized by majority of the respondents than the personal cosmopolite source and mass media source. This trend might be due to that majority of the farmers were small and marginal in nature. Generally they depend on their friends, family members and neighbours for getting information related to Bt cotton cultivation.

Under personal cosmopolite source input dealers were frequently contacted by majority of the respondents. The farmers express that input dealers

are easily available to them, as source of information for plant protection chemicals than other personal cosmopolite source.

Under mass media source, television was frequently utilized by the respondent farmers. Majority of the farmers has television as mass media source, which reflect importance of television in programmes for effective dissemination of farm information. Farm programmes and advertisements on Bt cotton hybrids and new plant protection chemicals in television, cell phone and news papers could be the main source of information for the farmers.

Table 3. Distribution of respondents according to their sources of information utilisation

Cate-gory	S. No.	Source of information	Frequently (Once in a week)		Some times (Once in a month & more than that)		Never	
Personal localite sources			**n**	**%**	**n**	**%**	**n**	**%**
	1	Family members	97	80.83	23	19.17	0	0
	2	Friends/ neighbours	102	85	18	15	0	0
	3	Other farmers	11	9.17	109	90.83	0	0
	4	Local leaders/ Adarsha Rythus	53	44.17	67	55.83	0	0
Personal Cosmopolite sources								
	5	Agricultural Extension Officers	24	20	96	80	0	0
	6	Mandal Agricultural officer (MAO)	13	10.83	107	89.17	0	0
	7	Scientists	4	3.33	116	96.67	0	0
	8	Input dealers	92	76.67	28	23.33	0	0
	9	NGO personnel	38	31.67	82	68.33	0	0
Mass media sources								
	10	News papers	21	17.5	34	28.33	65	54.17
	11	Agricultural Magazines	14	11.67	27	22.5	79	65.83
	12	Radio	0	0	12	10	108	90
	13	Television	52	43.33	39	32.5	29	24.17
	14	Cell phones	33	27.5	43	35.83	44	36.67
	15	Pamphlets / leaflets	15	12.5	36	30	69	57.5

Interestingly, farmers opined that cell phones were also highly utilized by the farming community for getting technical information from the scientists of District Agriculture Advisory and Transfer of Technology Centre (DAATTC), Krishi Vignan Kendras (KVKs) and Agriculture Research Scientist (ARS) of ANGRAU.

The listening, viewing and reading habits need to be enhanced further for creating large scale awareness of the technologies. More over, information flow through there sources need to be ensured to cater the need of the farming community.

Farmers also informed that the popular articles, press notes written by ANGRAU scientists in Annadata, rythu nestam, padipantalu, vyasayam were the major source of information on improved Bt cotton cultivation practices.

Vyavasaya panchangam should be made available to every revenue village for large scale adoption of agriculture practices in general and Bt cotton cultivation practices in particular by the farming community. If the mass media sources are utilized by the majority that would serve for large scale awareness which will in turn help in adoption of Bt cotton cultivation practices. The findings of the present study were in agreement with the study of Vasantha (2002) and Chinchmalatpure *et al.* (2010).

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Research Note
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EVALUATION OF RICE PRODUCTION TECHNOLOGIES FOR HIGHER MONETARY RETURNS AND WATER USE EFFICIENCY

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Rice (*Oryza sativa* L.) is an important food crop globally and it is a major crop in Andhra Pradesh. Rice is promoted as a water intensive and high chemical input responsive crop. Intensive support from Government in terms of reallocating national water resources, subsidising chemical inputs and price support mechanisms, rice has become a preferred crop for extensive coverage.

In India, rice is grown under different agro ecological situations. Rice cultivation requires large quantity of water and producing one kg rice requires 3000-5000 litres of water depending on the different rice cultivation methods viz., transplanted rice, direct sown rice, system of rice cultivation and aerobic rice. Owing to increased water scarcity and labour scarcity, a shifting trend is towards less water consuming rice productions. This warrants alternate methods of rice cultivation that aims at water saving, low cost of cultivation and higher productivity. Transplanting alone costs about 15% of total rice production cost and delayed transplanting due to labour shortage causes sustainable loss in yield (Ponnuswamy *et al.,*1999). Therefore, there is need to find alternative methods for rice cultivation to tackle the problem of high production with labour scarcity. Direct sowing of sprouted seed in puddled fields using drum seeder reduces the input costs i.e., cost of seed, nursery raising, transplanting and it is a good method under late onset of monsoon .

The present study was conducted in farmers fields to evaluate different low cost production technologies in rice cultivation for its large scale adoption for high water productivity.

Field experiments were carried out during *kharif* seasons of 2007-08 and 2008-09 in sixteen farmers fields of four mandals of Vizianagaram district, Andhra Pradesh to evaluate the performance of different low cost technologies in rice cultivation. Soils of experimental fileds were red loams with a P^H of 7 to 8, EC of 0.2 to 0.4 dSm^{-1}, low in organic carbon (0.3 - 0.4%) and normal compactness. Treatments consisted of different rice cultivation methods viz., aerobic rice cultivation, system of rice intensification (SRI), direct sown rice in puddled soil and conventional rice cultivation (transplanted rice).Young , 8-12 days old seedlings were transplanted in SRI method. The seedlings were carefully pulled from nursery bed at 2-3 leaf stage along with soil without any disturbance to their roots. Young seedlings were planted shallow to establish quickly with a spacing of 25x25 cm. Light irrigation was given on next day of transplantation. Regular wetting and drying of soil helps in better root growth. Manually operated weeder was used for effective weed management in SRI. Weeds were incorporated by moving the weeder between the rows. First weeding was done at 10-12 days after transplanting. Three weedings were done once in 10 days. For direct sowing using drum seeder, the rice seeds were soaked in water for 24 hours followed by incubation in gunny bags for 24-48 hours depending upon the rice variety and prevailing temperature. The field was well puddled and levelled after draining the standing water before sowing to avoid damage of sprouted seed and to enable water to spread uniformly over the field. After puddling, the field was left for 1-2 days for settling of the puddled soil. The pre germinated seeds were sown in eight rows with 20 cm spacing using drum seeder at optimum seed rate of 30 kg ha^{-1}. Weeds were kept under check by operating cono weeder at 10 days after sowing or by using pre emergence herbicide oxadiargyl @ 90 g ha^{-1} with sand mixture at seven days after sowing. The field was kept moist and wet with no standing water in the field upto 20 days after sowing. In aerobic rice, the dry seeds were broadcasted @ 75 kg ha^{-1} in thoroughly prepared dry soil. In conventional transplanting, 25-28 days seedlings were transplanted with a spacing of 20x15 cm. Hand weeding was done three times at 15, 30 and 45 days after sowing in aerobic rice and two times at 20 and 35 days in transplanted rice.

Data on grain yield, straw yield, net returns, benefit-cost ratio and water use efficiency were

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calculated for the rice production technologies.The prevailing prices of rice grain (Rs. 5330 /- per ton) and rice straw (Rs. 900/- per ton) were used to work out the economics.

The average yield recorded in on-farm demonstrations conducted in Vizianagaram was 7.87 t ha^{-1} with direct sowing rice and 7.02 t ha^{-1} with SRI; 5.44 t ha^{-1} with aerobic rice and 5.38 t ha^{-1} in farmers practice of transplanting. Direct sown rice using drum seeder followed by system of rice intensification registered higher grain yield compared to aerobic rice and farmers practice of transplanting (Table 1).Grain yields under aerobic rice was slightly higher than those from farmers practice of transplanting. The percentage of increase in grain yield in direct sown rice and SRI were 31.6 per cent and 23.4 per cent over farmers practice of transplanting. The per cent of increase in grain yield in direct sown rice and SRI were 30.9 per cent and 22.5 per cent over aerobic rice. The higher grain yield with directly sown rice was due to higher panicles per m^2 (381- 407) and filled grains per panicle (183-191).The higher number of panicles per m^2 in directly sown rice with drum seeder was due to higher number of mother plants per unit area. Early establishment of seedlings in direct sown sprouted seed might be the reason for higher tillers per m^2 than conventional transplanting. Similar findings were reported by Halder and Patra (2007). The higher grain yield with SRI cultivation can be attributed to rotary weeding, keeping moist condition in the field at saturation level, better aeration and optimum utilization of nutrients which helped the plant to put forth better root system and more number of productive tillers, more filled grains over other systems. Similar results of higher yield, water use efficiency in SRI cultivation were reported by Pasha *et al.,* (2012) .

Directly sown rice (937 mm) and SRI utilized (982 mm) utilized less quantity of water through irrigation and rainfall (580 mm) compared with aerobic rice (1061 mm) and farmers practice of transplanting (1358 mm). The percent of water saving in direct sown rice and SRI were 31.0 and 27.7 over farmers practice of transplanting. The per cent of water saving in directly sown rice and SRI were 11.7 and 7.45 over aerobic rice. Water saving of 40 per cent with moisture level at field saturation point was reported by Bhagat *et al.* (1999) when compared to continuous shallow ponding with similar yields. Whereas, Subbarao *et al.* (2009) reported 47 per cent and 30 per cent water saving in SRI and rotational irrigation than farmers practice. Higher water use efficiency was recorded with directly sown rice (8.4) followed by SRI cultivation (7.15) compared to farmers practice of transplanting (3.96) and aerobic rice (5.13).Similar results of higher water use efficiency and water saving were reported by Subbarao *et al.* (2009).

Among the different rice cultivation methods, direct sowing rice registered higher net returns (Rs.32,443 ha^{-1}) than SRI (Rs. 30,445 ha^{-1}); aerobic rice (Rs. 13,740 ha^{-1}) and farmers practice of transplanting (Rs.13,294 ha^{-1}).Higher B:C ratio was recorded with directly sown rice (1:2.97) and SRI (1:2.17) than aerobic rice and farmers practice of transplanting (Table 2).The results favour the adoption of directly sown rice and system of rice intensification over farmers practice of transplanting.

Results of on farm demonstrations conducted in farmer's field revealed that adaptation practices involved in direct sowing rice and SRI technologies resulted in increased number of tillers per hill ; number of productive tillers per hill and number of grains per panicle which resulted in increase of yield. Adoption of SRI method resulted in 23.4 per cent increase in yield compared to conventional method of rice cultivation.

Both tillering and root growth were increased by the set of practices used , leading to increased grain yield.

Biophysical observations, cost of cultivation and water measurements were carried out in the farmer's fields. The seed rate in the direct seeded field is about 60% lower than the transplantation method. The yield difference between the direct seeding and the transplantation method was around 2.49 t ha^{-1}. The variable cost of the farmers was also less by about Rs.4500 per hectare. The amount was the reduced cost, normally required for nursery raising and transplantation. Not more than two labourers are required for direct seeding, whereas 25 are needed for transplantation .

Direct sowing of rice and SRI cultivation were adopted and practiced by farmers using ground water as irrigation source. These two techniques were advantageous over farmer's method of rice cultivation for being high yielding, water saving, seed saving and labour saving. Whereas, direct sowing of rice is advantageous over SRI, aerobic rice and transplanting. The profitability of rice production with direct sowing and SRI technologies were calculated as Rs.19,149 ha^{-1} and Rs.17,151 ha^{-1} compared with transplanting. Farmer's net returns with SRI were

Table 1. Grain yield , water use efficiencies as influenced by different techniques in rice cultivation

Water saving techniques	Grain yield (t/ha^{-1})	Straw yield (t/ ha^{-1})	Water use (mm)	Water use efficiency ($kg\ ha^{-1}\ mm^{-1}$)
Farmers practice of transplanting @ 75 kg/ha	5.38	6.24	1358	3.96
Aerobic rice @ 75 kg/ha	5.44	5.83	1061	5.13
Direct sowing rice using drum seeder @ 30 kg/ha	7.87	7.77	937	8.4
System of rice intensification (SRI) @ 5 kg/ha	7.02	12.06	982	7.15

Table 2 . Economics as influenced by different techniques in rice cultivation

Water saving techniques	Cost of cultivation (Rs/ha)	Gross returns (Rs./ha)		Total gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
		Grain yield	Straw yield			
Farmers practice of transplanting @ 75 kg/ha	21,000	28,675	5,619	34,294	13,294	1.63:1
Aerobic rice @ 75 kg/ha	20,500	28,995	5,245	34,240	13,740	1.67:1
Direct sowing rice using drum seeder @ 30 kg/ha	16,500	41,947	6,996	48,943	32,443	2.97:1
System of rice intensification (SRI) @ 5 kg/ha	17,825	37,417	10,853	48,270	30,445	2.71:1

Cost of Paddy @ Rs. 5330/- per ton and cost of rice straw @ Rs. 900/ per ton

67% higher (Sekhar and Jayesh , 2005). Direct sowing of rice is emerging as a potential alternative to conventional rice cultivation and is showing great promise to address the problems of water scarcity and high energy usage.

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GROWTH AND YIELD OF SUNFLOWER AS INFLUECED BY PLANTING GEOMETRY AND LAND CONFIGURATIONS UNDER DIFFERENT FERTILIZER LEVELS

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Sunflower (*Helianthus annuus* L.) oil is preferred among the consumers in India for its health benefits and sunflower oil is the largest selling oil in the branded oil segment. It is also a crop of choice for farmers due to its wider adaptability, high yield potential, shorter duration and profitability.

The productivity of sunflower in India is low (692 kg ha^{-1}) as compared to other nations and one of the major reason for low productivity is due to its cultivation mainly under rainfed conditions with sub optimal crop stand, imbalanced nutrition and lack of soil moisture conservation techniques, thus leading to poor seed set and high per cent of chaffy seed, low oil content and yield.

Plant spacing effects are highly pronounced in sunflower because there is no possibility of filling gaps between plants by branching or tillering. Planting geometry determines the distribution pattern of plants in a field. It affects evaporation, water use efficiency of the crop and weed intensity/competition. Proper spacing of plants in a particular area makes plant canopy more effective in intercepting the radiant energy and shading effect on weeds (Saleem *et al.,* 2008).

Under dryland conditions, response to the applied fertilizers varies with the available soil moisture. Hence, efficient soil moisture conservation is the key for successful crop production under this situation. Application of fertilizers having nutrients viz., nitrogen, phosphorous and potash can increase sunflower growth and yield substantially (Reddy *et al.,* 2007). Intensive agriculture with fertilizer use is highly skewed towards nitrogen, has deprived the soil of other essential nutrients, especially P and K. Hence, balanced fertilizer application is important for high seed and oil yield.

The present experiment on sunflower was conducted during *kharif* 2013 at College Farm, Acharya N. G. Ranga Agricultural University, Rajendranagar. The soil of experimental site was sandy clay with pH of 7.54, electrical conductivity 0.32 dSm^{-1}, low in organic carbon (0.36 %), low in available nitrogen (267 kg ha^{-1}), phosphorus (31 kg ha^{-1}) and high in potassium (352 kg ha^{-1}). The experiment was laid out in split plot design consisting of twelve treatments (Four main and three sub plots) and replicated thrice. The main plots consisted of : M_1- Flat bed sowing at 60 cm x 30 cm, M_2- Ridge and furrow sowing at 60 cm x 30 cm, M_3- Flat bed with paired row planting at 45 cm x 40 cm (90/40 cm) and M_4- Broad bed and furrow with paired row planting at 45 cm x 40 cm (90/40cm) and S_1- 75 % RDF, S_2- 100 % RDF (60:60:30 N, P_2O_5 and K_2O kg ha^{-1}) and S_3- 125% RDF were the sub plot treatments. The crop (DRSH-1 hybrid) was sown on 9th July and harvested on 18th October, 2013. Full dose of P_2O_5 and K_2O along with half of the nitrogen in all the treatments was applied as basal. Remaining nitrogen was applied in two equal splits i.e. 1/4th at 30 DAS and remaining 1/4th at flowering as per the treatments. Need based plant protection measures were taken. The crop was grown completely under rainfed conditions. A total of 442.05 mm rainfall was received in 30 rainy days during the crop growth period.

Perusal of the data (Table 1) indicates that planting geometry and land configurations had no significant effect on growth parameters at harvest (plant height and dry matter accumulation).Graded

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Table 1.Growth, yield attributes and yield of sunflower as influenced by planting geometry and land configurations under different fertilizer levels

Treatment	Plant height (cm)	Total dry matter (g plant^{-1})	Head diameter (cm)	Filled seeds head^{-1}	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index (%)	B:C ratio
Planting geometry and land configuration (M)								
M_1- Flat bed (60 cm x 30 cm)	178.1	150.26	15.8	771	1960	3780	34	2.43
M_2- Ridge and furrow (60 cm x 30 cm)	179.4	155.78	16.8	785	1994	3689	35	2.40
M_3- Flat bed with paired row 45 cm x 40 cm (90/40 cm)	178.2	153.04	15.4	897	2079	3689	36	2.60
M_4- Broad bed and furrow with paired row 45 cm x 40cm (90/40cm)	187.1	160.69	16.7	913	2052	3905	34	2.43
SEm ±	7.5	5.31	0.4	33	168	182	1	-
C.D at 5 %	NS	NS	NS	113	NS	NS	NS	-
Fertilizer levels (S)								
S_1- 75 % RDF	176.5	148.42	15.4	821	1763	3668	32	2.25
S_2- 100 % RDF	180.5	153.44	16.3	831	2080	3748	36	2.53
S_3- 125% RDF	184.9	162.97	16.8	873	2221	3889	36	2.60
SEm ±	1.7	1.13	0.4	14	105	46	1	-
C.D at 5 %	5.1	3.39	1.1	42	316	138	3	-
Fertilizer level at same or different level of planting geometry and land configurations								
SEm ±	3.4	2.25	0.73	45.95	211	91	2.5	-
C.D at 5 %	NS	NS	NS	NS	NS	NS	NS	-
Planting geometry and land configurations at same level of fertilizer levels								
SEm ±	7.9	5.62	0.71	49.79	240	197	2.29	-
C.D at 5 %	NS	NS	NS	NS	NS	NS	NS	-

NS: non-significant

level of fertilizers had exerted significant influence on plant height and dry matter accumulation. Application of 125% RDF (184.9 cm) produced taller plants over 75% RDF (176.5 cm) and was comparable with 100% RDF (180.5 cm) which in turn was comparable with 75% RDF. Similarly, the dry matter accumulation was also highest with 125% RDF (162.97 g) over 75% (148.42 g) and 100% RDF (153.44 g).

Apropos head diameter there was no significant differences observed with respect to planting geometry and land configurations. Among the fertilizer levels, crop fertilized with 125% RDF recorded significantly higher head diameter (16.8 cm) over 75% RDF (15.4 cm) but 125% RDF was comparable with 100 % RDF (16.3 cm) which in turn was comparable with 75% RDF.

Number of filled seeds head^{-1} differed significantly among planting geometry and land configurations. Among the treatments M_4 recorded higher number of filled seeds head^{-1} (913) over M_1 (771) and M_2 (785) but (M_4) was comparable with M_3 (897) which in turn was comparable with M_2. The crop sown under M_1 (771) and M_2 (785) recorded significantly lower number of filled seeds head^{-1} and were comparable with each other. Higher seeds head^{-1} under M_4 and M_3 could be attributed to the adequate availability of soil moisture over other treatments. Among the fertilizer levels application of 125% RDF had recorded significantly higher number of filled seeds head^{-1} (873) over 75% RDF (821) but 125% RDF was comparable with 100% RDF (831) which in turn was comparable with 75% RDF.

Cumulative effect of improved growth parameters (plant height and dry matter accumulation) through efficient metabolic activity, increased photosynthetic rate and supply of photosynthates from source to sink had accommodated more number of filled seeds head^{-1} under 125% RDF. These results are in line with those of Thorat *et al*. (2007) and Pavani *et al.* (2013).

There were no significant differences observed in terms of seed, stalk yield and harvest index due to planting geometry and land configurations.Among the fertilizer treatments, application of 125% RDF had recorded significantly higher seed, stalk yield and harvest index (2221, 3889 kg ha^{-1} and 39 %) over 75% RDF (1763, 3668 kg ha^{-1} and 32 %) but 125 % RDF was comparable with 100% RDF (2080, 3748 kg ha^{-1} and 32 %). Seed yield is the function of several growth parameters (plant height, leaf area index and dry matter accumulation) yield attributing characters *viz*., head diameter, number of filled seeds, test weight and yield plant^{-1}. Improved growth parameters, greater head diameter due to adequate supply of fertilizers under 125% RDF had positively reflected in higher seed, stalk yield and harvest index. Head diameter is the most important attributing character, which improves the seed yield by providing maximum number of florets for higher seed set. Harvest index basically depends on the economic yield (seed). Higher seed yield under 125 RDF and 100 % RDF over 75 % RDF had also reflected in higher harvest index values. These findings corroborate with those of Kadasiddappa *et al.* (2007) and Pavani *et al.* (2012). Among the treatment combination flat bed and paired row sowing recorded higher B: C ratio (2.6) over other treatments.

From the present results it can be concluded that planting geometry and land configurations could not significantly influence growth, and yield of sunflower whereas the fertilizer levels had significant influence on growth, yield attributes and yield of sunflower. Among the treatments flat bed with paired row sowing and application of 125% RDF recorded higher benefit cost ratio (2.60) over rest of the treatments.

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Research Note
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YIELD AND YIELD ATTRIBUTES OF RABI GROUNDNUT AS INFLUENCED BY MOISTURE REGIMES AND PHOSPHOGYPSUM LEVELS

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In India area, production and productivity of groundnut is 4.19 million hectares, 5.62 million tonnes and 1341 kg ha^{-1} respectively. In India, Andhra Pradesh ranks 2nd in area and production but ranks 25th in productivity. There is possibility to double the groundnut yields during *rabi* season over *kharif* with limited number of irrigations. Cultivation of groundnut under moisture stress conditions and imbalanced nutrient management are the main reasons for low productivity of groundnut in Andhra Pradesh. Irrigation water, a crucial input in crop production is scarce and expensive. Efficient use of this input is essential which can be achieved through judicious water management practices. Adequate and timely supply of water is essential for higher yields. Because of high productivity under assured irrigation, a climatological approach based on IW/CPE ratio (IW– irrigation water, CPE – cumulative pan evaporation) in irrigation scheduling has been found most appropriate as it integrates most of the weather parameters which determine the water requirement of a crop.

Phosphogypsum is a solid waste by-product of the wet phosphoric acid production from rock phosphate and is a cheaper source of sulphur. In India, 6 to 8 Million tonnes of phosphogypsum is produced annually which contains 16 per cent sulphur and 21 per cent calcium along with some amount of phosphorus (0.2-1.2 % P_2O_5), trace amounts of silica, iron, aluminium, sodium, potassium and some heavy metals.The phosphogypsum, unlike other sulphur sources offers all desirable agronomic features of an efficient sulphur fertilizer besides supplying calcium that is readily available to the growing plant, while elemental sulphur and organic sulphur must undergo microbial conversion before sulphur is made available to plants, but the sulphur in phosphogypsum becomes readily available in sulphate form. At the same time, sulphate form is kept available for a longer period due to its low solubility in water. Most of the other sulphate salts that are used for fertilizer are highly soluble and the sulphate may be leached from the soil before the plant removal (Biswas and Sharma, 2008).

In spite of additional nutritional value, a high proportion is either dumped or staked for increasing concern to the risk of exposure to radiation. However, the relative radiation risk to people or the environment falls significantly below the level of radiation to which we are exposed through naturally occurring radioactive material (NORM). Hence, it may not be prudent, therefore, to allow such wastage of this large sulphur and calcium rich by-product (16% S and 21% Ca) in the back drop of wide spread sulphur and calcium deficiencies in Indian soils (Biswas and Sharma, 2008).

The field experiment was conducted at college farm, Acharya N. G. Ranga Agricultural University, Rajendranagar during *rabi* 2013-14 on sandy loam soils having low organic carbon and available nitrogen, medium available phosphorous, sulphur and calcium, high potassium and neutral in reaction. The experiment was laid out in split plot with combinations of three moisture regimes (Depth of irrigation 5 cm) *viz.,* 0.6, 0.8 and 1.0 IW/CPE ratios and five phosphogypsum fertilizer levels *viz.,* Pg : Control (500 kg ha^{-1} gypsum at flower initiation), Pg, : Phosphogypsum @ 250 kg ha^{-1} (at flower initiation), Pg*f* : Phosphogypsum @ 250 kg ha^{-1} (½ as basal and ½ at flower initiation), Pg„ : Phosphogypsum @ 500 kg ha^{-1} (½ as basal and ½ at flower initiation), Pg_5: Phosphogypsum @ 500 kg ha^{-1} (at flower initiation) and was replicated thrice. Groundnut variety K-6 (Kadiri-6) was sown on 10-10-2013 at a spacing of 22.5 cm x 10 cm with one seed $hill^{-1}$. Recommended dose of 30: 50: 50 N, P_2O_5 and K_2O kg ha^{-1} applied to all the treatments. N and P through urea and DAP, K through muriate of potash. P and K

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as basal. ½ N at basal and ½ at 25 -30 DAS and gypsum was applied as per the treatments. Mean maximum and minimum temperatures were 32.8°C and 22.1°C respectively and 282.2 mm rainfall was received in 11 rainy days during the crop growing period. Mean bulk density and available soil moisture in 60 cm depth of soil was 1.6 g cm^{-3} and 26.89 mm respectively. Mean moisture percentages at field capacity and permanent wilting point was 19.2 and 5.9. The applied irrigation water was 267 ha.mm in case of the treatment I_3 (1.0 IW/CPE ratio) followed by at I_2 (0.8 IW/CPE ratio) (222 ha.mm) and I_1 (0.6 IW/CPE ratio) (178 ha.mm) with five, four and three irrigations respectively along with one irrigation to all treatments one day before harvesting. For every irrigation, 50 mm of water was applied to each plot using water meter in closed channels. Daily readings of evaporation were recorded from USWB class "A" open pan evaporimetre and irrigations were scheduled based on IW/CPE ratios.

Perusal of data in Table 1 indicates that yield attributes *viz.,* number of pods $plant^{-1}$, number of kernels pod^{-1}, 100 kernel weight (g) and shelling percentage were significantly higher with moisture regime at I_3 (1.0 IW/CPE) and was on par at I_2 (0.8 IW/CPE) with respect to number of pods $plant^{-1}$, number of kernels pod^{-1}, 100 kernel weight (g), shelling percentage but superior over I_1. Frequent irrigations under I_3 treatment might have created favourable moisture conditions for the crop growth, hence, consequently increased the values of the yield attributes than other treatments (I_1 and I_2). These results are in close conformity with the findings of Patel *et al*. (2009), Dey *et al.* (2007) and Shaikh *et al.* (2004).

Among the phosphogypsum levels, application of phosphogypsum @500 kg ha^{-1} at flower initiation recorded significantly maximum yield attributes and statistically on par with application of gypsum @ 500 kg ha^{-1} at flower initiation with all yield attributes except number of pods $plant^{-1}$.Among yield attributes interaction between moisture regimes and phosphogypsum levels was significant with number of pods $plant^{-1}$. Significantly higher number of pods $plant^{-1}$ (15.8) observed at 1.0 IW/CPE and with phosphogypsum @ 500 kg ha^{-1} applied at flower initiation (Pg5) followed by I_2Pg_5 and I_3Pg_2 respectively. Lowest number of pods $plant^{-1}$ (12.2) was recorded at interaction of I_1Pg_3 (0.6 IW/CPE) (phosphogypsum @ 250 kg ha^{-1} ½ as basal and ½ at flower initiation) (Table 2). The marked improvement in yield attributes might be due to balanced nutrition and efficient and greater partitioning of metabolites and adequate translocation of nutrients to the developing reproductive parts resulting in the production of greater pod number and shelling percentage These results are in close conformity with the findings of Rout and Jena (2009) and Dey *et al.* (2007).

The data pertaining to groundnut pod and haulm yield was presented in Table 1. The highest pod and haulm yields (21.5 and 38.4 q ha^{-1}) was recorded when irrigation was scheduled at I_3 (1.0 IW/CPE), which was on par with I_2 (0.8 IW/CPE) treatment and both were significantly superior from remaining levels of irrigation. The lowest yields (17.4 and 32.3 q ha^{-1}) were recorded with I_1 (0.6 IW/CPE) treatment compared to other treatments. The higher pod and haulm yields with frequent irrigation (I_3) might be accounted for their favorable influence on the yield and yield attributing characters (number of pods per plant, number of kernels pod^{-1}, and 100 kernel weight, respectively). Pod and haulm yield of groundnut was significantly increased with increase in the frequency of irrigation which was ascribed to adequate moisture availability in turns favored congenial conditions for the optimum growth of crop and consequently increased the yield attributes with I_3 compare to I_2 and I_1 treatments. These results are in close conformity with the findings of Suresh *et al.* (2013) and Shaikh *et al.* (2004).

Application of phosphogypsum @ 500 kg ha^{-1} at flower initiation recorded maximum pod and haulm yields (21.4 and 37.6 q ha^{-1}) but in which only haulm yield was on par with gypsum application @ 500 kg ha^{-1} at flower initiation. Lowest pod and haulm yields (17.9 and 34.4 q ha^{-1}) were recorded under Pg_3 (phosphogypsum @ 250 kg ha^{-1} ½ as basal and ½ at flower initiation) treatment. Phosphogypsum application @ 500 kg ha^{-1} at flowering stage might have ensured adequate supply of calcium and sulphur, have favored not only in pod formation and also in better filling of the pods thus would have

Table 1. Yield and yield attributing characters of *rabi* groundnut as influenced by moisture regimes and phosphogypsum levels

TREATMENTS	Yield attributes				Yield (kg ha^{-1})	
	No. of pods plant^{-1}	No. of kernels pod^{-1}	100 kernel weight (g)	Shelling %	Pod yield	Haulm yield
Moisture regimes (I)						
I1-0.6 IW/CPE	13.0	1.47	40.1	64.7	1742	3234
I2-0.8 IW/CPE	13.7	1.50	41.0	68.0	2081	3719
I3-1.0 IW/CPE	14.1	1.52	41.4	69.8	2147	3799
SEm±	0.1	0.01	0.2	0.8	18	28
CD at 5 %	0.5	0.03	0.8	3.2	73	109
Phosphogypsum levels (Pg)						
Pg1-Gypsum @ 500 kg ha^{-1} at flower initiation	13.7	1.5	41.3	68.2	2060	3665
Pg2-PG @ 250 kg ha^{-1} at flower initiation	13.3	1.5	40.2	66.8	1958	3556
Pg3- PG @ 250 kg ha^{-1} ½ as basal and ½ at flower initiation	13.0	1.5	40.0	64.9	1795	3444
Pg$_4$- PG @ 500 kg ha^{-1} ½ as basal and ½ at flower initiation	13.4	1.5	40.7	67.1	2001	3555
Pg$_5$- PG @ 500 kg ha^{-1} at flower initiation	14.6	1.6	42.1	70.6	2136	3701
SEm±	0.1	0.03	0.4	0.8	20	55
CD at 5 %	0.4	0.1	1.0	2.4	59	161
Interaction (I x Pg)						
Sub treatments at same level of main treatments						
SEm±	0.3	0.02	0.5	1.9	41	62
CD at 5 %	0.8	NS	NS	NS	36	287
Main treatments at same level of sub treatments						
SEm±	0.3	0.1	0.6	1.5	111	90
CD at 5 %	0.8	NS	NS	NS	116	270

Pg- Phosphogypsum

Table 2. Number of pods plant^{-1} of *rabi* groundnut as influenced by interaction between moisture regimes and phosphogypsum levels

Phosphogypsum levels	Moisture regimes			Mean
	I1 (0.6 IW/CPE)	I2 (0.8 IW/CPE)	I3 (1.0 IW/CPE)	
Pg1-Gypsum@ 500 kg ha^{-1} at flower initiation	14.5	13.8	12.6	13.7
Pg2-PG @ 250 kg ha^{-1} at flower initiation	12.5	12.7	14.7	13.3
Pg3- PG @ 250 kg ha^{-1} ½ as basal and ½ at flower initiation	12.2	13.0	13.7	13.0
Pg_4- PG @ 500 kg ha^{-1} ½ as basal and ½ at flower initiation	12.6	14.1	13.5	13.4
Pg_5- PG @ 500 kg ha^{-1} at flower initiation	13.3	14.7	15.8	14.6
MEAN	13.0	13.7	14.1	13.6
Sub treatments at same level of main treatments				
SEm±				0.3
CD at 5 %				0.8
Main treatments at same or different level of sub treatments				
SEm±				0.3
CD at 5 %				0.8

Table 3. Pod and haulm yield (kg ha^{-1}) of *rabi* groundnut as influenced by interaction between moisture regimes and phosphogypsum levels

Phosphogypsum levels	Pod yield (kg ha^{-1})				Haulm yield (kg ha^{-1})			
	Irrigation scheduling			MEAN	Irrigation scheduling			Mean
	I1-0.6 IW/CPE	I2-0.8 IW/CPE	I3-1.0 IW/CPE		I1-0.6 IW/CPE	I2-0.8 IW/CPE	I3-1.0 IW/CPE	
Pg1-Gypsum @ 500 kg ha^{-1} at flower initiation	1820	2134	2224	2060	3351	3822	3821	3665
Pg2-PG @ 250 kg ha^{-1} at flower initiation	1634	2064	2175	1958	3046	3641	3982	3556
Pg3- PG @ 250 kg ha^{-1} ½ as basal and ½ at flower initiation	1560	1848	1978	1795	3262	3371	3698	3444
Pg_4- PG @ 500 kg ha^{-1} ½ as basal and ½ at flower initiation	1788	2162	2054	2001	3100	3775	3789	3555
Pg_5- PG @ 500 kg ha^{-1} at flower initiation	1908	2197	2303	2136	3411	3985	3706	3701
MEAN	1742	2081	2147	1990	3234	3719	3799	3584
Sub treatments at same level of main treatments								
SEm±				41				62
CD at 5 %				111				287
Main treatments at same level of sub treatments								
SEm±				36				90
CD at 5 %				116				270

increased number of filled pods, shelling percentage and 100 kernel weight.

The results of the experiment clearly suggest that phosphogypsum is also efficient in increasing the pod and yield of groundnut similar to that of gypsum. The higher pod and haulm yield with application of phosphogypsum @ 500 kg ha^{-1} might attributed for their favorable influence on yield and yield attributing characters (number of pods per plant, number of kernels pod^{-1}, 100 kernel weight). As phosphogypsum has relatively low solubility as compared to highly soluble S carriers, availability of S is made for a longer period. These results are in close conformity with the findings of Rout and Jena (2009).

The interaction effect between moisture regimes and phosphogypsum levels was significant and higher pod yield (23.03 q ha^{-1}) was observed with interaction effect of I_3Pg_5 (1.0 IW/CPE and phosphogypsum @ 500 kg ha^{-1} at flower initiation), which was on par with I_3Pg_1, I_2Pg_5, I_3Pg_2, I_2Pg_4, I_2Pg_1, I_3Pg_4, I_2Pg_2 respectively (Table 3). Lowest pod yield (15.6 q ha^{-1}) observed with interaction level of irrigation scheduled at 0.6 IW/CPE and phosphogypsum @ 250 kg ha^{-1} ½ as basal and ½ at flower initiation. The interaction effect between moisture regimes and phosphogypsum levels showed that significantly highest haulm yield obtained at interaction of I_2Pg_5 (0.8 IW/CPE and Phosphogypsum@ 500 kg ha^{-1} at flower initiation).

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Research Note
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DEVELOPMENT AND EVALUATION OF NUTRIENT RICH SNACK BARS FROM GRAIN AMARANTH

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A good nutrition bar has a balanced formula of nutrients viz., 10 to 15 g of protein, 20 to 30 g of carbohydrate and 5 to 7 g of fat. A nutrition bar attempts to provide nutritional benefit to the human body that is appealing and convenient as a food item. According to Donald and Kasarda (2000), amaranth grain contains more protein than wheat and also other gluten-free grain. One cup of raw amaranth contains 28.1 g of protein followed by Oats (26.3 g) and white rice (13.1g). Ljubica *et al*. (2009) reported that extruded amaranth grain products have specific aroma and can be used as snack food which can supplement as breakfast cereals, or raw material for further processing. It is also rich in iron, calcium, pantothenic acid and magnesium. It is also high in lysine which is a limiting amino acid in other cereals and millets. The ingradient Jaggery has magnesium which enhances the strength of nervous system and relaxes the muscles. It has anti allergy property and thus is useful to take care of asthma.(Source: www.clinivo.com). Sesame seeds protect our body from free radicals. Phytic acid present in these seeds inhibits colon cancer. Groundnuts are a good source of protein, calcium, phosphorus, iron, zinc and boron.

The study was conducted at Post Graduate Research Centre, Rajendranagar, Hyderabad. All the ingredients for preparation of the product were procured from the local super market.The amaranth seeds were popped by dry hot air popcorn popper at a temperature of 180°C. Acacia gum was powdered and then stored at room temperature. Sesame, tofu, pumpkin and groundnut seeds were coarsely powdered and mixed together. Jaggery was dissolved in hot water and strained. Powdered gum acacia was added to it and then cooked to a soft ball stage. The mixture along with popping amaranth seeds was added to the cooked syrup and mixed thoroughly. The mixture was poured on pre greased surface and rolled out. It was allowed to set and then cut into shape of bar of 3/4 cm thickness.

Fresh basic and experimental products were evaluated for their organoleptic properties and textural character. Sensory evaluation was done to assess the acceptability by a panel of 20 judges. A score card was prepared, keeping in view of the quality characteristics of the product under study. The various evaluation parameters studied were colour, appearance, texture, taste and overall acceptability.A Five point hedonic scale i.e. from 1-5 was prepared to rank each parameter with 5 point being assigned to the highly acceptable parameter. Standard AOAC (2005) procedures were followed to estimate the proximate composition of the developed products. Samples were analysed in triplicates for moisture, protein, fat, ash, iron and calcium contents. In addition, grain bar was microbiologically evaluated for TBC, and TMC count at 0 day, 15th day and 30th day using the procedures laid down by Cruikshank *et al*. (1975). The packaged products were stored at room temperature. Sensory evaluation was carried out for the stored products at 0day, 15th day and 30th day. A group of panel members consisting of 20 judges and students from the Dept of Food and Nutrition, College of Home Science, Hyderabad. Evaluated the fresh products and stored products using the ANOVA and t-test. The results obtained for assessing various nutrient status components are presented in Table 1.

From Table1 it can be concluded that the moisture content of basic bar was found to be 3.8 %. On the other hand, it was 4.1% for the experimental bar. A significant increase in the moisture was found in the sample of experimental bar prepared from popped amaranth seeds which may be due the internal moisture being made free as a result of grain during popping. The protein content was found to be 9.70g in basic bar and 10.3g in the experimental bars respectively. An increase to the extent of 0.6gm in the experimental bars by addition of sesame seeds, pumpkin seeds, ground nuts and tofu. The fat content of basic bar was found to be 2.6 g, where as for experimental bar, it was found to be 2.8 g . The obtained fat content values are less compared to other studies, due to the difference of grain and the ingredients used. The ash content of the basic bar was found to be 2.2 g, where as in the experimental

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bar, it was found to be 2.28 g respectively which higher. The calcium content in basic bar was found to be 472.2 mg, where as in the experimental bar, it was 473.09 mg. The iron content in basic bar was found to be 11.5 mg, where as in the experimental bar, it was 16.35mg.

and overall acceptability of both the basic and experimental bars during the entire storage period. The interaction between treatments and packaging material was found to be non-significant ($p>0.05$) during storage period on overall acceptability of grain bars. Microbial analysis indicated that TBC, TMC and mould count in the fresh bars was 10cfu / g for the

Table1. Results of proximate analysis of the snack bars (per 100 g of product)

Variable	Basic	Experimental	T-value
Moisture(gm)	3.8±1.7	4.1±5.77	12.18261**
Protein(gm)	9.70±.10	10.27±.01	14.46303**
Fat(gm)	2.6±1.3	2.8±.12	2.750034*
Energy (k cal)	340.6*	341.2*	
Crude fibre(gm)	5.7*	5.3*	0.6181846
Ash(gm)	2.21±.3	2.8±.12	
Calcium(mg)	472.24±.14	473.09±.44	4.770438**
Iron(mg)	11.28±.28	16.35±.31	31.6416**
Values are significant at CD>5%*(2.179)			
Values at significant CD>1%** (3.055)			

The scores for colour of the bars ranged from 3.5 to 4.5 and texture 3.2 to 4.2 respectively on hedonic scales. The scores for flavour, taste, and overall acceptability ranged from 2.4 to 4.3, 2.7 to 4.5 and 3.9 to 4.9. All the parameters were highly rated by all the panellists for experimental bars than control bars. The experimental bar was best accepted with highest total mean score ($p>0.05$) There was no significant change in taste, texture, colour, flavour basic product where as the experimental bars these counts were below detectable levels (BDL).

It could be concluded from study that the prepared snack grain bar made from amaranth seed is nutritious, gives instant energy and especially useful to eradicate anaemia problem prevailed in lactating woman.

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INFLUENCE OF INTEGRATED NITROGEN MANAGEMENT ON YIELD COMPONENTS AND YIELD OF SCENTED RICE (*Oryza sativa* L.)

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Rice (*Oryza sativa* L.) stands second in the world after wheat in area and production. It occupies an area of 157.4 m. ha with an annual production of 470.7 MT and a productivity of 4390 kg ha^{-1} in the world. Scented rice has occupied a prime position in Indian society not only because of its high quality, but also because it has been considered auspicious. The basmati type is accepted as the best scented, longest and slender rice in the world and the Indian subcontinent continues to be its home land. Both India and Pakistan have monopoly over its production and marketing in the world. Although scented rice which is popular in world market is long grained, majority of the Indian indigenous scented rice are small and medium-grained. Scented rice constitutes a small but an important sub-group of rice. These are rated best in quality and fetch much higher price than high quality non-scented rice in international market.

The concept of integrated nutrient management seeks to sustain soil fertility through an integration of different nutrient sources (Bahadur *et al.,* 2013). It provides immense opportunity in scented rice in improving grain quality and yield by supplying appropriate nutrient content at right time. Therefore, the present research was conducted to study the influence of combined application of organic manures and two different levels of nitrogen fertilizer on yield and yield components of scented rice.

A field experiment was conducted during *kharif* 2012 at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The experiment was conducted on sandy clay loam soil.

Treatments consisted of control plot (without fertilizers), Recommended dose of Nitrogen (120 kg N ha^{-1}), higher nitrogen level (180 kg N ha^{-1}), combination of RDN/higher N level with farm yard manure (10 t ha^{-1}), vermicompost (2.5 t ha^{-1}), *in-situ* green manure (Dhaincha) and complete organic treatment with farm yard manure + vermicompost + *in-situ* green manuring with (Dhaincha).In all there were 10 treatments which were replicated thrice. The trial was conducted in randomized block design.

The data pertaining to yield attributes as influenced by nutrient management practices is presented in Table1.Each higher level of nitrogen (180 kg N ha^{-1}) and its combination with organic manures significantly increased the panicles m^{-2}, panicle length (cm), filled grains per panicle over lower level of N (120 kg ha^{-1}) and its combination with organic manures as well as compared to complete organic treatment. Among the different combinations, application of 180 kg N ha^{-1} along with *in-situ* green manuring gave higher number of panicles m^{-2} (321 m^{-2}) coupled with more length (21 cm) and higher number of filled grains (139) per panicle over other treatments involving RDN (120 kg ha^{-1}) alone and its combination with farm yard manure/vermi compost, complete organic treatment and control plot. However, it was found on par with that of 180 kg N ha^{-1} alone and its combination with farm yard manure, vermicompost and also with that of conjunctive use of 120 kg N ha^{-1} through urea with *in-situ* green manure dhaincha. The control plot recorded least number of panicles m^{-2} (221 m^{-2}), with smaller panicle length (17.5 cm) and less number of filled grains (74.0). This supports the fact that optimum nitrogen supply is crucial for more tiller production and survival. This supports the fact that optimum nitrogen supply is crucial for more tiller production and survival. For optimum tillering, the nitrogen content in the leaves must be around or above 4 per cent. Higher nitrogen supply with these treatments might have met the nitrogen requirement for the growth and survival of tillers thus more effective tillers were observed at higher nitrogen dose of 180 kg ha^{-1} as urea alone and in combination with *In-situ* green manure. These results are in line with the observations of Kumari *et al.* (2010) and Bahadur *et al.* (2013). Further, the increase in the length of panicle at higher level of nitrogen might be due to better nutrition of panicle primordia. These results are in

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confirmation with those of Bhowmick *et al.*(2011).The influence of different treatments of organic, inorganic alone and their combinations on 1000 grain weight (g) was not significant. Lowest test weight (g) was recorded with control plot (11.0 g).These results are in confirmation with the observations of Saha *et al.* (2007) and Singh *et al.* (2010).

The scented rice responded significantly to different nutrient management practices tested in present study (Table 2).Between the two nitrogen levels, significantly higher grain (4885 kg ha^{-1}) yield is recorded with the application of higher N level (180 kg ha^{-1}) compared to that of 120 kg N ha^{-1} through urea (4233 kg ha^{-1}).The conjunctive use of different organic manures (farm yard manure/vermi compost/ *in-situ* green manuring with dhaincha) with these two levels of N through urea showed that integrated use of green manuring only at 120 kg N ha^{-1} as urea improved grain yield (5055 kg ha^{-1}) over its sole

Table 1. Effect of different combinations of fertilizer rates and organic manures on yield attributes

Treatments	Panicles m^{-2}	Panicle length (cm)	Filled grains $panicle^{-1}$	Unfilled grains $panicle^{-1}$	Test weight(g)
Control	221.0	17.5	74.0	21.3	11.0
120-60-60 kg NPK ha^{-1}	278.0	20.0	107.0	14.0	11.2
180-60-60 kg NPK ha^{-1}	309.0	20.6	130.0	14.3	11.5
120-60-60 kg NPK ha^{-1} + FYM (10 t ha^{-1})	279.0	20.0	107.0	13.3	11.3
120-60-60 kg NPK ha-1 + V.C (2.5 t ha-1)	281.0	20.1	110.0	13.0	11.3
120-60-60 kg NPK ha-1 + in-situ G.M (Dhaincha)	307.0	20.3	129.0	13.3	11.4
T7-180-60-60 kg NPK ha-1 + FYM (10 t ha-1)	314.0	20.6	132.0	14.0	11.5
180-60-60 kg NPK ha-1 + V.C (2.5 t ha-1)	316.0	20.8	136.0	14.0	11.5
180-60-60 kg NPK ha-1 + in-situ G.M (Dhaincha)	321.0	21.0	139.0	14.0	11.7
In-situ G.M +FYM (10 t ha-1) + V.C (2.5 t ha-1)	250.0	18.8	90.0	18.3	11.1
S.Em ±	8.4	0.3	3.9	0.4	0.3
CD at 5%	25.1	1.0	11.6	1.3	NS

application (4233 kg ha^{-1}) and also it was found at a par to that of 180 kg N ha^{-1} through urea (4885 kg ha^{-1}) and its combination with dhaincha green manuring (5237 kg ha^{-1}). Lowest grain yield (2304 kg ha^{-1}) was recorded with control plot. The complete organic treatment (3241 kg ha^{-1}) was found inferior to all other treatments except control plot. Among the different sources of organics, dhaincha proved superior, perhaps because of its fast decomposition and solubilizing effect on native soil nutrients which led to better availability of nutrients besides improving the soil environment. Besides N, dhaincha adds appreciable amount of P, K, Ca, Mg, S and micro nutrients to the soil. Availability of nitrogen due to application of inorganics alone could be for a shorter period as mineralization of nitrogen was more rapid and in turn the losses of inorganic nitrogen due to volatilization and leaching etc., would be more. In

case of organic manures (farm yard manure. green manure and poultry manure), the rate of decomposition, C : N ratio and amount of organic material will decide availability of nitrogen to plants (Singh, 2006). Earlier results of long term fertility management at Maruteru indicated a significant improvement in grain yield due to combined application of organic and inorganic treatments. The

Table 2. Effect of different combinations of fertilizer rates and organic manures on yield

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index(%)
Control	2304	3005	43.3
120-60-60 kg NPK ha^{-1}	4233	4875	46.4
180-60-60 kg NPK ha^{-1}	4885	6107	44.4
120-60-60 kg NPK ha^{-1} + FYM (10 t ha^{-1})	4411	4910	47.3
120-60-60 kg NPK ha^{-1} + V.C (2.5 t ha^{-1})	4597	4930	48.2
120-60-60 kg NPK ha^{-1} +In-situ G.M (Dhaincha)	5055	5300	48.8
180-60-60 kg NPK ha^{-1} + FYM (10 t ha^{-1})	5094	6277	44.7
180-60-60 kg NPK ha^{-1} + V.C (2.5 t ha^{-1})	5145	6358	44.7
180-60-60 kg NPK ha^{-1} + In-situ G.M(Dhaincha)	5237	6456	44.7
In-situ G.M +FYM (10 t ha^{-1}) + V.C (2.5 t ha^{-1})	3241	3700	46.6
S.Em ±	135	228	0.12
CD at 5%	403	679	0.36

efficiency of inorganic fertilizers might have also been increased when it was applied along with organic manures and brought a beneficial effect on rice grain yield due to increase in productive tillers per square meter as reported by Srinivas *et al.* (2010).The straw yield of scented rice as was also influenced by different treatments. Application of higher level of nitrogen (180 kg N ha^{-1}) through urea alone (6107 kg ha^{-1}) and its combination with organic manures such as farm yard manure (6277 kg ha^{-1}), vermi compost (6358 kg ha^{-1}), *in-situ* green manure (6456 kg ha^{-1}) recorded higher straw yield over application of nitrogen @ 120 kg N ha^{-1} through chemical fertilizer alone (4875 kg ha^{-1}) and its combination with organic manures, complete organic treatment (3700 kg ha^{-1}) and control plot (3005 kg ha^{-1}). Among all treatments significantly higher straw yield was recorded with 180

kg N ha^{-1} through urea in combination with *in-situ* green manure (6456 kg ha^{-1}) fallowed by integrated use with farm yard manure (6277 kg ha^{-1})/ vermi compost (6358 kg ha^{-1}) over all other treatments. This was in agreement with findings of Chaudhary *et al*. (2011) and Bahadur *et al*. (2013).

From the results, it can be concluded that application of 180 kg N ha^{-1} as urea + *in-situ* green manuring to scented rice resulted in better yield components, grain yield (5237 kg ha^{-1}) and straw yield (6456 kg ha^{-1}) compared to lower nitrogen level (120 kg N ha^{-1} as urea) and its combination with organic manures except green manure (5055, 5300 kg ha^{-1}).

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IDENTIFICATION OF SPECIFIC MOLECULAR Id's AMONG ADVANCED BREEDING LINES OF RICE (*Oryza sativa* L.) VARIETY- SAMBA MAHSURI

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Rice (*Oryza sativa* L.) is a staple food crop for billions of people living in Asia accounting for 21%, 14% and 21% of global energy, protein and fat supply, respectively (Kennedy and Burlingame,2003). The use of rice genetic resources available at gene banks is an important task, especially for incorporating genetic variability/desired genes into rice crop, which can potentially generate new cultivars with broadened genetic base and allows new and useful allelic combinations (McCouch, 2005).

Advanced breeding lines(pre released) include homozygous lines, mutant lines, lines derived from biotechnology programmes contains valuable gene combinations. These lines serve as an important source of genetic variation mostly in breeding for high yielding rice varieties and hybrids. With this background, molecular studies were conducted to assess the genetic diversity and identify the special molecular Id's among 42 advanced breeding lines (mutant lines-derived from sambamahsuri variety in M_4 generation, which showed tolerance to Yellow Stem Borer(YSB).The screening of microsatellite alleles in some potential breeding lines would generate a database which would be useful for further work.

Compared to morphological analysis, molecular markers can reveal differences among accessions at the DNA level, thus, provide a more direct and reliable information for germplasm conservation and management. Among several markers available for evaluating the extent of genetic variation in rice, SSR or microsatellites are co-dominant markers, their map positions on the rice genome are well known, and PCR-based markers that are both technically efficient and cost-effective to use (Chen *et al*., 1997 and Temnykh *et al*., 2001).

Fourty-two advanced generation breeding lines of M_4 generation of sambamahsuri, a popular grain quality(variety) were collected from Directorate of Rice research (DRR), Hyderabad. Sixty microsatellites(5 markers per chromosomes)dispersed throughout the 12 chromosomes were employed to assess the genetic diversity.

The genomic DNA from leaf samples were isolated using the procedure developed by Zheng *et al.,* (1991) with minor modifications and quantity of DNA was estimated using gel electrophoresis. Genomic DNA samples were diluted according to the band concentration with 10 µl stock DNA and 90µl Sterile distilled water (SDW) and subject ted to polymerase chain reaction (PCR).The PCR was conducted in a total reaction of 10 µl per sample. It contained SDW(5.3 µl), 10X reaction buffer (1µl), dNTPs (1µl),forward microsatellite primer(0.3µl), reverse microsatellite primer(0.3µl),Taq polymerase (0.1 µl) and genomic DNA(2 µl).This reaction mixture was processed in programmable Thermal Cycler, programmed for 35 cycles, initial denaturation for 5 min at 94^{0}C, denaturation for 30 sec at 94^{0}C, annealing temperature, 30 sec at 55^{0}C, extension for 1 min at 72 ^{0}C, final extension for 7 min at 72.After amplification, the amplified products were mixed with 1/6th volume of fel loading dye (40% sucrose; 0.25% Bromophenol blue) and loaded onto each well of 3% agarose (3gms of agarose dissolved in 0.5XTBE buffer) gel and run at a constant voltage of 90 volts for 3 hrs. The The gel was documented in the UV-transilluminator ALPHA IMAGER gel documentation system.

The amplified DNA fragments were scored manually by binary data matrix with '1' indicating the presence of the band and '0' indicating the absence of the band. The data was entered into a binary matrix and analysis was done using the software NTSYSpc version 2.02(Rohlf, 1998).Cluster analysis was done using Sequential Agglomerative Hierarchical Non-

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overlapping (SAHN) clustering was performed on Squared Euclidean distance matrix and similarity matrix using Jacquard's coefficient utilizing the Unweighted Pair Group Method with Arithmetic Averages (UPGMA) method.

In the present study, a total of 60 SSR markers (5 markers per chromosomes) were selected to assess the extent of genetic diversity across 42 mutant lines of sambhamahsuri (M_4 generation). Of

Table 1. Allelic variation and PIC values for 21 polymorphic SSR loci Identified among 42 advanced breeding lines

S.No	Chromosome No	Name of primers	No. of Alleles	PIC values	Repeat motives
1	1	RM10038	2	0.7	(TA)12
2	1	RM 562	2	0.565	(AAG)13
3	2	RM485	2	0.622	(TA)18
4	2	RM166	2	0.68	(T)12
5	3	RM218	2	0.605	(TC)24ACT5(GT)11
6	3	RM15630	2	0.671	(GA)55
7	4	RM6487	2	0.682	(GCG)8
8	4	RM1359	2	0.565	(AG)25
9	5	RM480	2	0.685	(AC)30
10	6	RM19350	2	0.79	(AT)12
11	7	RM21539	2	0.625	(ATT)32
12	7	RM22131	2	0.73	-
13	8	RM38	2	0.679	(GA)16
14	10	RM6404	2	0.765	(GAG)8
15	10	RM2504	2	0.795	(AT)28
16	11	RM286	2	0.566	(GA)16
17	11	RM26213	3	0.816	(TA)46
18	11	RM26998	3	0.811	(TC)12
19	12	RM27406	2	0.585	-
20	12	RM101	2	0.805	(CT)37
21	12	RM28424	2	0.684	(ATA)34

the 60 SSR markers, 21 were found to be polymorphic with control viz., BPT 5204, 9 were not amplified and rest were monomorphic. A total of 44 alleles were detected across 42 lines of sambhamahsuri. The number of alleles generated per locus by each marker ranged from 2 to 3 (Table 1) within an average of 2.09. This was comparable to the report of Prabakaran *et al.,* 2010 for genetic divergence of rice land races where in they reported average alleles of 2.2 per locus. The results obtained in present study were lower than the observations made by Shah *et al.,* 2013 for average number of alleles detected were 2.75 in diversity within the aromatic and non-aromatic rice varieties respectively. However, in the present study , less no. of alleles were detected since the works was carried among the EMS mutants of sambamahsuri, where the variations are expected in the small regions of the genome as EMS generally generate point mutations.

Polymorphism Information Content(PIC) value is the reflection of allelic diversity and frequency among the varieties or lines. To measure the informativeness of each SSR marker, PIC values were calculated. In the present study, PIC values varied widely among SSR loci tested and it ranged from 0.565 (RM562 of chromosome 1) to 0.81 6(RM 26213 of chromosome 11), with an average of 0.685 per marker. This value of average PIC per marker corresponds well with the average PIC Value of 0.68 reported by Lapitan *et al*.(2007) who studied the genetic diversity of Philipine rice cultivars using SSR markers.

The Cluster Analysis performed by using UPGMA based on similarity co-efficient values. It resolved 42 mutant lines into two major clusters with 37% dissimilarity. While cluster-I was major cluster with 41 lines and it was divided into two sub clusters i.e IA and IB and they showed 35% dissimilarity. Cluster II consisted of only one breeding line (Table 2).Cluster IA was a major subcluster which had 40 lines, where as subluster IB consisted of only one breeding line. For clarity, again divided the Cluster-IA into two subclusters *viz* I-AB and I-AC and they showed 26% dissimilarity. The subcluster I-AB comprised of 32 lines where as I-AC comprised of 8 lines only. This analysis revaled that most of the mutant lines (32 lines) might have maximum no.of shared mutant loci, Where as 8 lines might have mutations othere than those loci. However, these 8 lines have some common mutationa loci, so they clustered in one group. But the one line (SM-911) did not grouped with them must be having mutations at serval loci, which is need to verify with the phenotype. Upadhyay *et al*.(2011) had reported clustering of 29 rice genotypes in to major clusters while studying the development of molecular tags for rice lines.

The banding pattern which was distinct, unique and less frequent at a particular base pair by a particular marker from the control and rest of the lines was considered as specific bands (Fig 1). In the present study, out of 21 polymorphic markers, 4 SSR markers *viz.,* RM485 on chromosome 2, RM6487 and RM1359 on chromosome 4 and RM26998 on chromosome 11 were identified as specific markers (Table 3). Similar results were reported by Upadhyay *et al.,* 2011, where 14 genotypes produced specific alleles out of 29 genotypes with 12 SSR markers. Specific markers(Molecular Ids) identified in present study will also be used for particular mutants. The loci which undergone mutations in particular mutants needs to be associated with morphological characters like resistance reaction to Yellow Stem Borer(YSB) to

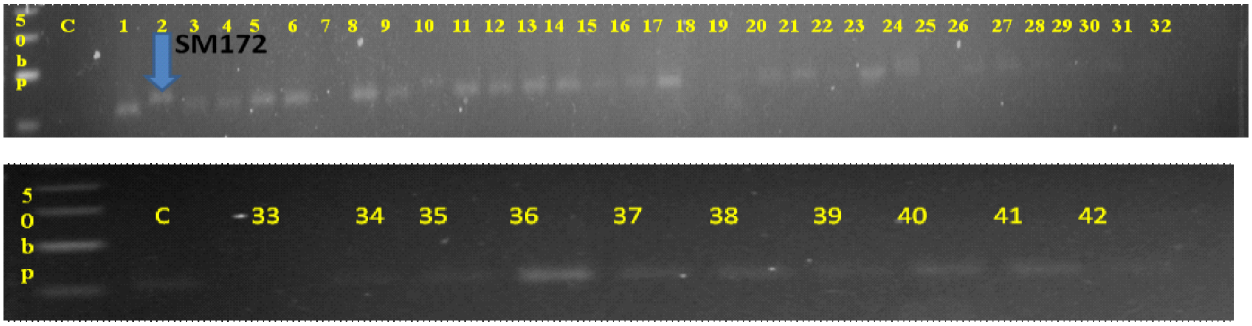
Table 2. Distribution of 42 advanced breeding lines of samba mahsuri into different clusters

Cluster	Number	Genotypes
I	41	SM-50-11, SM-172, SM-223, SM-267, SM-615, SM-639, SM-647, SM-655, SM-684, SM-691, SM-698, SM-700, SM-702, SM-703, SM-706, SM-713, SM-827, SM-834(UK), SM 834, SM-836, SM-838, SM-839, SM-846, SM-848, SM-849, SM-850, SM-858, SM-869, SM-870, SM-871-9, SM-871, SM-876, SM-921, SM-925, SM-927, SM-928, SM-931, SM-932A, SM-932B, SM-933 and SM-1036.
II	1	SM-911

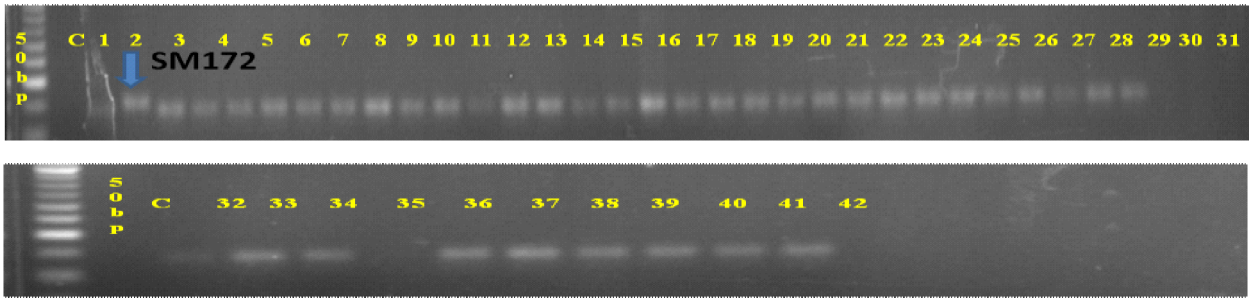
know clearly which loci corresponds to the altered phenotype. The hypothesis of EMS mutation which causes the point mutation in the genome was verified and evidenced from this study.

Fig 1. Gel Pictures of allele specific makers

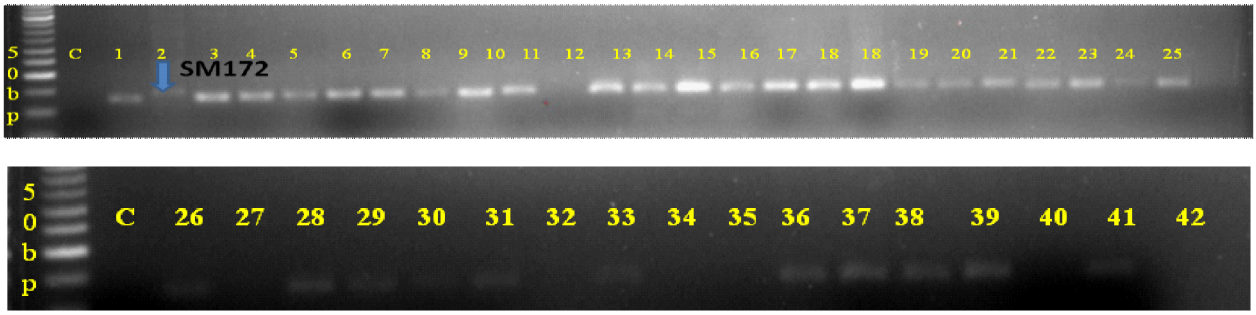
RM 485



RM 1359



RM 6487



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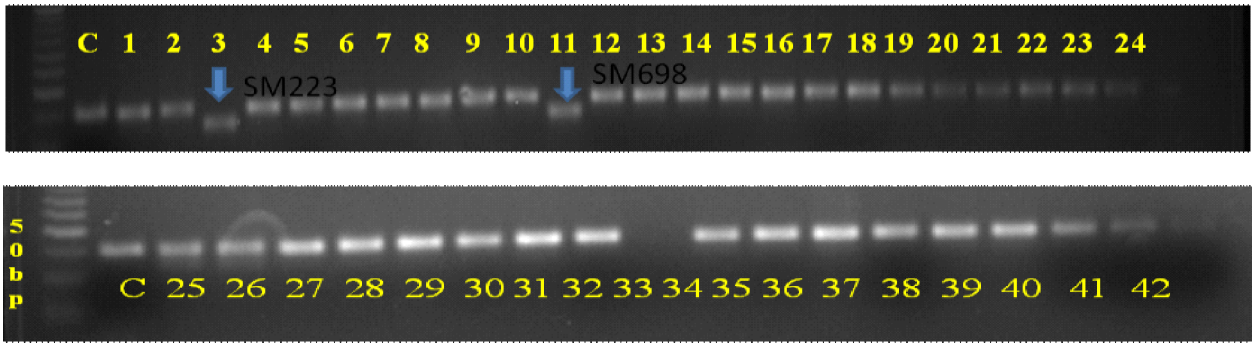

Table 3. Specific markers (Molecular Ids) identified among Advanced breeding lines

S.No	Chromosome No	Markers	Advanced breeding lines	Base pair (bp)
1	2	RM485	SM 172	110
2	4	RM6487	SM 172	150
3	4	RM1359	SM 172	155
4	11	RM26998	SM 223 and SM 698.	125

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Research Note
The J. Res. ANGRAU 42(2) 74-76, 2014

RESPONSE OF SAFFLOWER (*Carthamus tinctorius* L.) VARIETIES TO DIFFERENT NITROGEN LEVELS IN CALCAREOUS VERTISOLS

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Safflower (*Carthamus tinctorius* L.) is an important *rabi* oilseed crop. Safflower yields about 32-40% seed oil. Safflower oil is rich in polyunsaturated fatty acids which helps in reducing blood cholesterol. India is the largest producer of safflower in the world, with a cultivated area of 178.4 lakh ha, a total production of 145.3 lakh tons and an average productivity of 498 kg/ha. Accelerated production is possible mainly by the use of appropriate cultivars, in addition to the other management practices. Seed is one of the least expensive but most important factor influencing yield potential since seeds contain all the genetic information to determine yield potential, adaptation to environmental conditions, and resistance to insect pests and disease. Nitrogen need of safflower depends on the adequate nitrogen in the soil, soil productivity and preceding crop (Armah-Agyeman *et al.,* 2002; Siddiqui and Oad, 2006). The present study was under taken to find out suitable safflower variety for growing in calcareous vertisols and understand the variation in response to nitrogen by different varieties.

Field experiment was conducted during *Rabi* 2012 at Regional Agricultural Research Station, Nandyal. The soil was clayey in texture, slightly alkaline in reaction (pH 8.6) and low in available nitrogen (159 kg/ha), high in available phosphorus (46 kg P_2O_5/ha) and medium in available potassium status (223 kg K_2O/ha). The calcium content of the soil is 15 meq/100 g of soil and the average calcium carbonate content of the soil is 5-10%.The experiment was laid out in a randomized block design with factorial concept and replicated thrice. The treatments consisted of three varieties/hybrids (Manjira, TSF-1, NARI-6) and four nitrogen levels (0, 20, 40, 60 kg/ha). The size of the gross plot was 5.4m x 4.2 m and net plot was 3.6m x 4.8 m. Nitrogen fertilizers were applied as per treatments. The recommended dose of phosphorus (20 kg P_2O_5) was given as basal along with 50% of N, while the remaining half of N was applied at 35 DAS. Observations on plant height, number of branches per plant, number of capitulam per plant, number of seeds per capitulam, 1000 seed weight (gm) and yield (kg/ha) were recorded. Data was analysed statistically as suggested by Panse and Sukhatme(1978).

Growth and yield attributing parameters

Plant height was highest with NARI-6 but was at par with TSF-1 and significantly lowest with Manjira. Increase in nitrogen level augmented the plant height significantly up to 20kg of N/ha dose and further increase in N levels did not influence the plant height significantly (Table1).Significantly higher number of branches/plant were recorded with NARI-6 followed by Manjira and lowest was with TSF-1. Number of branches/plant was non significant with N levels. Higher number of capitulam/plant was recorded with Manjira (32.2) compared to NARI-6(28.1) and TSF-1(23.1).Application of N at 60 kg/ha produced significantly higher number of capitulam/ plant (31.8) compared to 20kg N/ha (27.9) and control (21.1). Nitrogen directly involves in imparting improved concentration of chlorophyll which is essential for harnessing solar radiation for photosynthesis activity and to carryout essential plant functions including nutrient uptake. Better nutrient uptake of the crop might have resulted into good yield attributes. Singh *et al.* (1992) also reported significant increase in number of capitulam/plant with increasing doses of nitrogen.

Number of seeds/capitulam was highest (23.0) with NARI-6 but was at par with TSF-1 while, the lowest was with Manjira (14.1). With increase in levels of N from 0 to 60 kg/ha number of seeds/ capitulam was increased. However, application of 60

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kg N/ha was at par with 40 kg N/ha which was in turn at par with 20 kg N/ha.Significantly higher test weight was recorded with TSF-1 and with increase in N levels, test weight of seed also increased significantly recording significantly highest with N at 60 kg/ha and lowest 0 kg N/ha. Application of nitrogen might have increased the protein percentage which inturn increased the seed weight.

Yield and Economics

Varieties and N levels exerted significant effect on safflower yield. Among the varieties, TSF-1 produced higher seed yield (1452 kg/ha) but was at par with NARI-6 (1277kg/ha) which was in turn at par with Manjira (1228 kg/ha) (Table 2). Increase in N fertilization from 0 to 60 kg/ha increased the safflower yield significantly irrespective of varieties, highest being with 60 kg N/ha but was at par with 40 kg N/ha. Increased availability of nutrients resulting in better growth of crop might be the reason for higher seed yield at 60 kg N/ha. Higher number of capitulam/plant and increase in test weight of seed due to adequate N nutrition is explainable in terms of possible increase in nutrient mining capacity of plant as a result of better root development and increased translocation of carbohydrates from source to growing points in well-fertilized plots, which finally resulted in to higher yields. The results corroborates with the findings of Das and Ghosh (1993). Interaction effect of TSF-1 with 60 kg of N/ha recorded the highest yield but was at par with 40 kg of N/ha, while significantly lower yield was recorded with Manjira with no fertilization.

Safflower variety TSF-1 produced higher gross (Rs 36812/-) and net returns (Rs 24562/-) followed by NARI-6 with gross (Rs 32373/-) and net returns (Rs 20123/-) per ha respectively, while the lower with Manjira. As regards to N levels, increase in N level from 0 to 60 kg/ha increased the gross and net returns irrespective of the varieties and the highest being with 60 kg N/ha. Interaction between TSF-1 and 60kg/ha of nitrogen application produced the highest gross and net returns. B: C ratio followed the same trend as that of gross and net returns. Kulekci *et al*., (2009) reported that 60 kg of N/ha was optimum and economic dose for higher seed yield, gross returns, net returns and B: C ratio.

Table 1. Yield attributes and yield (kg/ha)of safflower as influenced by varieties and nitrogen levels

Treatments	Plant height (cm)	No. of branches /plant	No. of capitulam/ plant	No. of seeds/ capitulam	1000 seed wt.(gm)
Dates of Sowing					
Manjira	58.5	12.3	32.2	14.1	35.4
TSF-1	75.7	8.9	23.1	20.8	39.3
NARI-6	81.8	14.8	28.1	23.0	35.0
SEm±	2.3	0.57	0.94	0.89	0.93
CD at 5%	6.7	1.7	2.7	2.6	2.7
N Levels (kg/ha)					
0	67.0	10.3	21.1	16.1	29.4
20	72.6	12.0	27.9	18.6	34.2
40	73.0	12.9	30.4	19.9	38.0
60	75.4	12.7	31.8	22.5	44.6
SEm±	2.6	0.66	1.09	1.03	1.07
CD at 5 %	7.7	1.9	3.2	3..0	3.6
Dates of Sowing X Nitrogen Levels					
SEm±	4.6	1.15	1.89	1.79	1.86
CD at 5%	13.5	3.3	5.5	5.2	N.S

Table 2. Yield and Economics of safflower as influenced by varieties and nitrogen levels

Treatments	Seed yield (kg/ha)	Gross Returns (Rs/ha)	Net Returns (Rs/ha)	B:C Ratio
Varieties				
Manjira	1228	31138	18888	2.5
TSF-1	1452	36812	24562	3.0
NARI-6	1277	32373	20123	2.6
SEm±	61.6	-	-	-
CD at 5%	180	-	-	-
N Levels (kg/ha)				
0	1130	28633	17133	2.5
20	1238	31374	19374	2.6
40	1434	36339	23839	2.9
60	1476	37416	24416	2.9
SEm±	71.1	-	-	-
CD at 5 %	208	-	-	-
Varieties X Nitrogen Levels				
SEm±	123.2	-	-	-
CD at 5%	361	-	-	-

The present study suggests that safflower hybrid TSF-1 could be grown profitably on rain fed vertisols with 40 kg of N /ha for realizing higher seed yield and remunerative returns.

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