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PRODUCTIVITY ENHANCEMENT OF SAFFLOWER (*Carthamus tinctorius* L.) THROUGH IMPROVED CROP VARIETIES

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ABSTRACT

Front line demonstrations were conducted in 80 farmers fields to demonstrate production potential of and economic benefits of improved technologies comprising high yielding fusaruim and aphid resistant variety (TSF-1) in Ranga Reddy district of Southern Telangana during *rabi* 2010-2011, 2011-12, 2012-13 and 2013-14 under residual soil moisture conditions The additional yield under improved technologies over local practice ranged from 221 to 279 kg/ha with a mean yield of 255 kg/ha. In comparison to local practice, there was an increase of 27% during 2010-11(TSF-1), 24% during 2011-12 (Manjira), 33% during 2012-13(Annegeri-1) and 34% during 2013-14 (TSF-1). The improved varieties also resulted in higher benefit cost: ratio of 1.26 to 1.51 with TSF-1 compared to 0.74 to 1.09 for local check.

Safflower (*kusum /kardi*) has been under cultivation in India for its brilliantly coloured florets and the orange red dye (carthamin) extracted from them and seed. The seed contains 24-36% oil. The cold pressed oil is golden yellow and is largely used for cooking purposes. The oil is as good as sunflower oil having enough amount of linoleic acid (78%), which is very useful for reducing blood cholesterol content. The unsaturated fatty acids of safflower lower the serum cholesterol. It is cultivated in countries like USA, Mexico, Aregentina and China. India occupies first position in cultivation of safflower area. In India It is cultivated in an area of 2.41 lakh ha with a production of 1.21 lakh tones and productivity of 498 kg ha^{-1} (DOR 2013). Though two-fold increase in the productivity of safflower was witnessed in the last three decades the present productivity of 498 kg ha^{-1} is still very low as compared to the production potentials of improved safflower production technologies/demonstrations under real farm situations.

Safflower is an important winter season oilseed crop grown in Telangana, Maharashtra and Karnataka. In Telangana its cultivation is mainly confined to Ranga Reddy, Mahabubnagar, Adilabad, Nizamabad, while in Andhra Pradesh it is cultivated in Anantapur and Kurnool. In general, average productivity of safflower continues to be lower (650 kg ha^{-1}) than expected from improved technology from the last ten years, mainly due to its cultivation on residual soil moisture as fallow crop or contingent oilseed crop. The major constraints responsible for lower yield are namely Fusarium wilt, aphids and low safflower oil content. The yield of safflower can be increased by using fusarium wilt, aphid resistant varieties. Keeping this in view, Front Line Demonstrations on safflower were conducted to demonstrate the production potential and economic benefits of improved technologies in farmers fields with three improved varieties *viz.,* TSF-1 and Annegeri-1 and local check.

MATERIAL AND METHODS

Eighty (80) Front Line Demonstrations were organized on an area of 0.4 ha and adjacent to the farmers field in which the crop was cultivated farmers variety was also raised. The beneficiaries were selected in five mandals *viz.,*Tandur, Yalal, Peddemul, Basheerabad and Vikarabad of Ranga Reddy district in Southern Telangana zone during *rabi* season of 2010-11, 2012-12, 2012-13 and 2013-14. The crop was raised under rainfed conditions in medium black soils with low to medium fertility status under safflower sole cropping systems. The package of practices consists of seed treatment, optimum plant population (1,11,111 lakhs ha^{-1}), the improved breeder seed (10 kg ha^{-1}) fusarium wilt and aphid resistant variety TSF-1 (Tandur tellakusuma), along with Manjira and Annegeri-1 were distributed in the demonstration. The spacing followed was 45 cm x 20 cm. entire dose of N, P and K through Diammonium Phosphate,

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Urea and Muriate of Potash @ 40:20:30 kg ha^{-1} respectively was applied as basal before sowing. The seeds were treated with bavistin @3g kg^{-1} of seed. The crop was sown during 2nd fortnight of October to 1st week of November. Hand weeding was carried out at 25 days after sowing. Intercultivation with bullock drawn guntaka was done at 15 days interval until 60 days after emergence. The first intercultivation was done at 30 days after sowing. Need based plnat protection measures were carried out for controlling sucking pest aphid by spraying dimethoate 2ml/litre twice at branching and at flowering bud stage. When the crop attained physiological maturity stage, the crop was harvested manually and threshed by beating with sticks, winnowed, cleaned the seed and recorded the seed yield data (kg ha^{-1}).

RESULTS AND DISCUSSION

Effect of Weather

A total rainfall of 1360.9 mm, 664.7 mm, 799 mm, and 822.2 mm was received in 58, 46, 72 and 67 rainy days during 2010-11, 2011-12, 2012-13 and 2013-14 respectively. There was normal receipt of rain during the years; however a rainfall of 132 mm was received in ten rainy days during the first fortnight of October and later 23 mm was received during the month of November during 2013-14. This caused unusual delay of sowing in some of the farmers fields during October thereby resulted in poor yields as compared to the years of low rainfall. Excessive rainfall or humidity increased the infestation of fungal diseases in safflower crop. Waterlogging due to poor drainage in the farmers fields at seed formation recorded substantial reduction in yield during the year 2012-13 and 2013-14 *rabi* season.

Yield

The productivity of safflower in Ranga Reddy district under improved production technologies ranged from1251 to 1432 kg ha^{-1} with a mean yield of 1141 kg ha^{-1}. The productivity under the improved technologies varied from 1020 to 1432 kg ha^{-1}, during 2010-11 for the variety TSF-1, 1030 to 1282 kg ha^{-1}, during 2011-12 for the variety Manjira, 952 to 1312 kg ha^{-1} during 2012-13for the variety Annegeri-1 and 942 to 1251 kg ha^{-1}, during 2013-14 for the variety TSF-1 (Table 1) as against the yield range between 821 to 971 with a mean yield of 896 kg/ha under farmers local practice of this variety. The additional yield under improved technologies over local practice ranged from 221 to 279 kg ha^{-1} with a mean yield of 255 kg ha^{-1}. In comparison to local practice, there was an increase of 27% during 2010-11(TSF-1), 24% during 2011-12 (Manjira), 33% during 2012-13(Annegeri-1) and 34% during 2013-14 (TSF-1) in production of safflower under improved technologies in respective years for the varieties Manjira, Annegeri-1 and TSF-1. This increased grain yield with improved technologies was mainly because of inherent potential of the resistant varieties along with seed treatment and maintaining optimum plant population. Venkattakumar *et al.* (2009) also reported that improved technologies demonstrated through frontline demonstrations resulted in seed yield increase ranging from 19 to 50%. Sreelakshmi *et al.* (2012) also reported that the yield increase under improved varieties with pigeonpea ranged from 36 to 60.7%.

Table 1. Yield of safflower as influenced by improved varieties and local practices

Year	Variety	Yield in kg ha^{-1}				Additional yield over local check kg ha^{-1}	% increase in yield over local check
		Local check	Max	Min	Average		
2010-11	TSF-1	971	1432	1020	1226	255	27
2011-12	Manjira	935	1282	1030	1156	221	24
2012-13	Annegeri-1	853	1312	952	1132	279	33
2013-14	TSF-1	821	1251	942	1096	275	34

Net return

The economics of improved technologies over the traditional farmers practice/varieties was calculated depending on the prevailing prices of inputs and output costs (table.2). It was found that cost of production of safflower under improved variety varied from Rs12650 to 15600 ha^{-1} in case of TSF-1, Rs 13500 ha^{-1} for manjira and Rs 14750 in case of Annegeri-1, as against Rs 12050 to 15050 ha^{-1}, 13150 and 14050 ha^{-1} local check respectively during the years 2010 – 11 to 2013-14. The improved varieties registered an additional cost of production ranging from Rs 550 to Rs 600 ha^{-1} for TSF-1, Rs 550 ha^{-1} for Manjira and Rs 900 ha^{-1} for Annegeri-1 over the local check. The additional cost incurred in the improved technologies was mainly due to more costs involved in the procurement of improved seed variety only. The improved variety seeds are breeder seeds. Since the breeder seed costs depend on the prevailing university rates. Breeder seed costs ranged from 55 to 60 rupees per kg seed during the respective years. Annegeri-1 was procured from University of Agricultural Sciences, Dharwad, Karnataka @ 70 rupees per kg seed. Cultivation of safflower under improved variety accrued higher net returns of Rs 19070 to 19600 ha^{-1} in case of TSF-1, 18220 in case of Manjira and Rs 18900 ha^{-1} in case of Annegeri-1, as compared to farmers practice /local check which recorded from Rs 11190 to Rs 13170 ha^{-1}, Rs12890 ha^{-1} and Rs 11450 ha^{-1} during the respective years. There was an additional net returns of Rs 5900 to Rs 8410 ha^{-1} for TSF-1, Rs 5330 ha^{-1} for Manjira and Rs 7450 for Annegeri-1, respectively during the years 2010-11 to 2013-14 over the local check under demonstration plots. Kumar *et al.* (2014) reported that the Improved Technology plots recorded higher mean productivity, gross returns, additional net returns, B:C ratio than the farmers practice plots indicating the technical and economic feasibility of Improved technology.

Table 2. Cost of cultivation (Rs ha^{-1}), net returns (Rs ha^{-1}) and benefit: cost ratio of safflower as influenced by improved variety and local check.

Improved variety	Total cost of cultivation (Rs ha^{-1})		Net returns (Rs ha^{-1})		Benefit : Cost ratio		Additional cost of cultivation (Rs ha^{-1})	Additional net returns (Rs ha^{-1})
	Improved variety	Local check	Improved variety	Local check	Improved variety	Local check		
TSF-1	12650	12050	19070	13170	1.51	1.09	600	5900
Manjira	13500	13150	18220	12890	1.33	0.98	550	5330
Annegeri-1	14750	14050	18900	11450	1.26	0.81	700	7450
TSF-1	15600	15050	19600	11190	1.26	0.74	550	8410

The improved varieties of safflower also incurred higher benefit cost: ratio of 1.26 to 1.51 with TSF-1 compared to 0.74 to 1.09 over local check, for Manjira it was 1.33 over 0.98 for local check and for Annegeri-1 the ratio was 1.26 as against 0.81 for local check during the respective years of 2010-11 to 2013-14.

The results from the present study clearly brought out the potential of improved varieties in enhancing the safflower production and economic gains in rainfed conditions of southern Telangana.

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ASSOCIATION OF VARIOUS MORPHO-PHENOLOGICAL TRAITS WITH YIELD AMONG VARIOUS RICE (*Oryza sativa* L.) GENOTYPES

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ABSTRACT

The objective of the study was to evaluate different varieties of rice for their growth and yield characteristics. An experiment was conducted during *kharif* 2013 and *kharif* 2014 at ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad. Fourty three genotypes from different groups were evaluated in a randomized block design (RBD) with three replications. Data on various growth and yield parameters reveled that the parameters were significantly differed among the genotypes. Evaluation of fourty three rice genotypes from different groups showed significant differences among the genotypes. Positive and significant correlation of yield was found with total dry matter per hill (0.89), tillers per plant (0.58, days to flowering (0.40) and days to maturity (0.35). Grain yield was positively associated with plant height (0.07), percent filling grains (0.17) and 1000 seed weight (0.07). It indicated that grain yield can be increased whenever there is an increase in characters that showed positive and significant association with grain yield. Hence due weightage should be given to these characters during selection for future crop improvement programme.

Genus *Oryza* contains approximately 23 species, of which 21 are wild type and two; *O. sativa* and *O. glaberrima,* are cultivated world wide (Vaughan, 2003). It is a staple food and more than half of world population depends on its consumption and income generation (Bucheyeki *et. al.,* 2011). About 95% of global output of rice is produced and consumed in developing countries. It is most important food crop for 2.89 billion people in Asia, 40 millions in Africa and 1.3 millions in the Americas (Food and Agricultural Organization, 2000)

Rice occupies pivotal role in Indian Agriculture. It is the staple food of more than 70% people and source of livelihood of 120-150 million rural households. It contributes about 43% to total food grain and 53% to cereal production, and thus holds the key to sustain food sufficiency in country (Siddiq *et. al.,* 2004). The varieties have different physiological and morphological characteristics that contribute towards yield (Yang *et al*., 2007; Yang and Hwa, 2008). Ashrafuzzaman *et al*. (2009) found variation in morphological and yield components in different varieties of aromatic rice. Growth and yield characteristics of genotypes depend on genetic and environmental factors. Alam *et al*. (2008) reported that among production factors varietal selection at any location has an important role. Proper crop management depends on the growth characteristics of various varieties to get maximum benefit from new genetic material.

For successful crop production knowledge of varietal morphological and physiological characteristics is necessary. Crop genotypes play a dominant role in crop production systems. They affect crop productivity by their higher yield potentials, resistance against insect pest and diseases under different climatic conditions.

It is desirable to study yield and yield contributing traits like number of effective tillers per plant, number of spikelets, 1000 grain weight, grain filling percentage, days to 50% flowering, days to maturity, and plant height have shown positive association with grain yield per plant (Watoo *et al*., 2010).

Correlation coefficient is an important statistical constant which indicates the degree of association among the various characters. For genetic improvement of yield and other characters in any crop, it is essential to know the nature and extent of association of various component characters with yield. To evaluate different varieties of rice for their

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growth and yield characteristics, an experiment was conducted during *kharif* 2013 and *kharif 2014.*

MATERIAL AND METHODS

The details of the materials used and techniques adopted during the course of investigation are described below.

The present investigation was conducted during *kharif* 2013 and 2014 at ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad. The soil type of the experiment site is a clayey vertisol with pH of 8.33, available nitrogen of 175 Kg ha^{-1}, available phosphorus of 75 Kg P_2O_5 ha^{-1}, available potassium of 317 Kg ha^{-1} and organic carbon of 0.54%. To characterize the weather conditions during the crop growing season, the meteorological parameters were recorded from the meteorological observatory located at Agricultural Research Institute, Rajendranagar, Hyderabad. During the Rice crop growth period in kharif, 2013 total rainfall received was 703.2 mm. The mean monthly maximum temperature ranged from 28.0 to 32.6°C with an average of 29.8°C. The mean monthly minimum temperature ranged from 10.1 to 23.9°C with an average of 18.4°C. Relative humidity forenoon and afternoon during the crop growing period fluctuated between 81.8 to 89.9 % and 36.6 to 75.9 %, respectively. The mean monthly bright sunshine hours per day varied from 3.4 to 8.9 hours with an average of 5.8 hour. Likewise the mean monthly wind velocity ranged from 1.7 to 10.5 km h^{-1} with an average of 4.4 km h^{-1} .

During the Rice crop growth period in kharif, 2014 total rainfall received was 433.20 mm. The mean monthly maximum temperature ranged from 28.3 to 31.7°C with an average of 30.8°C. The mean monthly minimum temperature ranged from 12.0 to 23.6°C with an average of 19.7°C. Relative humidity forenoon and afternoon during the crop growing period fluctuated between 79.23 to 87.43 % and 40.93 to 62.39 %, respectively. The mean monthly bright sunshine hours per day varied from 3.2 to 7.1 hours with an average of 5.7 hours. similarly, the mean monthly wind velocity ranged from 1.6 to 12.4 km h^{-1} with an average of 5.1 km h^{-1}.

The experiment was laid out in randomized block design and replicated thrice. Forty three genotypes, from different five groups, viz., advanced breeding lines, Germplasm lines, Wild introgressed lines, tropical japonica lines, land race varieties and popular varieties were used during kharif 2013 and *kharif* 2014. During all the four seasons plot size was maintained 2 x 1 m for each entry with spacing 20 x 10 cm. Row to row and hill (plant) to hill distance was 20 cm and 10 cm respectively.

The data on phenological parameters was noted on plot basis. These observations were noted from sowing to harvest of the crop. The data was recorded for five randomly selected plants from each replication leaving the first two border rows from all the four sides, in order to avoid the sampling error. The observations were recorded as per the following procedure. Mean of readings from five plants were taken replication wise and the mean data was used for statistical analysis for the characters. Plant height was measured in centimeter from the ground level to

List of Entries included in the Experiment

Sl No	Variety group	Entry
1.	Released Variety	Jaya, Rasi, IR 36, Lalat, IR 64, NDR 359, MTU-1010, Krishna Hamsa, Sampada, MTU-1001, ADT 43, ADT 49, WGL 14, BPT 5204, Sita, HKR 47, Pantdhan 12, Pantdhan 4, Jyoti, Mahamaya, Varadhan, Akshayadhan, Sugandha Samba, Sumati, Tella Hamsa
2.	Advance Breeding line	IET-21542, RNR-6378, RNR-6378
3.	Tropical Japonica	TJP 139, TJP 82
4.	Wild Introgression	S 40, 24 K
5.	Land race (MP)	Asanchidiya, Ranikajal, Bhejaridhan, Khudharidhan, Surja, Paradeshiya, Dhaniyadhan, Nevaripeeli, Sonkaichi
6	Germplasm	E 2710, E 2940

the top of the panicle (excluding awn) at the time of maturity. Number of effective tillers/plant was counted as per plant basis. Phenological observations were determined by counting number of days from date of sowing to the maturity of the plants in the plot initiated. Total dry matter was recorded on dry weight basis at the time of harvest, which includes, stem, leaves and panicle weight. A sample of 100 well developed fresh whole seeds was collected and weighed in grams and computed to 1000 grains weight. Total number of spikelet on main panicle was counted and recorded at the time of maturity. Percentage of viable seeds was estimated by counting the number of well filled grains of five randomly selected panicles for each genotype and expressed in percentage. Spikelet per plant was determined by counting the number of both well filled and aborted spikelet of five randomly selected replicates. The total numbers of panicles per plant was recorded in three replications for each genotypes and grain yield/plant was recorded.

RESULTS AND DISCUSSION

The data indicate that the grand mean of all the genotypes for days to 50% flowering was 103 days. The significant differences were observed among the genotypes. Entire duration from sowing to 50% flowering among the genotypes was 82 days (land race variety Khudharidhan) to 119 days (released variety Akashyadhan). Data recorded for different groups indicate that the maximum days required for 50% flowering was recorded in germplasm line group (114 days) and advanced breeding line group (113 days). However the lowest mean days (90 days) were recorded in land race variety group for 50% flowering. The data indicate that the mean number of days taken for days to maturity was 132 days and significant differences were observed among the genotypes. Entire duration from sowing to maturity among the genotypes was 108 days (land race variety Khudharidhan) to 132 days (released variety Akashyadhan). Data recorded for different groups indicate that maximum days were required for germplasm line group (147 days) and less number of days for land race variety group (118 days) to reach maturity. Plant height is an important trait contributing yield. Plant height in rice is generally considered to be controlled by both qualitative and quantitative genes . Ashrafuzzaman *et al*. (2009) also considered that plant height is mostly governed by genetic makeup of the genotypes, but the environmental factors also influence it. The pooled data of plant height during the *kharif* season indicated significant differences in plant height among the genotypes. The grand mean of plant height in all the genotypes at maturity stage was 108.89 cm and ranged from 87.17 cm (Jyoti) to 176.10 cm (tropical japonica variety TJP 82).The differences among all these genotypes were statistically significant. Among the different groups, the mean average plant height recorded by tropical japonica line group (133.60 cm), and land race variety group (120.74 cm) exceeded grand mean of all the genotypes (108.89 cm). While, the Germplasm line group, recorded the minimum plant height (101.20 cm). Significant variation in plant height among the genotypes was earlier reported by many scientists, and the results confirm the investigations of Akram *et al.*, (2007). The mean value for total dry matter per hill at maturity was (46.66g), and it varied from 27.35g (land race variety Surja) to 76.79g (released variety Jaya). Among the different groups, the maximum mean value of total dry matter per hill was recorded in Wild introgression line group (58.98g) than the grand mean of all the genotypes. However the lowest mean value was recorded in land race variety group (39.33g) as total dry matter per hill at maturity. Results are in confirmation with (Hussain *et. al.,* 2014), concluded that dry matter of all varieties increased from transplanting upto maturity.

YIELD AND YIELD ATTRIBUTES

The number of effective tillers also significantly differed among the genotypes which ranged from 5.67 (released variety Sugandha samba) to 19.33 (Jaya). Among the different groups, the tropical japonica line group recorded the maximum number of tillers hill^{-1} (12.25) which was more than the grand mean of all the genotypes (10.38). However the lowest values were recorded in wild introgression line group (7.88). The results confirm the investigations of Hussain *et al.* (2014).

Tropical japonica line TJP139 produced the highest number of spikelets panicle^{-1}(65.00) and the land race variety Khudaridhan produced the minimum numbers of spikelets panicle^{-1}(13.16). The maximum mean spikelets panicle^{-1} were recorded in tropical japonica line group (59.50), while the minimum were recorded in land race variety group (26.02). Difference in spikelets number can be attributed as genetic nature of different varieties Hussain *et al.* (2014).

Higher values of filling percentage were observed in the land race variety Khudharidhan (93.89), while the released variety Pantdhan-12 had the lowest percentage of filling grains (54.13). The maximum mean percentage of filled grains panicle $^{-1}$, was recorded in land race variety group (82.82) and the lowest mean percentage of filled grains panicle $^{-1}$ was recorded in advanced breeding line group (66.29). Dutta *et al.* (2013) stated that this trait may not be useful as a criterion for selection for increased grain yield, as this trait is under the influence of favourable environment rather than genotype and selection for such trait might not be rewarding. Similar to traits, 1000 seed weight also differed significantly in different rice genotypes which ranged from 12.13g (Germplasm line E2940) to 29.74g (released variety Mahamaya). Among the different groups, the maximum mean 1000 seed weight was recorded in tropical japonica line group (23.19g) and the lowest mean value was recorded in germplasm line group (12.91g). Akram *et al.* (2007) reported significant differences in 1000 seed weight in rice genotypes.

All genotypes produced variable grain yield ranging from 6.93g (land race variety Surja) to 40.46g (released variety Jaya). Among the different variety groups, the higher grain yield was harvested from tropical japonica line group (27.52g) and less grain yield was harvested from land race variety group (16.60g). Earlier scientists, (Muhammad *et al.*, 2012) also reported the significant variation in grain yield among the genotypes.

The results regarding correlation are shown in (Table 2) Positive and significant correlation of yield was found with total dry matter per hill (0.89), tillers per plant (0.58, days to flowering (0.40) and days to maturity (0.35). Augustina *et.al.* (2013) who obtained a positive significant association in biomass with grain yield, Sadeghi (2011) for 50% flowering and days to maturity. Results for tillers per hill are in variance with Babu *et.al.*(2013) reported the positive association of tillers per hill with grain yield .Grain yield was positively associated with plant height (0.07),percent filling grains (0.17) and 1000 seed weight (0.07). Khan *et.al.*(2009) reported the positive association of plant height with grain yield. Results are in variance with Kishor *et al.* (2007) for per cent grain filling and 1000 seed weight, where they reported significant positive association with grain yield.

Regarding the inter-correlation , the association of plant height was positive with total dry matter (0.014), days to 50% flowering (0.11), days to maturity (0.11), percent grain filling (0.11), while it was negatively associated with effective tillers per hill (-0.02) and 1000 grain weight (-0.05). Effective tillers per hill had positive significant association with dry matter (0.42) and positive with % grain filling (0.21), while negative association with days to 50% flowering (-0.01) and days to maturity (-0.09). Total dry matter had positive significant association with days to 50% flowering (0.59), days to maturity (0.55), positive association with percent grain filling (0.04) and negative association with 1000 seed weight (-0.06). Days to 50% flowering had strong positive association with days to maturity (0.95) and negative significant association with percent grain filling (-0.36) and negative association with 1000 seed weight (-0.21).Days to maturity had negative significant association with percent grain filling (-0.33) and negative association with 1000 seed weight (-0.25). Percent grain filling had positive significant association with 1000 seed weight (0.34). Similar results were reported by Reddy *et al.*(2014) that days to 50% flowering had positive significant association with days to maturity and negative association with number of effective tillers per hill.

Table 1. Mean squares of various traits of rice genotypes evaluated under *kharif* seasons

Source of variation	Plant height	No. of effective tillers/hill	TDM at maturity g/hill	Days to 50% flowering	Days to maturity	Spikelets/ panicle	Percent filling grains	1000 seed weight	Grain weight g/hill
Environments	1044.0	22.9	185785.3	432.3	3775.8	75.9	849.8	903.0	14120.3
Varieties	1979.9	38.9	824.2	595.4	653.5	784.8	530.7	117.7	209.5
Environments x Varieties	301.4	5.51	486.0	67.1	166.9	281.1	476.8	11.0	143.9
Pooled error	3.8	1.0	22.2	0.7	0.9	21.6	19.4	0.8	4.9

Table 2. Simple linear correlation of morpho-phenological characters with grain yield during the seasons

Parameter	Plant height	No. of effective tillers/hill	TDM at maturity	Days to 50% flowering	Days to maturity	Percent filling grains	1000 seed weight	Grain weight
Plant height	1.00	-0.02	0.14	0.11	0.11	0.11	-0.05	0.07
No. of effective tillers/hill		1.00	0.42**	-0.01	-0.09	0.21	0.02	0.58**
TDM at maturity			1.00	0.59**	0.55**	0.04	-0.06	0.89**
Days to 50% flowering				1.00	0.95**	-0.36**	-0.21	0.40**
Days to maturity					1.00	-0.33**	-0.25	0.35**
Percent filling grains						1.00	0.34**	0.17
1000 seed weight							1.00	0.07
Grain weight								1.00

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IDENTIFICATION AND DNA PROFILING OF SUPERIOR GRAIN QUALITY GENOTYPES IN RICE (*Oryza sativa* L.)

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ABSTRACT

Rice (*Oryza sativa* L.) is the only cereal crop cooked and consumed mainly as whole grains and quality considerations are much more important than any other food crop, which define market and end-use qualities. Grain quality parameters of twenty five rice genotypes (9 Jagtial varieties, 6 pre-released cultures, three mega varieties, one Nellore variety, one private company variety and five hybrid rice parental lines) were estimated at RRS, RARS, Jagtial during *Kharif* 2013, to identify the genotypes having better quality characters. It is revealed that hulling percentage is very good in all the genotypes and ranged from 78% (Swarna) to 84% (JGL11470).The milling recovery varied from 64% (JGL11118) to 72% (JGL23710).The Head Rice Recovery varied from 50% (JGL23714) to 62% (JGL3855).The kernel length is highest in MTU1010 (6.7mm) and lowest is 5mm (JGL23710). 13 varieties had short slender type(SS), 3 were of medium slender(MS) and 9 were of long slender(LS) grain type. Amylose content was intermediate in most of the tested genotypes except in CMS46B (10%) and highest was in Swarna (26.6%). Varieties with intermediate amylose are fluffy and retain soft texture on cooling, so the intermediate ones are mostly preferred for cooking. One SSR marker (RM444) out of ten was able to differentiate JGL1798, JGL19621 and MTU1010 from other genotypes. Among the quality traits, 1000 grain weigh, Amylose% and alkali spreading value recorded highest GCV and PCV followed by Kernel length and breadth. Milling % and amylose % showed significant positive correlation with HRR and L/B ratio showed significant negative correlation. Hence, selection for improvement based on these parameters will be a right step in right direction.

Rice is the staple food for over half of the world population and it is ranked as the number one human food crop in the world. More than 90% of the world rice is grown and consumed in Asia (Tyagi *et. al.,* 2004) and considerably more the rice production is anticipated due to the rapid population growth in this part of the world. Rice occupies a pivotal place in Indian food and livelihood security system. It provides about 75% of the average calories and 55% of protein in average daily diet of the people. Three billion people depend on it as a major source of their subsistence diet. Grain quality in rice is determined by the factors such as milling quality, grain shape, size, nutritional value, cooking and eating qualities . The nutritional values and processing properties are very important for overall health of people and commercial purpose including economy of rice growers.

Good grain quality fetches higher price for the farmers so the demand for better quality is increasing in economically developed and developing countries. Earlier plant breeders concentrated on breeding for high yield and pest resistance. Recently trend has changed to incorporate preferred quality characteristics that increase economic value of rice.

Since last one decade, grain quality improvement received special emphasis as spread of the variety mostly depends on attractive grain quality and satisfactory cooking quality. Till today India has released 70% rice varieties without testing for quality characters (Thongbam *et. al.*, 2010). Now quality characters are considered during variety development and release. So breeders have given due emphasis for quality characters. Shobha Rani *et. al.* 2008 studied the quality of 78 released varieties for India and found some good varieties. Thereafter, by realizing the importance, quality characters of 28 land races of Assam, (Das and Borah 2008), 11 rice genotypes of Faizabad (Srivastava *et al.,* 2012) were studied. Estimation of genetic parameters and correlation among the quality parameters help in breeding for new genotypes with good grain quality (Singh *et al.,* 2012).

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Yearly number of similar grain type varieties are being released for cultivation. As a consequence, it is essential to build the fingerprinting database of the main commercial cultivars in the market for rapid and unambiguous cultivar identification. DNA profiling also helps in identification of markers linked to important traits present in the variety. SSR markers have been used in genetic analysis and fingerprinting of different rice accessions (Rampant *et al.*, 2011).

Keeping these in view, grain quality characters of 25 promising genotypes including popular varieties of Telangana state and hybrid parental lines were evaluated for genetic analysis of quality characters and DNA profiling of these genotypes was carried out using 10 SSR markers.

MATERAL AND METHODS

Present investigation was carried out at experimental farm of Rice Research Scheme of Regional Agricultural Research Station (RARS), Jagtial, Karimnagar, Telangana, India during *Kharif,* 2013. Twenty five different genotypes of the station and other locations (9 Jagtial varieties (JGL384, JGL1798, JGL3828, JGL3844, JGL3855, JGL11118, JGL11470, JGL11727 and JGL17004), 6 pre-released cultures (JGL18047, JGL19621, JGL20171, JGL23710, JGL23713 and JGL23714), three mega varieties (BPT5204, Swarna and MTU1010), one Nellore variety (NLR34449), one private company variety (Jaisriram) and five hybrid rice parental lines (CMS11B, CMS14B, CMS23B, CMS46B and JMS2)) were used to identify varieties and hybrid parental lines having good grain quality traits. The 25 days old seedlings were transplanted in main field in two replications with plot size of 5 meter square and recommended dose of N; P; K (100:50:40kg ha^{-1}) was applied. All crop protection measures were taken during the crop growth period and harvested at maturity stage. After the harvest, samples were cleaned thoroughly using winnower to remove the chaff, other foreign matters and air-dried in hot sun up to 14 per cent moisture content.

Physical properties

Physical properties of paddy are important as they are the main criteria for price fixation and recovery of rice from paddy. These include kernel length, breadth, L/B ratio, Hulling%, Milling% and Head Rice Recovery% (HRR). Kernel length and breadth are measured by the dial micrometer. Grains of different genotypes were classified in to different grain types as per the Ramaiah (1969) classification (Short slender, Short bold, Medium slender, Long slender, long bold and Extra long slender). Standard Huller, Polisher and grading machines were used for estimation of hulling%, milling% and HRR.

Chemical properties

Chemical properties of rice determines the cooking and eating properties; these include Gelatinization temperature, Alkali spreading value and Amylose content.

Gelatinization temperature (GT):

Time required for cooking is determined by the gelatinization temperature of starch. It is the range of temperature where at least 90% of starch granules swell irreversibly in hot water with loss of crystallinity. GT is indexed by alkali digestion test (Little *et. al.*, 1958).

Amylose content:

Amylose content in rice determines the stickiness of rice after cooking. Amylose content of 25 genotypes was estimated by following procedure described by Juliano (1971). In this process iodine solution is used as an indicator of starch. Rice contains amylose (indirect form of starch) which turns into violet by addition of iodine, when high amount of amylose is present it turns into violet colour, where as low amount of amylose represents yellow colour. On the basis of amylose content Juliano and villareal (1993) classified rice into five groups *viz.*, waxy (0.0 to 5), very low (5.1 to 12), low (12.1 to 20), Intermediate (20.1 to 25) and High (>25).

DNA profiling

Profiling of 25 genotypes was carried out using 10 SSR primers (Table 3) by extracting DNA using mini-prep method (Thippeswamy, 2007) and PCR amplification.

PCR amplification

DNA amplification was carried out in 20µl reaction volume containing 20ng genomic DNA, IX PCR buffer (tris buffer with 1.5mM $MgCl_2$), 1µl dNTP (2.5mM each dNTP), 5pM of each forward and reverse primer, 0.5 units of *taq* polymerase enzyme. Amplification was performed in a thermal cycler (Eppendorf, USA) with a program of initial denaturation at 94°C for 5 minutes, cyclic denaturation at 94° C for 2 minutes, primer annealing at 50°-54° C (vary from marker to marker) for 1 minute and primer extention 72° C for 2 minutes. The cycle was repeated and ended with the final extention at 72° C for 8 minutes. The amplified PCR products were resolved on 3% agarose gel along with 50 bp molecular weight marker (Bangalore Genie, India), stained with ethidium bromide and documented using Gel documentation system (Alpha Innotech, USA). Banding pattern of each primer was recorded. The genotypic data set was generated based on the PCR amplification profile of each genotype by scoring presence and absence of different alleles and number of alleles.

RESULTS AND DISCUSSION

All the 25 genotypes were tested for physico-chemical grain quality characters. Analysis of variance revealed that there were significant differences among the genotypes for grain quality characters. Grain quality varies from one variety to other, data revealed that hulling percentage is very good in all the genotypes and ranged from 78 per cent (MTU1010) to 84 per cent (JGL11470) (*Fig.* 1). The Milling recovery varied from 64 per cent (JGL11118, NLR34449, MTU1010, JMS2, CMS14B, CMS46B) to 72 per cent (JGL23710).

Rice millers prefer varieties with high milling and head rice recovery (HRR), whereas consumer preference depend on cooking and eating qualities. A variety should possess high turnout of whole head rice and milled rice. Highest head rice recovery of 62 % was observed in Swarna variety followed by JGL384 (60%). Three genotypes recorded (CMS14B, CMS46B and JGL23714) 50 percent HRR, was lowest among the genotypes studied. This may be because of the fact that the HRR depends on variety, grain type, cultural practices and drying condition.

Consumer preference initially is determined by kernel length and breadth. Most of the South Indian consumers prefer medium slender grain type. The kernel length is highest in MTU1010 (6.7mm) and lowest is 5mm (JGL23710) among the varieties. Among hybrid rice parental lines, longest grain was observed in JMS2 (7.4mm) followed by CMS46B (7.2mm), CMS14B (7.0) and CMS23B (6.2mm) was shortest, all the varieties identified belongs to different grain types like short slender (SS), medium slender (MS) and long slender (LS) type. Out of 25 genotypes, 13 genotypes belong to short slender type (SS), 3 were of medium slender (MS) type and 9 were having long slender (LS) grains. All the Maintainer lines used in the study were having long slender grains (*Fig. 2*). Similar variability for physical grain quality characteristics was observed in 22 promising genotypes by Shejul *et al.* (2013). In the present study highest 1000 grain weight was recorded in MTU1010 (27.6 g) and lowest in JGL23714 (9.9 g).

Amylose is important chemical quality parameter which indicates the stickiness after cooking. Low amylose varieties were moist, sticky and glossy. Rice with high amylose becomes hard on cooking, whereas, the intermediate ones are fluffy and retain soft texture on cooling. So the intermediate ones are mostly preferred for cooking and eating. Amylose content was intermediate in most of the tested genotypes except in CMS46B (10%), which is very low and highest was in Swarna (26.6%), followed by NLR34449 (25.8%) and JGL3844 (25.9%) and JGL17004 (25.7%) (Table1). Among the high amylose genotypes identified in the study, JGL17004 recorded low alkali spreading value and others recorded low gelatinization temperature. Based on the results, NLR34449, JGL3844 and JGL17004 varieties having good physico-chemical and cooking qualities. Further selection for improvement based on these parameters will be a right step in right direction of hybrid rice development.

In development of wide adaptable varieties or hybrids, more emphasis should be given to HRR than total rice yield since it is more important commercially and easier to improve quality. Heritable traits, Grain dimensions and hardness, Moisture content, Immature or fissured grains and mill type are factors affecting HRR. Genetic analysis of grain quality traits shows high genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for alkali spreading value (30.408, 30.408), followed by 1000 grain weight (28.561, 28.707) , amylose per cent (19.966, 19.974), Kernel breadth (12.252, 13.298) and kernel length (12.171, 12.274). Lowest GCV and PCV was observed for hulling per cent (1.934, 2.473) and these traits also had high heritability and genetic advance as per cent of mean (Table 2). These are in line with the earlier report of Sunayana Rathi Yadav and Sarma (2010). Strong positive correlation was observed between amylose% and Milling% with HRR. Significant negative correlation was observed between L/B ratio and HRR. Direct positive effect of Milling% and 1000 grain weight was more on HRR in path coefficient analysis. In literature, there are very limited reports on use of HRR as dependent variable. The HRR showed positive association with kernel length after cooking, elongation ratio and hulling in 25 low land rice varieties of eastern India (Bose *et al.*, 2007). Based on these results HRR can be improved by improving Milling%, 1000 grain weight and amylose%. Hence selection for improvement based on these parameters will be useful.

DNA fingerprinting technique is useful in many areas like mapping of genes and genetic tests. Additionally, there are several methods for accessing the DNA profile of an individual, depending on the type of test being done. The DNA fingerprinting unlike the usual fingerprinting which is based on the morphological features reveals the identity of an organism at the molecular level. This is primarily based on the polymorphisms occurring at the molecular level i.e. on the base sequences of the genome. The DNA profiling is primarily used in plants for protection of biodiversity, identifying markers for traits, identification of gene diversity and variation etc. The most popular or widely used markers for DNA profiling are SSR markers. DNA profiling of all the 25 genotypes was carried out and polymorphism was observed among all the 25 genotypes. Highest no of alleles were observed with the primer RM 1233 and RM214 (Table 3). Among the ten SSR markers RM444 clearly differentiated JGL1798, JGL19621and MTU1010 (*Fig.* 3) from other genotypes. This information is useful for rapid identification of a genotype.

Table 1. Chemical grain quality parameters of rice genotypes.

Genotype	Amylose%	Amylose Classification	Alkali Spreading value	Classification	Gelatinization temperature
JGL384	20.4	Intermediate	7	High	Low
JGL1798	24.1	Intermediate	7	High	Low
JGL3828	20.9	Intermediate	7	High	Low
JGL3844	25.9	High	7	High	Low
JGL3855	23.0	Intermediate	7	High	Low
JGL11118	23.3	Intermediate	1	Low	High
JGL11470	21.5	Intermediate	3	Low-Medium	High - Medium
JGL11727	22.6	Intermediate	7	High	Low
JGL17004	25.7	High	1	Low	High
JGL18047	20.1	Intermediate	5	Medium	Medium
JGL19621	24.6	Intermediate	5	Medium	Medium
JGL20171	20.2	Intermediate	7	High	Low
JGL23710	23.1	Intermediate	7	High	Low
JGL23713	23.2	Intermediate	7	High	Low
JGL23714	15.0	Low	7	High	Low
BPT5204	24.1	Intermediate	5	Medium	Medium
SWARNA	26.6	High	7	High	Low
MTU1010	21.8	Intermediate	7	High	Low
NLR34449	25.8	High	7	High	Low
Jaisriram	18.2	Low	7	High	Low
CMS11B	20.4	Intermediate	7	High	Low
CMS14B	13.0	Low	5	Medium	Medium
CMS23B	28.6	High	7	High	Low
CMS46B	10.0	Very low	7	High	Low
JMS2	17.5	Low	7	High	Low

Table 2. Genetic parameters of grain quality traits

Trait	Coefficient of variability		Heritability (Broad Sense)	Genetic Advance as % of Mean	Phenotypic correlation coefficients with HRR%	Genotypic correlation coefficients with HRR%	Genotypic path coefficients (Direct effects on HRR)	Phenotypic path coefficients (Direct effects on HRR)
	Genotypic	Phenotypic						
Kernel Length (mm)	12.171	12.274	0.983	24.863	-0.2247	-0.2131	14.8812	-0.0932
Kernel Breadth (mm)	12.252	13.298	0.849	23.254	0.1609	0.1654	-15.8631	-0.3471
L/B ratio	5.853	8.579	0.465	8.224	-0.5549**	-0.747**	-9.5559	-0.4674
1000 grain weight	28.561	28.707	0.99	58.537	0.0444	0.0574	0.1081	0.6068
Amylose%	19.966	19.974	0.999	41.111	0.4643**	0.4834**	-1.2118	0.1083
Alkali Spreading value	30.408	30.408	0.99	62.641	0.0404	0.0422	-0.1861	0.0272
Hulling %	1.934	2.473	0.612	3.116	-0.0036	-0.1293	-0.3652	-0.0062
Milling %	3.165	3.502	0.817	5.893	0.5039**	0.4623**	0.3164	0.4586
HRR %	5.794	6.058	0.915	11.414				

Table 3. Primer sequences of SSR marker

S. No.	Marker	Forward primer sequence	Reverse primer sequence	No of alleles
1	RM444	GCTCCACCTGCTTAAGCATC	TGAAGACCATGTTCTGCAGG	3
2	RM5526	TCAGCCTGGCCTCTCTTATC	ATGATCCTCCACCCACTAGC	2
3	RM527	GGCTCGATCTAGAAAATCCG	TTGCACAGGTTGCGATAGAG	4
4	RM6094	TGCTTGATCTGTGTTCGTCC	TAGCAGCACCAGCATGAAAG	3
5	RM1233	ATGGGCACGTGTAATTCATTCG	ATCCTCGAAAGTAGGAAAGC	5
6	RM3472	CACACACTCTC TCAATCTCAACACC	AGAAGCGAGAGGAGGGAGATAGC	2
7	RM85	CCAAAGATGAAACCTGGATTG	GCACAAGGTGAGCAGTCC	4
8	RM261	CTACTTCTCCCCTTGTGTCG	TGTACCATCGCCAAATCTCC	4
9	RM214	CTGATGATAGAAACCTCTTCTC	AAGAACAGCTGACTTCAC	5
10	RM6340	GCATGATGCAAGGGAGATCG	CTTCCTCATCTCCCTCACCTTCC	4

Fig 1. Hulling%, Milling% and Head rice recovery of rice genotypes

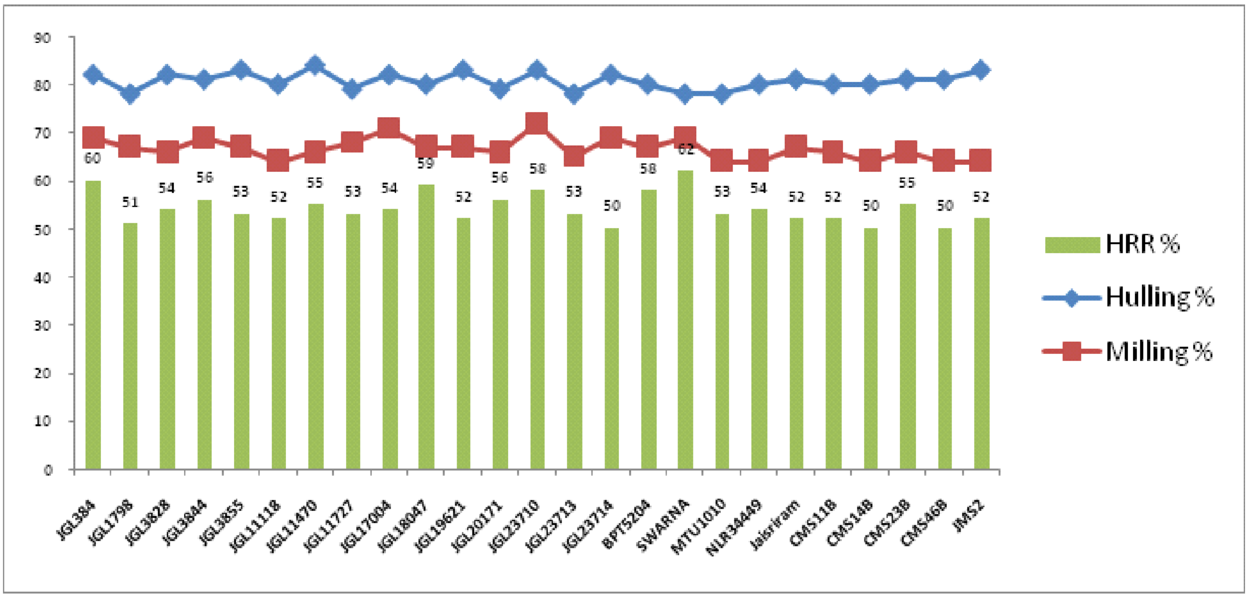


Fig 2. Kernel length, L/B ratio, Grain type and test weight of rice genotypes

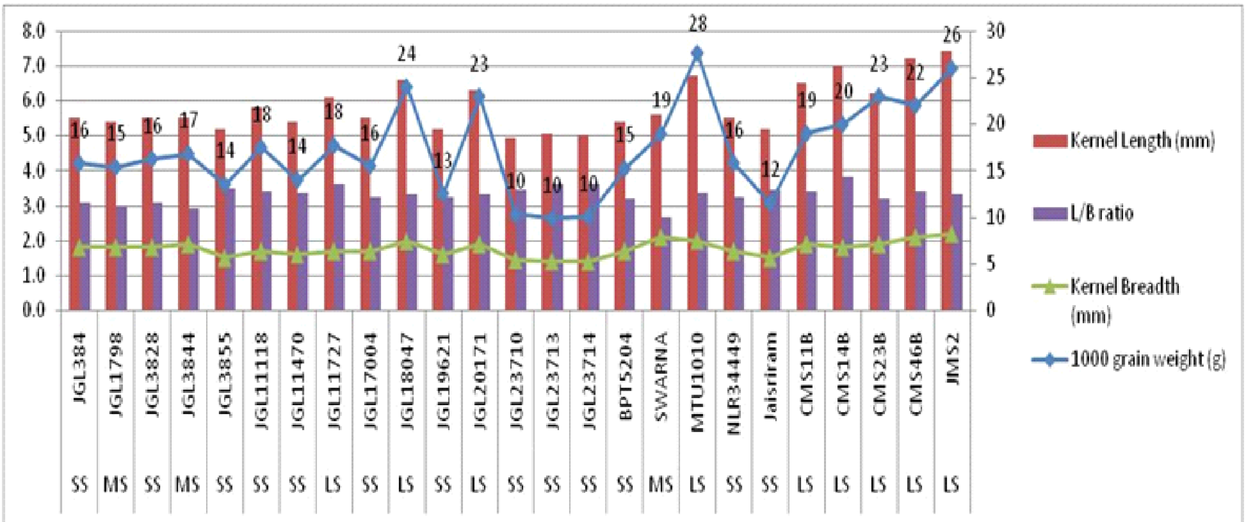
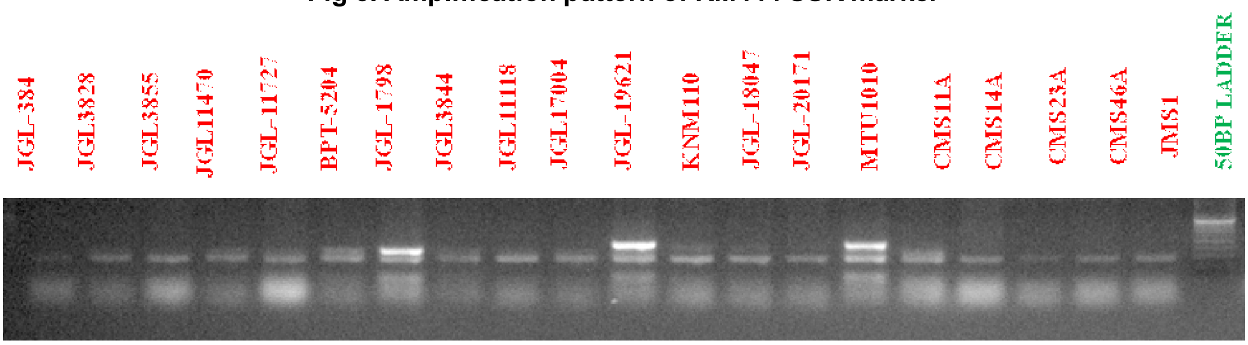


Fig 3. Amplification pattern of RM444 SSR marker



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EFFECT OF SOWING DATES AND VARIETIES ON GROWTH, YIELD AND ECONOMICS OF AEROBIC RICE (*Oryza sativa* L.) DURING *KHARIF* SEASON

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ABSTRACT

A field experiment was conducted duringtwo consecutive *kharif*seasons of 2012 and 2013 on clay soils of Agriculture Research Station, Madhira in Central Telangana Agro Climatic Zone of Telangana State, India to study the effect of different sowing dates on growth and yield of different duration rice varieties under aerobic environment. The results indicated that, the crop sown on 18thJunee produced more plant height, effective tillers and drymatter followed by 7thJulyy sown crop and decreasedsignificantly with every successive 15 days delay in sowing from 20thJulyy to 18thAugustust during both the years. The effective tillers, filled spikelets panicle^{-1} grain and straw yield, net returns and B:C ratio were also significantly more with 18thJunee and 7thJulyy sown crop when compared to subsequent dates sown crop. Among the varieties, the medium duration *cv* JGL 11470 and long duration *cv* MTU 1061 produced more plant height, drymatter, grainand straw yield, net returns and B:C ratio over short duration variety MTU 1010 and extra short duration variety JGL 17004.

Rice (*Oryza sativa* L.) is the staple food in Asia but also the single biggest user of fresh water. More than 80% of the developed fresh water resources in Asia are used for irrigation purposes and consumes up to 43 % of the world's developed irrigation resources (Boumanet *al.,* 2007). About 22 million hectares of irrigated dry season rice experience "economic water scarcity" in South and South-East Asia (Tuong and Bouman, 2002). The common method of rice cultivation in India is transplanting the nursery which is very laborious and time consuming. The high cost of farm labour invariably delays transplanting and often leads to the use of aged seedling. To address these problems, growing rice under aerobic soil conditions is evolved. Aerobic rice offers such advantages as faster and easier planting, could be successfully cultivated with 600 to 700 mm of total water in summer and entirely on rainfall in wet season (Hittalmani, 2007)and reduced labour cost, and often higher profit in areas with an assured water supply. However, at the same time, no varieties have been specifically developed for this purpose. The existing varieties used for rice culture do not appear to be well adapted for growth and yield under aerobic condition. There is a little intervention which has been made so far on suitability of existing rice varieties to aerobic method of cultivation under varied dates of sowing as per the situation. Viewing these facts, a field experiment was conducted to evaluate the effectiveness of sowing dates and varieties on growth and yield of aerobic rice in Telangana State.

MATERIAL AND METHODS

A field experiment was conducted for two consecutive seasons of *kharif,* 2012 and 2013 at Agriculture Research Station, Madhira situated at an altitude of 189 m above mean sea level at 16°53' N latitude and 80°22' E longitude.The soil of the experiment cites was clay in texture, saline in reaction. The experiment was laid out in split plot design replicated thrice.The treatments combination comprised 5 sowing dates in the main plot *viz.*18 June (D_1), 7July (D_2), 20 July (D_3), 4 August (D_4) and 18 August (D_5) and 4 varieties in the sub plot *viz.* JGL 17004 (105 days), MTU 1010 (120 days), JGL 11470 (135 days) and MTU 1061 (160 days). The net size of each plot was 16 m^2 (4.0 × 4.0 m). Row to row distance was made at 20 cm apart and seed was sown continuously in the row.Seeds were sown at the rate of 40 kgha^{-1} in each date of sowing in the line. One-fourth of the recommended dose of nitrogen (120 kg ha^{-1}) and full dose of phosphorus (60 kg ha^{-1})halfpotash (30 kg ha^{-1}) and zinc sulphate (25kg ha^{-1}) were applied at sowing, and the remaining nitrogen was top-dressed in three equal splits dose, at 15 DAS, active tillering(30- 35 DAS), and at panicle initiation stage (the time of Panicle initiation stage varies with the varieties) respectively. The remaining half of the potassium applied at panicle initiation stage. For effective weed management, Pendimethalin (1 kg *a.i.* ha^{-1}) was used in moist condition at evening hours in all the treatments just after sowing of rice. Bispyriback sodium @ 250 ml ha^{-1} was applied as postemergence

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at 2 to 3 leaf stage of the weeds in addition to hand weeding at 35 to 40DAS to reduce the competition between weeds and crop. Fe SO_4 was to foliage at 20 and28 DAS to avoid iron deficiency in the crop. Tricyclazole @ 0.6 g liter^{-1}was applied twiceto control blast disease. Irrigation was applied @ 5 cm at 7 to 8 days interval to maintain soil moisture at field capacity from sowing to one week before harvest during dry spells in the season.The plant height, tillers production and dry matter accumulation were recorded at physiological maturity stage of the crop growth. The yield attributes and grain yield was recorded at harvest and sun dried straw yield was recorded 15 days after harvest.

RESULTS AND DISCUSSION

The crop sown on 18 June (D_1) recorded maximum plant height (128 cm and 124 cm) and successive delay in sowing by 15 days until 18 August (D_2 to D_5) significantly reduced the plant height during 2012 and 2013, respectively(Table 1). Plant height is directly proportional to the length of the vegetative phase of the crop. Increased plant height in earlier planting dates was due to availability of prolonged period for vegetative growth (Akram*et al.*, 2007). The interaction effect of dates of sowing and varieties on plant height of aerobic rice was significant (Table 2). The highest plant height (152 cm and 141 cm) was recorded with the long duration cv. MTU 1061 (V4) when it was sown on 18 June (D_1) followed by medium (V_3), short (V_2) and extra short (V_1) duration varieties in 2012 and 2013, respectively. The difference in plant height among the varieties was due to their varied vegetative growth period. These results are in accordance with the findings of Reddy *et al.* (2002) because of differential duration. The interaction effect of plant height with dates of sowing shows that, in 18 June sown crop (D_1) the plant height of the long duration variety MTU 1061was significantly higher to all other varieties followed by the medium duration variety JGL 11470 which in turn significantly superior to short and extra short duration varieties viz. MTU 1010 and JGL 17004 in both the years. The lowest plant height was recorded with JGL 17004. The differential response of different varieties to varied dates of sowing was well documented by several researchers(Sing *et al.,*2002,Akhter*et al*. , 2007 and Rai and Kushwaha, 2008).

There was no significant difference in drymatter accumulation noticed from 18 June (D_1) to 4 August (D_5) and a significant reduction was observed only in the crop sown late on 18 August (D_5) in 2012(Table 1). Whereas in 2013, the effect of sowing dates on drymatter accumulation was not significant.The early sown crop might have better opportunity toexperience favourable cardinal temperature, rainfall, solar radiationresulted in higher plant height thereby accumulation of more drymatter compared to late sown crop. Several researchers evidently proved that, a marked decrease in drymatter accumulation with delay in sowing of aerobic rice (Gill *et al.,* 2006;Haghverdian, 2010 and Soghra*et al.*, 2013). Among the varieties, the long duration cultivar of MTU 1061 (V_4) accumulated more drymatter m^{-2} (1416 g m^{-2} and 1276 g m^{-2}) and was on par with the medium duration variety of MTU 11470 and significantly superior over rest of the varieties in 2012 and 2013, respectively. The difference in drymatter accumulation among the varieties might be due to their genetic potential and differential plant height.

Among the dates of sowings, the crop sown on 18 June (D_1) and 7 July (D_2) produced consistently maximum number of effective tillers m^{-2} (217 and 219) in 2012 and 2013, respectively and were on par with each other and significantly superior to 4 August (D_4) and 18 August (D_5) date sown crop (Table 1). The more number of panicles m^{-2} in early sown crop was due to the fact that the rice genotypes had longer duration for their vegetative growth compared to those sown late in the season.These results are in conformity with those of Rai and Kushwaha (2008) who observed a marked reduction in the number of tillers m^{-2} at maturity stage in 15 July sown crop as compared with June 15 and 01 July sown crop. Among the varieties the extra short and short duration varieties *viz.*, JGL 17004 (V_1) and MTU 1010 (V_2) registered higher number of effective tillers m^{-2} and were on par with each other and significantly superior over medium (V_3) and long (V_4) duration varieties. The lowest number effective tillers m^{-2} in medium and long duration varieties than the extra short andshort duration varieties might be due to prolonged growth period,more relative growth rate andbiomass production resulted in intra plant competition among the tillers for growth resources lead to more mortality of tillers when compared to short and extra short duration cultivars (Gill *et al.*, 2006).

The higher number of filled spikelets panicle^{-1} (183 and 159) was recorded with 18 June (D_1) sown crop during 2012 and 2013, respectively and was significantly superior to rest of the dates in 2012 and it was on par with 7 July (D_2) and 20 July (D_3) sown crop in 2013 (Table 1).In earlier sown crop more number of spikelets panicle^{-1} might be due to favourable environment which might have helped in production of longer panicles and more number of spikelets panicle^{-1}. Late sowing shortened the growth period of the plant which reduced the number of grains panicle^{-1} than early sown crop under aerobic culture (Muhammad *et al.*, 2010). Among the varieties the medium duration cultivar JGL 11470 (V_3) was recorded significantly the highest number of filled spikelets panicle^{-1} (214 and 210)over JGL 17004 (V_1), MTU 1010 (V_2) and MTU 1061(V_4) and was followed by the extra short duration variety JGL 17004 (V_1), which in turn significantly superior (178 and 165) to MTU 1010 (V_2) and MTU 1061(V_4) in 2012 and 2013, respectively (Table 1). The number of spikelets panicle^{-1}is basically genetic feature of a variety. The genotypic variation among the varieties in terms of number of filled spikelets panicle^{-1} was well documented by the several researchers(Reddy*et al.,* 2012, Mukesh *et al.*, 2013 andPraveen *et al.,* 2013). The number of filled spikelets panicle^{-1} recorded with each variety was distinct and differed significantly across all the dates of sowing during both the years of study (Table 3). In 18 June (D_1) sown crop, recorded significantly the more number of filled spikelets panicle^{-1} (256 and 224) with the medium duration variety JGL 11470 (V_3) followed by the extra short duration variety JGL 17004 (188 and 154) and which in turn significantly superior to long (MTU 1061) and short (MTU 1010) duration varieties during 2012 and 2013, respectively. The similar trend was observed across all the dates of sowing during both the years of study. The variation in number of grains panicl-^{1} between the cultivars was due to difference in their genetical features. However, environment played a significant role in difference within the cultivar in terms of number of filled grains panicle^{-1} i.e. it was reduced with delayed sowing in all the cultivars.

The crop sown on 7 July (D_2) and 20 July (D_3) recorded more 1000 grain weight (17.4 g and 17.4 g) and was significantly superior to 18 June (D_1), 4 August (D_4) and 18 August (D_5) sown crop and the 1000 grain weight observed with 18 June (D_1) and 4 August (D_4) sown crop was comparable with each other and significantly superior to 18 August (D_5) sown crop in 2012(Table 1).The test weight among the dates of sowing was not significant in 2013. Higher test weight obtained from the crop sown in Julymonth might be attributed to well distributed rainfall, sufficient soil moisture, optimum photoperiod available for crop growth and development. These results are in line with the findings of Muhammad *et al.* (2010). Among the varieties, the short duration cultivar MTU 1010 (V_2) recorded significantly the highest 1000 grain weight (22.0 g and 21.9 g) over the long duration variety MTU 1061(20.5 g and 20.7 g) and which in turn significantly superior to extra short and medium duration varieties viz., JGL 17004 (13.7 g and 12.6 g) and JGL 11470 (12.1 g and 12.0 g) in 2012 and 2013, respectively. These results clearly indicated that, the 1000 grain weight is a varietal feature which might be affected least with the environmental conditions.

Significantly more grain yield (5422 kg ha^{-1} and 4944 kg ha^{-1}) was realized from the crop sown on 18 June (D_1) and was comparable with grain yield (5254 and 4893kg ha^{-1}) of 7 July (D_2) sown crop and thereafter reduction in grain yield was noticed with every successive 15 days delay in sowing from 20 July (D_3) to 18 August (D_5) during 2012 and 2013, respectively (Table 4). The higher grain yield in D_1 and D_2 was due to higher effective tillers and spikelets panicle^{-1} compared to rest of the dates (Table 1). These results were in conformity with the results of Rai and Kushwaha (2008) who reported that, 15.3 per cent more grain yield of aerobic rice was obtained from 15 June sown crop when compared to late sowing of 15 July, which might be due to optimum conditions available for growth and development resulted in more storage of photosynthates in the grain in early sown crop. Among the varieties tested, the long duration variety MTU 1061 (V_4) produced more grain yield (5547 kg ha^{-1} and 5132 kg ha^{-1})and was on par with the medium duration variety JGL 11470 (V_3), which in turn significantly superior to short (MTU 1010) and extra sort (JGL 17004) duration varieties during 2012 and 2013, respectively. These results are in line with the findings of Patra*et al.* (2008) and Gopal (2008) who reported that, the grain yield in short and medium duration varieties were lower than long duration varieties.

The results showed that, the highest straw yield (8611 kg ha^{-1} and 7772 kg ha^{-1}) was recorded in 18 June (D_1) sown crop and decreased thereafter with every 15 days delay in sowing from 7 July (D_2) to 18 August (D_5) during 2012 and 2013, respectively (Table 4). However, the decrease in straw yield with every successive 15 days delay in sowing was not significant up to 4 August (D_4) sown crops during both the years. Whereas, a significant reduction in straw yield was observed in 18 August (D_5) sown crop during both the years of study. These results were in accordance with the findings of Kumar *et al.* 2013, who reported that, the straw yield and harvest index was not differed significantly under different dates of sowing.Among the varieties tested, the long duration variety MTU 1061 (V_4) recorded significantly higher straw yield (9199 kg ha^{-1} and 8603 kg ha^{-1}) and was followed by the medium duration variety JGL 11470 (8768 kg ha^{-1} and 8396 kg ha^{-}) ^{1} which in turn significantly superior to short and extra short duration varieties viz., JGL 17004 (V_1) and MTU 1010 (V_2) in 2012 and 2013, respectively.The difference in straw yield among the varieties was also noticed byPraveen *et al.* (2013).

The higher net returns (Rs. 28994 ha^{-1} and Rs. 20432 ha^{-1}) and B:C ratio (Rs. 1.59 $ha^{-1}$and Rs. 1.40 ha^{-1}) was recorded in 18 June (D_1) sown crop, which was however, comparable with 7 July (D_2) sown crop and significantly superior to 20 July (D_3), 4 August (D_4) and 18 August (D_5) sown crop in 2012 and 2013, respectively (Table 4). Among the varieties, the long duration variety MTU 1061 (V_4) recorded significantly higher net returns (Rs.28365 ha^{-1} and Rs. 21602 ha^{-1}) and B : C ratio (Rs. 1.55 ha^{-1} and Rs. 1.41 ha^{-1}) though comparable with the medium

Table 1. Plant height (cm), dry matter accumulation (g m^{-2})effective tillers m^{-2}, filled spikelets panicle-1 and 1000 grain weightat harvest of aerobic rice as influenced by dates of sowing and varieties

Treatments	Pant height (cm)		Drymatter (g m^{-2})		Effective tillers m^{-2}		Filled spikelets $panicle^{-1}$		1000 grain weight (g)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Dates of sowing (D)										
18 June (D_1)	128	124	1358	1174	217	213	183	159	17.1	16.9
7 July (D_2)	122	120	1362	1209	219	212	173	157	17.4	17
20 July (D_3)	116	115	1343	1206	204	202	161	157	17.4	16.9
4 August (D_4)	110	106	1252	1148	199	195	149	153	16.9	16.8
18 August (D_5)	100	98	1141	1073	194	186	147	140	16.6	16.5
S.Em$\pm$	0.3	0.4	43	36	4	3	2.8	1.5	0.1	0.2
CD at 5%	0.9	1.4	140	N.S.	13	10	9	5	0.2	N.S.
Varieties (V)										
JGL 17004 (V_1)	108	106	1144	1052	214	216	178	165	13.7	12.6
MTU 1010(V_2)	109	105	1286	1128	220	210	119	105	22.0	21.9
JGL 11470 (V_3)	119	116	1318	1192	190	185	214	210	12.1	12.0
MTU 1061(V_4)	126	123	1416	1276	203	196	139	132	20.5	20.7
S.Em$\pm$	0.7	0.5	48	36	3	2	2	1.35	0.16	0.1
CD at 5%	1.9	1.6	139	103	8	7	5.9	3.9	0.5	0.4
Interaction	*	*	NS	NS	NS	NS	*	*	NS	NS

Table 2. Interaction effect of dates of sowing and varieties on plant height at harvest of aerobic rice

Treatments	2012					2013				
	JGL 17 004	MTU 1010	JGL 11470	MTU 1061	Mean	JGL 17 004	MTU 1010	JGL 11470	MTU 1061	Mean
18-June	113	113	135	152	128	110	108	135	141	124
07-July	111	113	128	137	122	109	107	127	136	120
20-July	110	108	120	128	116	107	105	120	128	115
04-August	108	105	110	117	110	104	103	107	109	106
20-August	99	104	97	99	100	102	101	91	101	98
Mean	108	108	118	126		106	105	116	123	
				S.Em±	CD at 5%				S.Em±	CD at 5%
Varieties at same date of sowing				1.5	4				0.9	4
Varieties at same or different dates of sowing				1.3	4				1.1	3

Table 3. Interaction effect of dates of sowing and varieties on filled grains panicle-1 at harvest of aerobic rice

Treatments	**2012**					**2013**				
	JGL 17 004	**MTU 1010**	**JGL 11470**	**MTU 1061**	**Mean**	**JGL 17 004**	**MTU 1010**	**JGL 11470**	**MTU 1061**	**Mean**
18-June	154	110	224	154	160	188	135	256	154	183
07-July	158	106	220	149	158	199	127	219	148	173
20-July	165	105	216	139	157	166	122	213	142	161
04-August	178	103	210	121	153	152	112	196	136	149
20-August	167	101	181	109	140	186	101	185	116	147
Mean	165	105	210	134		178.2	119.4	213.8	139.2	
				S.Em±	CD at 5%				S.Em±	CD at 5%
Varieties at same date of sowing				3	9				5.7	13.8
Varieties at same or different dates of sowing				3	9				4.9	14.7

duration variety JGL 11470 (V_3) than rest of the varieties during 2012 and 2013, respectively.

From the above results it was affirmed that, 18 June and 7 July sown crop produced higher grain yield along with net returns and more benefit-cost ratio. the long and medium duration varieties MTU 1061 and JGL 11470 were found on par and produced significantly higher grain and straw yield, net returns with more benefit-cost ratio as compared to short and extra short duration varieties viz. MTU 1010 and JGL 17004. So, it would be better to choose long and medium duration varieties and follow optimum sowing dates from second forthright of June to first week of July under aerobic culture under assured water availability conditions in Telangana State.

Table 4. Grain yield, straw yield and economicsas influenced by dates of sowing and varieties in aerobic rice

Treatment	Grain yield ($kg\ ha^{-1}$)		Straw yield ($kg\ ha^{-1}$)		Net returns		B:C ratio	
	2012	2013	2012	2013	2012	2013	2012	2013
Dates of sowing(D)								
18 June (D_1)	5422	4944	8611	7772	28994	20432	1.59	1.4
7 July (D_2)	5254	4893	8504	7857	25948	19960	1.52	1.39
20 July (D_3)	5005	4754	8354	7818	22166	17173	1.44	1.33
4 August (D_4)	4769	4377	8248	7675	18031	11620	1.35	1.22
18 August (D_5)	4573	4257	7901	7411	14422	9473	1.28	1.18
S.Em$\pm$	65	48	115	81	897	659	0.02	0.01
CD at 5%	211	156	374	263	2923	2147	0.06	0.04
Verities(V)								
JGL 17004 (V_1)	3946	3752	6954	6288	8142	4036	1.17	1.08
MTU 1010(V_2)	5066	4632	8372	7538	23330	15979	1.47	1.32
JGL 11470 (V_3)	5459	5063	8768	8396	27812	21308	1.55	1.41
MTU 1061(V_4)	5547	5132	9199	8603	28365	21602	1.55	1.41
S.Em$\pm$	63	66	77	71	858	899	0.02	0.02
CD at 5%	183	190	221	206	2479	2599	0.05	0.05
Interaction (D ×V)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	NS	NS

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EFFICACY OF DIFFERENT INSECTICIDES AGAINST COTTON LEAFHOPPERS (*Amrasca biguttula biguttula*(*Ishida*) IN RCH-2 BG-II.

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ABSTRACT

Among the sucking pests attacking cotton, leafhoppers (*Amrasca biguttula biguttula* (*Ishida*)) are very important. Seven different insecticides *viz*., imidacloprid 70% WG, fipronil 80% WG, diafenthiuron 50% WP, buprofezin 25% SC, acephate 75% SP, acetamiprid 20% SP, imidacloprid 17.8% SL were evaluated against leafhoppers in RCH-2 BG-II cotton hybrid during *kharif* 2011-12 and 2012-13. Diafenthiuron was the most effective insecticide with 77.84 per cent reduction of leafhoppers population with highest yield(2227 kg ha^{-1}) followed by imidacloprid 70% WG, fipronil , buprofezin and acephate .

Cotton (*Gossypium spp*) is an important cash crop grown under tropical and sub-tropical regions of more than 80 countries. By far, cotton, the most important natural fiber or vegetable wool has been in cultivation commercially for domestic and export needs in many countries world wide and hence called "King of Fibers" or "White Gold". India stands first in terms of area occupying 12.20 million hectares, accounting for about 25 per cent of the global cotton area with a production of 334 lakh bales CCI, 2013. India ranks second in production after China, with an average productivity of 489 kg lint ha^{-1}. This low rate of production in the country is due to many factors out of which heavy attack by a wide variety of insect pests and lack of their effective control during crop season is most important factor.

Among the sucking pests attacking cotton, leafhoppers (*Amrasca biguttula biguttula* Ishida) are very important. Both nymphs and adults suck the sap from under surface of the leaf causing specking symptoms, crinkling, distortion of leaves and reddening all along the sides of leaves with downward curling. The losses in yield due to this pest have been reported to be 1.19 q per ha (Dhawan *et al.,* 1988). At present, most of the commonly used insecticides are not able to suppress its population below economic thresholds probably because of development of resistance, mostly to organo phosphates.

Neonicotinoids have been found very effective for the control of homopteran insects attacking cotton (Kumar and Santharam, 1999 and Mohan and Katiyar, 2000).The key neonicotinyl molecules *viz.,* imidacloprid and thiamethoxam have been widely used as seed dressers as well as spray formulations. Other molecules of this group are also relied on much for protecting cotton from *A. biguttula biguttula.* Thus, it is also likely that leafhoppers may lose sensitivity to this chemistry. For their precise use, the toxicity need to be readdressed in critical terms. Hence, imidacloprid and some selected new molecules in comparison with conventional insecticides were subjected to bioefficacy studies against leafhopper, *A. biguttula biguttula* under field conditions.

MATERIAL AND METHODS

The studies on evaluation of different chemicals on RCH-2 BG-II cotton hybrid against leafhoppers in field was undertaken during *Kharif*, 2011-12 and 2012-13 at Regional Agricultural Research Station, Warangal.The experiment was laid out in randomized block design (RBD) with three replications. The plot size was 4.8 x 4.8 m^2. The space between each of the 8 treatments and 3 replications was 1.2 m. The spacing between rows and plants was 90 x 60 cm. Sowings were taken up on 19-06-2011 during *kharif* 2011-12 and on 21-06-2012 during *kharif* 2012-13. All the agronomic practices recommended by Professor Jayashankar Telangana State Agricultural University were followed. The insecticides were applied at recommended doses when the leaf hopper population was above ETL.

For assessing the comparative performance of different chemicals for their performance against leafhoppers, pre and post spray observations were made. From each plot 10 plants were selected randomly and observations on leafhoppers were recorded. The data was subjected to stastical

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analysis after suitable transformation and the means were separated by DMRT (P= 0.05%).

RESULTS AND DISCUSSION

The pre count leafhopper population (Table.1) ranged between 9.27 to 12.87 and 10.27 to 12.27 leafhoppers/top 3 leaves during 2011-12 and 2012-13, respectively, indicating a uniform infestation in all plots. The post count data of 2011-12 revealed lower leafhoppers population in diafenthiuron (77.84 per cent reduction). It was on par with buprofezin (72.12), acetamiprid(71.91), imidacloprid 70%WG (70.12) and fipronil 80%WG (69.54) but significantly different from acephate and imidacloprid 17.8% SL. Even though imidacloprid 17.8% SL was superior over untreated control, however the yields were on par with each other (954 and 821 kg ha^{-1}, respectively). The highest yield was obtained in diafenthiuron (2058 kg ha^{-1}) which was on par with imidacloprid 70% WG (1918 kg ha^{-1}) (Table.2). All the chemicals were superior over untreated control.

The perusal of data of 2012-13 (Table.1) revealed lower leafhoppers population with diafenthiuron (77.92 per cent reduction) followed by imidacloprid 70% WG(72.78), the later being on par with fipronil(71.22), buprofezin(68.71) and acephate(68.67). Acetamiprid and imidacloprid 17.8% SL recorded higher leafhoppers population. As in first season, the yields in diafenthiuron treatment were highest (2397 kg ha^{-1})(Table 2) in second season also. Besides, the yields in imidacloprid 17.8 SL was on par with untreated control.

The overall mean population of leafhoppers clearly showed that it was significantly lowest in diafenthiuron(77.84 per cent reduction) treatment followed by imidacloprid 70% WG(71.38), the latter being on par with fipronil, buprofezin, and acephate. The highest population was recorded in untreated control. Thus among the seven insecticides evaluated against leafhoppers diafenthiuron was highly effective and significantly superior with lower leafhoppers population and also higher yields in both the seasons (2058 kg ha^{-1} and 2397 kg ha^{-1} respectively). Earlier, Ramalakshmi *et al.* (2012) reported that fipronil 5% SC @ 50 g.a.i ha^{-1} and fipronil 80% WG @ 50 g.a.i ha^{-1} , diafenthiuron 50% WP @ 375 g.a.i ha^{-1} buprofezin 25% SC @150 g.a.i ha^{-1} were highly effective followed by acephate 75% SP @ 750 g.a.i ha^{-1} and imidacloprid 70% WG @ 21 g.a.i ha^{-1} .

Table 1. Efficacy of different insecticides against leafhoppers in RCH-2 (BG-II) (2011-13)

Treatments	Dose gai/ha	Leafhoppers /top 3 leaves				Overall mean
		2011-12		2012-13		
		Pre count/top 3 leaves	Per cent reduction over control	Pre count/top 3 leaves	Per cent reduction over control	
Imidacloprid 70% WG	30	9.27 (3.20)	70.21 (88.39)	10.73 (3.41)	72.78 (90.92)	71.38 (89.66)
Fipronil 80% WG	62.5	11.60 (3.54)	69.54 (57.16)	10.33 (3.36)	71.22 (89.66)	70.22 (88.41)
Diafenthiuron50% WP	750	11.00 (3.44)	77.84 (95.57)	10.27 (3.35)	77.92 (95.58)	77.84 (95.57)
Buprofezin 25% SC	600	12.87 (3.71)	72.12 (90.47)	14.80 (3.95)	68.71 (86.44)	70.20 (88.46)
Acephate 75% SP	750	10.73 (3.36)	67.97 (85.78)	12.27 (3.64)	68.67 (88.75)	68.22 (86.26)
Acetmiprid 20% SP	100	11.00 (3.44)	71.91 (90.36)	10.73 (3.42)	59.93 (74.79)	65.36 (82.58)
Imidacloprid 17.8% SL	125	9.53 (3.23)	42.16 (45.54)	11.60 (3.54)	41.59 (44.10)	41.94 (44.82)
Untreated control	-	10.27 (3.33)	-	11.93 (3.54)	-	-
CD at 5%		**NS**	**9.21**	**NS**	**6.03**	**5.72**
SE m±		**0.22**	**2.95**	**0.14**	**1.93**	**1.83**
CV %		**11.48**	**7.60**	**7.00**	**5.09**	**4.78**

Figures in the parentheses are $\sqrt{x+1}$ transformation

Table 2. Yields recorded after treatment with different insecticides

Treatments	Dose g.ai ha^{-1}	Yield in 2011-12	Yield in 2012-13	Overall mean
Imidacloprid 70% WG	30	1918^{ab}	1755^{b}	1836.67^{b}
Fipronil 80% WG	62.5	1433^{c}	1956^{b}	1695.17^{b}
Diafenthiuron 50% WP	750	2058^{a}	2397^{a}	2227.83^{a}
Buprofezin 25% SC	600	1543^{bc}	1872^{b}	1703.00^{b}
Acephate 75% SP	750	1463^{c}	1988^{b}	1725.67^{b}
Acetmiprid 20% SP	100	1433^{c}	1849^{b}	1641.17^{b}
Imidacloprid 17.8% SL	125	954^{d}	1127^{c}	1041.00^{c}
Untreated control	-	821^{d}	1022^{c}	921.83^{c}
CD at 5%		390.08	243.71	271.04
SE m±		127.37	79.57	88.50
CV %		**15.18**	**7.89**	9.58

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POPULATION DYNAMICS AND INFLUENCE OF WEATHER PARAMETERS ON THE INCIDENCE OF SUCKING PESTS ON *BT* AND NON-*BT* COTTON (*Gossypium spp.*)

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ABSTRACT

Studies on population dynamics and influence of weather parameters on the incidence of cotton sucking pests were carried out at Regional Agricultural Research Station, Lam, Guntur during *kharif* 2009 and 2010. The highest leafhopper population of 13.64 in RCH 2 BG II, 6.92 in Mallika BG II and 8.75 in L 604 was recorded in 42nd, 44th and 41st std. week, respectively, while peak whitefly population was recorded during 52nd std. week (Dec. 24-31) in RCH 2 BG II (6.96 no./top 3 leaves/plant), while it was during 1st std. week (Jan. 1-7) both in Mallika BG II (11.66 no./top 3 leaves/plant) and L 604 (8.36 no./top 3 leaves/plant). Whereas peak incidence (no./top 3 leaves/plant) of aphids and thrips (14.86 and 7.48 in RCH 2 BG II, 29.14 and 15.40 in Mallika BG II and 23.10 and 14.80 in L 604 non-*Bt*) was recorded during 44th (Oct. 29 - Nov. 4) and 41st (Oct. 8-14) std. week, respectively. Maximum and minimum temperatures, evening relative humidity and rainfall have significant positive influence on aphids, leafhoppers and thrips population while both maximum and minimum temperatures have significant negative influence on whitefly population. Morning relative humidity had significant positive impact on whitefly and significant negative impact on leafhoppers and thrips population. The multiple linear regression analysis indicated that the total influence of all the weather variables accounted for 42.9, 57.2, 69.7 and 27.6 per cent variation in aphid, leafhoppers, thrips and whitefly populations, respectively which are significant (R^2=0.429*, 0.572*, 0.697* and 0.276* in aphid, leafhoppers, thrips and whitefly populations, respectively).

Cotton (*Gossypium spp.*), being the king of natural fiber is grown in 111 countries all around the world. India ranks first in area (12.19 million hectares) and second in seed cotton production (37 million bales) and productivity (482 kgha^{-1}). It is not only a principal cash crop but also each and every part of the cotton plant are useful to farmer in one way or the other (Shivanna *et al.*, 2009). Unfortunately, cotton is highly vulnerable to insect pests. Among the insect pests, a complex of sucking insect pests on cotton include aphids, *Aphis gossypii* (Glover); leafhoppers, *Amrasca biguttula biguttula* (Ishida); whiteflies, *Bemisia tabaci* Genn.; and thrips, *Thrips tabaci* Lindeman that damage the crop with regular occurrence at different growth stages and reduce the growth and yield up to 21.20 per cent (Dhawan *et al.*, 1988). The incidence and development of all the insect pests are much dependent up on the prevailing environmental factors such as temperature, relative humidity and precipitation (Aheer *et al.*, 1994). A thorough understanding of the population fluctuation in field in relation to the weather parameters would provide an idea about the peak period of pest activity and it would help in developing an appropriate strategy for the management. Keeping this in view the present study was undertaken.

MATERIAL AND METHODS

The investigation was conducted at Regional Agricultural Research Station (RARS), Lam, Guntur during two seasons, *kharif* 2009 and 2010. A bulk crop of two stacked *Bt* cotton hybrids *viz.*, RCH 2 BG II and Mallika BG II and non-*Bt* varietal cotton *i.e.* L 604 was raised in an area of 500 m^2 under normal agronomic practices without any insect pest management practices during both the years. Population of sucking pests (no./top 3 leaves/plant) was recorded on a total of 25 plants, which were randomly selected and tagged in bulk plot of each cotton type at weekly interval with the first occurrence of the pest and continued till last picking. The meteorological data (*viz.*, maximum and minimum temperatures, morning and evening relative humidities and rainfall) was recorded simultaneously from the observatory of RARS, Lam and used for correlation and multiple linear regression analysis studies.

RESULTS AND DISCUSSION

Seasonal incidence of sucking pests

Aphids

The infestation of *A. gossypii* was observed in the 39th (Sept. 24-30) std. week and lasted up to 4th (Jan. 22-28) std. week in all the three cotton hybrids/variety with the highest aphid population of 14.86 per top 3 leaves per plant in RCH 2 BG II, 29.14 per top 3 leaves per plant in Mallika BG II and 23.10 per top 3 leaves per plant in L 604 non-*Bt* in 44th std. week (Oct. 29 - Nov. 4). The present results are in line with those of Prasad *et al.* (2008) who reported high activity window for aphids between 42nd to 52nd weeks (October to December months) in cotton during 2001 to 2006. Srinivasa Rao (2004) also

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reported peak population of aphids during 44th std. week on MECH 162 *Bt*, MECH 184 *Bt* and Bunny non-*Bt* hybrids with 48.8, 42.8 and 62.6 aphids per three leaves per plant, respectively in Guntur district of Andhra Pradesh (Fig. 1a).

Leafhoppers

The leafhopper population crossed economic threshold level (ETL) (6 no./3 leaves)during 39th (Sept. 24-30) to 50th (Dec.10-16) std. weeks in RCH 2 BG II (except in 49th std. week), 42nd (Oct. 15-21) to 45th (Nov. 5-11) std. weeks in Mallika BG II (except in 43rd std. week) and 39th (Sept. 24-30) to 46th (Nov. 12-18) std. weeks in L 604 (except in 43rd std. week) and resulted in yellowing/hopper burn symptoms. The highest leafhopper population recorded was 13.64 (42nd std. week) in RCH 2 BG II, 6.92 (44th std. week) in Mallika BG II and 8.75 (41st std. week) in L 604. The present findings are similar to those of Prasad *et al.* (2008) who recorded peak activity window of leafhoppers from 37th to 47th std. week in cotton during 2001-2006. Similarly peak incidence of leafhoppers (3.14 no./leaf/plant) was observed during 41st std. week on MCU-5 cotton variety in Nawarangpur district of Orissa (Mohapatra, 2008) (Fig. 1b).

Thrips

Thrips population started infesting the plant during 39th std. week (Sept. 24-30) and continued up to up to 4th (Jan. 22-28) std. week in all the three cotton hybrids/variety. The population of thrips was below the ETL (24-30 no./3 leaves/plant) throughout its activity and varied from 0.04-7.48, 0.30-15.40 and 0.32-14.80 no. per three leaves per plant in RCH 2 BGII, Mallika BG II and L 604 non-*Bt*, respectively. The peak activity of thrips (7.48, 15.40 and 14.80 no./ top 3 leaves/plant in RCH 2 BG II, Mallika BG II and in L 604 non-*Bt*, respectively) was recorded during 41st std. week (Oct. 8-14). The present findings are in conformity with Rohini (2010) who reported the peak values of thrips (16.88 no./3 leaves/plant) recorded in 41st std. week at RARS, Lam, Guntur, Andhra Pradesh during 2009-10. Shivanna *et al.* (2009) reported maximum incidence (26.81 thrips/3 leaves/plant) of thrips population in April second fortnight (16-17th std. weeks) on transgenic *Bt* cotton hybrid (MRC 7201 BG II) during 2008-09 in Karnataka which are in variance with present findings which might be due to the prevailing climatic conditions and hybrids at that location (Fig. 1c).

Whiteflies

The whitefly population never crossed ETL at any stage of the crop period but continued throughout crop period with population ranging from 0.78-6.96, 2.10-11.66 and 1.91-8.36 no. per three leaves per plant in RCH 2 BGII, Mallika BG II and L 604 non-*Bt*, respectively . Unlike the other sucking pests, the incidence of whiteflies was very low in all the three cotton hybrids/variety. The highest whitefly population in the present study was recorded during 52nd std. week (Dec. 24-31) in RCH 2 BG II (6.96 no./ top 3 leaves/plant), while it was during 1st std. week (Jan. 1-7) both in Mallika BG II (11.66 no./top 3 leaves/ plant) and L 604 (8.36 no./top 3 leaves/plant). The present results are contradictory to those of Prasad *et al.* (2008) who reported peak window of whitefly incidence during 44th to 48th std. weeks during 2001-06, While Purohit *et al.* (2006) observed peak incidence of whiteflies (6.39 and 12.00 no./3leaves/ plant during 2003-04 and 2004-05, respectively) during 32nd std. week on GH-8 cotton variety (Fig. 1d).

The mean seasonal aphid, thrip and whitefly population was low in RCH 2 BG II (5.80, 2.44 and 2.36 no./ top 3 leaves/plant, respectively) compared to high population in Mallika BG II (10.13, 5.00 and 5.26 no./ top 3 leaves/plant, respectively) and L 604 (8.19, 4.10 and 4.14 no./ top 3 leaves/plant, respectively) while the population of leafhoppers was low in Mallika BG II and L 604 non-*Bt* (3.84 and 4.87 no./ top 3 leaves/plant) compared to higher population in RCH 2 BG II (7.64 no./ top 3 leaves/plant). This variation of pest populations among the three cotton hybrids/variety might be due to variations in their morphological characters.

Correlation coefficients

Maximum temperature

Correlation between maximum temperature and sucking insect pests showed that maximum temperature exerted highly significant positive influence on aphids (r= 0.354**), leafhoppers (r= 0.487**) and thrips (r= 0.721**) while the influence was significantly negative (r= -0.298*) on whitefly population. The present results are in accordance with the reports of Shivanna *et al.* (2009) who reported that maximum temperature had significant positive influence on both leafhoppers and thrips in cotton crop, whereas Mohapatra (2008) and Prasad *et al.* (2008) reported that the influence of maximum temperature was significantly positive on aphids and significantly negative on whiteflies, respectively in cotton. However, the present findings are contradictory to the reports of Srinivasa Rao (2004) and Selvaraj *et al.* (2011) who reported maximum temperature had significant negative influence on cotton leafhoppers (Table 1).

Minimum temperature

The minimum temperature had a highly significant positive influence on aphids (r= 0.634**), leafhoppers (r= 0.740**) and thrips (r= 0.736**) while the influence was significant negative (r= -0.274*) on whitefly population. The present results are in accordance with Srinivasa Rao (2004), Purohit *et al.* (2006) and Rohini (2010) who reported the minimum temperature had significant positive influence on cotton aphids, leafhoppers and thrips, respectively. Whereas Prasad *et al.* (2008) who reported whitefly population had significant negative association with minimum temperature in cotton at RARS, Lam, Guntur. Contrastingly Mohapatra (2008) and Selvaraj *et al.* (2011) who reported that minimum temperature had significant negative influence on leafhoppers (Table 1).

Morning relative humidity

The morning relative humidity correlated significantly and positive with whiteflies (r= 0.349**), while the correlation was significantly negative with leafhoppers (r= -0.334*) and thrips (r= -0.605**). The present findings are in conformity with the reports of Rohini (2010) who reported morning relative humidity had significant positive and negative influence on whiteflies and thrips population, respectively at RARS, Lam, Guntur, Andhra Pradesh during *kharif* 2009, while Sitaramaraju *et al.* (2010) reported that leafhoppers showed significant negative correlation with morning relative humidity (Table 1).

Evening relative humidity

The incidence of aphids (r= 0.550**), leafhoppers (r= 0.555**) and thrips (r= 0.295*) had significant positive association with evening relative humidity. Rohini (2010) and Purohit *et al.* (2006) support the present findings, who reported that evening relative humidity had significant positive influence on aphids and leafhoppers, respectively. But differed with Prasad *et al.*, (2008) who reported that cotton aphids have significant negative association with evening relative humidity at RARS, Lam, Guntur, Andhra Pradesh in 2001-06 (Table 1).

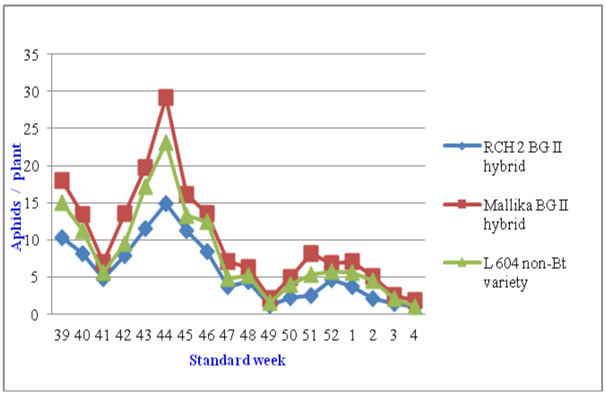
Rainfall

A positive significant effect of rainfall was found on the populations of aphids (r=0.365**), leafhoppers (r=0.358**) and thrips (r=0.277*). The present findings are in conformity with those of Purohit *et al.* (2006) and khan *et al.* (2008) who reported rainfall had significant positive influence on leafhoppers and thrips (in NIAB-98 variety), respectively. While Sesha Mahalakshmi (2007) who reported that correlation between aphids and rainfall was non-significant positive. But the findings of Srinivasa Rao (2004) who stated that rainfall had significantly negative influence on the leafhopper population during both 2002 - 03 and 2003 - 04 were contradict with the present results (Table 1).

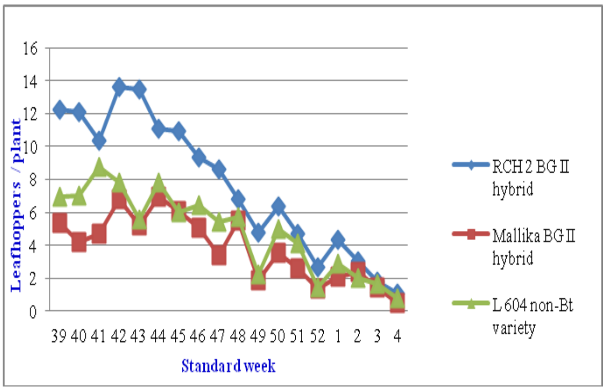
Regression equations

The multiple linear regression analysis indicated that the total influence of all the weather variables *viz.*, maximum and minimum temperatures, morning and evening relative humidities, and rainfall accounted for 42.9, 57.2, 69.7 and 27.6 per cent variation in aphid, leafhoppers, thrips and whitefly populations, respectively which are significant (R^2=0.429*, 0.572*, 0.697* and 0.276* in aphid, leafhoppers, thrips and whitefly populations, respectively). However none of these variables exerted significant influence on the variation of aphid and leafhopper population independently. Of the five variables, minimum temperature and morning relative humidity were found to have significant influence on variation of thrips population. Whereas all the variables except evening relative humidity were found to have significant influence on variation of whitefly population (Table 2).

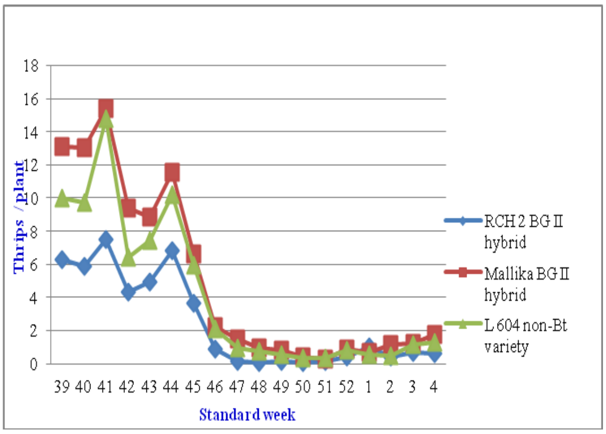
Fig. 1 Population dynamics of sucking pests on *Bt* and non-*Bt* cotton (Mean of two seasons of kharif 2009&2010)



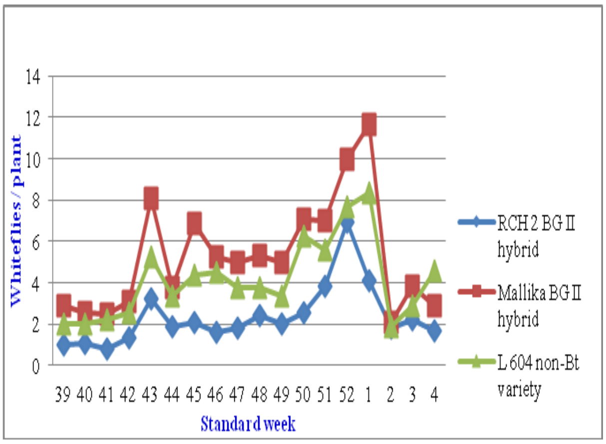
(a) Aphids, *Aphis gossypii* (Glover)



(a) Leafhoppers, *Amrasca biguttula biguttula* (Ishida)



(c) Thrips, *Thrips tabaci* Lindeman



(d) Whiteflies, *Bemisia tabaci* Genn.

Table 1. Correlation between weather parameters and incidence of sucking pests on cotton (Mean of two seasons *kharif* 2009-10&2010-11)

Weather parameter	Correlation coefficient (r)			
	Aphids	Leafhoppers	Thrips	Whiteflies
Maximum temperature (^{O}C)	0.354**	0.487**	0.721**	-0.298*
Minimum temperature (^{O}C)	0.634**	0.740**	0.736**	-0.274*
Morning relative humidity (%)	-0.150	-0.334*	-0.605**	0.349**
Evening relative humidity (%)	0.550**	0.555**	0.295*	-0.165
Rainfall (mm)	0.365**	0.358**	0.277*	-0.245

Table 2. Multiple linear regression analysis between weather parameters and incidence of insect pests on cotton (Mean of two seasons *kharif* 2009&2010)

Insect name	Regression equation	R^2
Aphids	$= -37.686 + 0.424X_1 + 0.858X_2 + 0.061X_3 + 0.171X_4 - 0.026X_5$	0.429*
Leafhoppers	$= -2.183 + 0.009X_1 + 0.721X_2 - 0.126X_3 + 0.072X_4 - 0.027X_5$	0.572*
Thrips	$= 4.433 + 0.347X_1 + 1.057X_2{}^{*} - 0.320X_3{}^{*} - 0.073X_4 + 0.006X_5$	0.697*
Whiteflies	$= 5.158 - 1.026X_1{}^{*} + 0.851X_2{}^{*} + 0.258X_3{}^{*} - 0.132X_4 - 0.063X_5{}^{*}$	0.276*

Where X_1 = Maximum temperature
X_2 = Minimum temperature
X_3 = Morning relative humidity
X_4 = Evening relative humidity
X_5 = Rainfall

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GENETIC VARIABILITY, HERITABILITY AND CHARACTER ASSOCIATION STUDIES FOR GRAIN YIELD AND YIELD ATTRIBUTING TRAITS IN SEGREGATING POPULATION OF RICE (*Oryza staiva* L.)

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ABSTRACT

Thirty five leaf blast resistant BC_1 F_2 rice plants were evaluated for eleven morphological characters during *kharif* season, 2014 at Directorate of Rice Research (DRR), Hyderabad. Analysis of variance revealed significant differences among the genotypes for most of the traits. Phenotypic coefficients of variability were higher than genotypic coefficients of variability for all the traits. Phenotypic coefficient of variation ranged from 9.58-49.59, while genotypic coefficient of variation ranged from 9.51-54.90. High heritability was recorded in number of filled grains (97%) followed by spikelet fertility (86%), number of productive tillers/plant (56%). Genetic advance as percentage of mean ranged from 4.50 % (days to flowering) to 56.1% (number of filled grains/panicle). Plant yield showed positive and significant correlation with panicle weight (0.392) and spikelet fertility (0.817). Number of filled grains (1.166), number of tillers (1.101), plant height (0.351) and panicle weight (0.073) had positive direct effect on plant yield and unfilled grains with high negative direct effect (-1.043). The results indicated that for increasing rice yield with blast resistance, a genotype should possess more number of filled grains, number of tillers per plant, high spikelet fertility and large panicle size with medium plant height.

Rice *(Oryza sativa* L.*)* is one of the most important cereal crop and occupies second prominent position in global agriculture. Globally rice is being grown in 117 counties and accounts for more than one fifth of the calories consumed by ~ 3 billion people as a source o staple food and India alone produces one fourth (22%) of the rice produced in the world. Rice is grown in a n area of 165 million hect5ares with a production 744.9 million tones and with an average productivity of 4.48 tonnes per hectare (FAO Rice Market Monitor, 2014). In India it is grown in an area of 44 million hectares with the production and productivity levels of 104.32 million tones and 2372 kg ha^{-1}, respectively. In Andhra Pradesh it is grown in an area of 41.31 lakh hectares.

With production of 130.8 lakh tones and productivity of 3166 kg ha^{-1} (Directorate of Economics and Statistics, 2013).

The predicted water scarcity, decrease in arable land, the constant battle against new emerging pathogens and pests, will impose great challenges for rice breeders and agricultural scientists (Khush, 2005). Rice productivity is adversely impacted by numerous biotic and biotic factors. Approximately – 52% of the world's rice production is lost annually sowing to eh damage caused by biotic factors, of which ~ 21% and ~30% is attributable to the attack of insect pest and diseases (Yarasi *et al*., 2008).

For ensuring stable production and adequate supply of rice, it is imperative to mitigate the losses caused by different insect pests and pathogens. Genetic resistance of host plants to infestation and damage by insects and disease offers the most effective, economical and environmentally stage method of crop protection. The plant breeding strategies have to be focused on the rapid attainment of new varieties with higher productivity. Selection of blast resistant genotypes with higher grain yield among segregating progenies would be more desirable than compromising for only resistance. Rice yield is a quantitative trait controlled by several minor genes, under the great influence of environment. Phenotypic selection of desirable genotype based on plant yield alone is highly misleading. Hence, the knowledge about nature and extent of association that existed between plant yield and its component characters is needed for an effective selection. The information about heritability, genetic advance, phenotypic and genotypic variance components of various economic traits are the immense importance to a plant breeder for identifying desirable genotypes. Path analysis provides information of direct and indirect effects each yield attributing trait and helps in phenotypic selection (Dewey and Lu, 1959; Khan *et al*., 2009).

The present experiment was conducted to select agronomically superior leaf blast resistant genotypes in segregating population of rice.

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MATERIAL AND METHODS

The research was conducted at Directorate of Rice Research (DRR), Rajendranagar, Hyderabad, during 2011-2013.

Plant material

The donor BPT/LAC/TETEP for blast resistance was crossed with female B95-1 (Improved Samba Mahsuri) parent and the Selected F_{1S} were backcrossed with B95-1 to raise BC_1F_{1S}. This BC_1F_{1S} were further selfed to develop segregating BC_1F_2 populations (Chahal and Ghosal, 2002).

Field screening for blast resistance

200 BC_1F_{12} individual having introgressed blast resistant genes, in B95-1 background were evaluated for their phenotypic confirmation in uniform blast nursery (UBN) during *Kharif* 2013, Pathology section, DRR, Hyderabad. The test material was surrounded by densely sown spreader rows of susceptible rice cultivar HR 12. To facilities heavy infection, high humidity was maintained by giving overhead irrigation (once in 2-3 days) throughout the growing period. The disease reaction on each line was recorded at 30 DAS and 60 DAS, standard 0-9 scale (IRRI, 1996). Further, the per cent disease index (PDI) was worked out using formula described by Wheeler (1969).

Biometric observations

Various agronomic characters such as plant height (cm), days to flowering, Number of tillers/plant, number of panicles/plant, panicle length (cm), panicle weight (g), number of filled grains per panicle, spikelet fertility (%), 1200 grain weight (g) and single plant yield (g), were recorded individually in 35 BC_1F_{2S} which showed leaf blast resistance (0-3 scale). Yielding ability of each segregating individual was compared with the standard check variety, Improved Samba Mahsuri.

Biometric observations

Various agronomic characters such as plant height (cm), days to flowering, Number of tillers/plant, number of panicles/plant, panicle length (cm), panicle weight (g), number of filled grains per panicle, spikelet fertility(%), 100 grain weight (g) and single plant yield (g), were recorded individually in 35 BC_1F_{2S} which showed leaf blast resistance (0-3 scale). Yielding ability of each segregating individual was compared with the standard check variety, Improved Samba Mahsuri.

Statistical analysis

The data collected were statistically analyzed for analysis of variance (ANOVA) as per Panse and Sukhatme (1978), Phenotypic, genotypic and environment variance was calculated using the formula suggested by Empig *et al*, (1970). The phenotypic and geneotypic coefficients of variation were calculated according to Burton and Devane (1953). Broad sense heritability (h^2_{bs}) and Genetic advance as a percentage of eman estimated by using the formula suggested by Hanson *et al.*, 1956 and Johnson *et al.*, (1955). Genotypic correlation coefficient was estimated as per Weber and Moorthy (1952) and path coefficient anlaysis as suggested by Dewey and Lu, (1959).

RESULTS AND DISCUSSION

Analysis of variance indicated that the differences among genotypes for most of the characters under study were found significant at á=0.05. Mean, SE (m), phenotypic, genotypic and environmental variances, phenotypic (PCV) and genotypic (GCV) coefficient of variation, board sense heritability (%) and genetic advance (% of mean) were estimated in the BC_1F_{1S} (Table 1). Phenotypic coefficients of variability were slightly higher than genotypic coefficients of variability for all the traits (Zahid *et al.*, 2006; Khan *et al.*, 2009) and it ranged from 9058-49.59. The genotypic co-efficient of variation was highest for grain yield per plant followed by number of panicles, number of tillers, panicle weight, spikelet fertility and number of filled grains was also observed by Augustina *et al.*, 2013. Highest heritability was recorded in number of filled grains (97%) followed by spikelet fertility (86%), number of panicles (80%) and number of tillers (56%). High Genetic advance as percentage of mean was recorded for number of filled grains (56.1%) followed by spikelet fertility (42.3%), number of panicles (35%) and grain yield per plant (31%). Estimates of theses genetic parameters are useful in making efficient phenotypic selection of desirable genotypes with the traits of interest. Hussain *et al.*, 2003; Khan *et al.*, 2009; Immanuel Selvaraj *et al*., 2011; Rahman *et al*., 2014 reported similar results for one or more characters.

Correlation of Path coefficient analysis

The association of grain yield with other characters was estimated through Correlation and Path coefficient analysis (Table 2,3). Positive and significant genetic correlation was observed between plant height and panicle length, panicle weight and spikelet fertility, panicle weight and grain yield poor plant, number of filled grains per panicle and spikelet fertility, spikelet fertility and grain yield per plant. Positive significant correlation was observed between days to flowering and number of panicles per plant. Negative significant association was found between days to flowering and number of filled grains per panicle. The results are in conformity with Immanuel Selvaraj *et al*., 2011; Seyoum 2012; Singh *et al*., 2013; Rahman., 2014.

The number of filled grains/panicle showed highest direct effect followed by number of tillers/plant, plant height and panicle weight on plant yield was also observed by Khan *et al*., 2009. High and negative direct effect was observed with number of panicles, panicle length, spikelet fertility and 100 grain weight on plant yield. Number of panicles/plant, number of filled grains per panicle and spikelet fertility showed positive and significant indirect effect on grain yield per plant (Rahman *et al*., 2014). Similarly, negative significant indirect effect of panicle length on grain yield per plant was also observed.

Table 1. Estiamtes of mean, SE(m), phenotypic, genotypic and environmental variances, phenotypic (PCV) and genotype (GCV) coefficient of variation, heritability and genetic advance (% of mean) in BC_1F_{2S}

	Mean SE(m)±	Range	Variance			Coefficient of variation		Heritability (bs) %	Genetic advance (% of mean)
			Phenotype	Genotype	Environment	PCV	GCV		
DF	96.53±2.58	82-113	84.73	83.48	1.26	9.58	9.51	29	4.5
PH (cm)	69.9±2.96	55-83	85.48	85.08	0.41	13.3	13.27	40	13.2
NT/PL	10.97±1.68	5-27	29.43	29.26	0.18	49.59	49.45	56	11
NP/PL	9.32±0.99	2-24	24.39	24.13	0.26	53.26	52.97	80	35
PL (cm)	20.69±16.35	16-23.96	6.17	5.91	0.25	9.68	9.65	18	12.5
PW (g)	1.65±13.5	0.4-2.88	2485.02	2485.01	0.01	42.74	42.74	26	10.5
NF/P	76.85±11	22.8-146.6	852.20	851.85	0.35	37.9	37.89	97	56.1
SF (%)	55.64±0.65	21.19-72.22	69.63	69.43	0.19	39.75	39.73	86	42.3
GY/Pl. (g)	9.16±0.042	1.22-20.46	26.83	26.64	0.19	55.1	54.9	48	31
100 GW (g)	2.06±1.86	1.2-2.57	0.09	0.08	0.01	14.92	13.67	53	7.6

DF-Days to flowering; PH-Plant Height (cm); NT/Pl.-Number of tillers per plant; NP/Pl.-Number of panicles per plant; PL-Panicle Length (cm); PW-Panicle Weight (g); NF/P-Number of filled grains per panicle; SF Spikelet fertility(%); GY/Pl.-Grain Yield per plant; 100 GW-100 grain weight (G)

Table 2. Phenotypic correlation coefficients among eleven morphological traits in BC_1F_{2S}

	DF	PH(cm)	NT/PL	NP/PL	PL (cm)	PW (g)	NF/P	SF (%)	100 GW (g)	GY/Pl. (g)
DF	**1**	0.039	0.292	0.361*	-0.029	-0.025	-0.423*	-0.360	-0.168	-0.275
PH (cm)		**1**	-0.082	-0.024	0.734**	0.243	0.163	0.202	-0.191	0.163
NT/PL			**1**	0.931	0.119	0.297	-0.069	-0.150	0.226	-0.142
NP/PL				**1**	0.099	0.279	-0.019	-0.140	0.40	-0.102
PL (cm)					**1**	0.246	0.170	0.104	-0.400	0.116
PW (g)						**1**	0.069	0.344**	0.156	0.392*
NF/P							**1**	0.401*	0.124	0.270
SF (%)								**1**	0.278	0.817**
100 GW (g)									**1**	0.141
GY/Pl. (g)										**1**

Table 3. Path analysis showing direct (diagonal) and indirect effect of ten agronomic traits on grain yield of BC_1F_{2S}

	DF	PH(cm)	NT/PL	NP/PL	PL (cm)	PW (g)	NF/P	SF (%)	100 GW (g)	GY/Pl. (g)
DF	**0.002**	0.014	0.3213	-0.279	0.0239	-0.002	-0.493	0.155	0.062	-0.168
PH (cm)	0.006	**0.351**	-0.089	0.018	-0.602	0.018	0.190	-0.087	-0.037	-0.191
NT/PL	0.021	-0.029	**1.101**	-0.720	-0.097	0.022	-0.081	0.065	0.032	0.290
NP/PL	0.002	-0.008	1.025	**-0.773**	-0.081	0.020	-0.023	0.060	0.032	0.420*
PL (cm)	0.011	0.258	0.131	-0.076	**-0.820**	0.018	0.198	-0.045	-0.026	-0.400*
PW (g)	0.008	0.085	0.327	-0.215	-0.202	**0.073**	0.082	-0.149	-0.089	0.156
NF/P	-0.015	0.057	-0.075	0.0151	-0.139	0.005	**1.166**	-0.173	-0.061	0.524*
SF (%)	-0.004	0.071	-0.165	0.108	-0.086	0.025	0.467	**-0.432**	-0.185	0.624*
100 GW (g)	-0.007	0.057	-0.156	0.078	-0.095	0.029	0.315	-0.353	**-0.227**	0.141

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OPTIMIZATION OF NITROGEN SCHEDULING FOR HIGHER PRODUCTIVITY IN MACHINE TRANSPLANTED RICE (*Oryza sativa* L.) IN SOUTHERN ZONE OF TELANGANA

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ABSTRACT

A field experiment was conducted at Agriculture Research Institiute (ARI), Rajendranagar, Hyderabad, Telangana on a clay loam soil during the *kharif* seasons of 2014 and 2015 to study the "Optimization of nitrogen scheduling for higher productivity in machine transplanted rice (*Oryzasativa* L.) in southern zone of Telangana". Experiment was taken up in a split plot design with three nitrogen levels (120, 160 and 200 kg N ha^{-1}) were kept as main plot treatments and three split schedules (2 equal splits at active tillering and panicle initiation, 3 equal splits at initial tillering, active tillering and panicle initiation and 4 equal splits at initial tillering, active tillering, tillering and panicle initiation) as sub plot treatments with three replications using the long duration variety BPT 5204. Application of 200 kg N ha^{-1}gave significantly higher number of panicles m^{-2} (395), panicle length (21.7cm), filled grains panicle^{-1} (237.0), grain yield (6,119 kg ha^{-1}) and straw yield (8,597 kg ha^{-1}) over 120 kg N ha^{-1}and was at par with application of 160 kg N ha^{-1}. Three equal split applications recorded maximum panicles m^{-2}(382), grain (6,028 kg ha^{-1}) and straw (8,164 kg ha^{-1}) yield. Combination of 200 kg N ha^{-1} applied at 3 equal split recorded highest grain yield, net returns and B:C ratio and was at par with 160 kg N ha^{-1} applied in 3 equal splits.

Rice (*Oryza sativa* L.) is the most important staple food for more than half of the world's population. In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products, a major source of dietary protein for most people in tropical Asia (Juliano, 1993). In India, it is grown on an area of 44.1 m ha with a production of 106.7 mt with a productivity of 2.42 t ha^{-1}. In Telangana state, rice is also the principal food crop cultivated throughout the state. The crop is cultivated in an area of about 2.01 m ha with an annual production of 6.62 m t and productivity of 3.29 t ha^{-1} (Statistical Year Book, 2015). At the current population growth rate (1.5%), the rice requirement of India by 2025 would have to be around 125 m t . In India, area under rice is expected to be reduced from 44.1 to about 40.0 m ha in the next 15-20 years and most of this reduction is attributed to water shortage and rapid urbanization. Plateauing of rice yield coupled with restriction on area expansion, shortage of water, labour and the need to achieve projected targets of about 125 m t by 2025 are the major challenges facing Indian researchers. To safeguard and sustain the food security in India, it is quite important to increase the productivity of rice under limited resources, especially land and water. Hence, the major challenges are to produce more rice per unit amount of natural resource. Among nutrients, nitrogen is the most important limiting element in rice growth and it is required in large amount (Jayanthi*et al.*, 2007). Additionally, rice production has heavy system losses of nitrogen when applied as inorganic sources in puddled field (Fillery*et al.*, 1984). Yield increase in magnitude of 70-80% of field rice could be obtained by the application of nitrogen fertilizer (IFC, 1982), a prime nutrient for protein and carbohydrate synthesis, growth and development of plant body. Optimum dose of nitrogen fertilization plays a vital role in growth and development of rice plant, thus lower dose of nitrogen seriously hampered its growth which drastically reduces yield. Synchrony of nitrogen supply with crop demand is essential in order to ensure adequate quantity of uptake and utilization and optimum yield, therefore rate and timing of nitrogen application are critical in terms of their effects on yield and are important crop management practices for improving nitrogen use efficiency and crop yields (Fageria and Baligar, 2005). Therefore, the present study was undertaken to evolve the best combination of nitrogen level and split schedules on higher productivity under machine transplanted rice cultivation.

MATERIAL AND MEHTODS

The experiment was conducted during *kharif* season of 2014 and 2015 at the Rice Section experimental site oft the Agricultural Research Institute (ARI), Rajendranagar, Hyderabad located at 17^{o}32' N latitude, 78^{o} 40' E longitude and at an altitude of 542.3 m above mean sea level. The soil was clay loam in texture, moderately alkaline in reaction (pH = 8.1), organic carbon (1.37%) and electrical conductivity (1.42 dsm^{-1}) with low available nitrogen (229 and 231 kg ha^{-1}), high available phosphorus (39.4 and 42.6 kg ha^{-1}) and potassium (531 and 535 kg ha^{-1}) in 2014 and 2015 respectively. The experiment was laid out in a split plot design where main plot

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treatments consisted of three N levels: N_1=120, N_2=160 and N_3=200 kg ha^{-1} and sub plot treatments were split schedules: S_1=2 equal splits at AT and PI, S_2=3 equal splits at IT, AT and PI and S_3=4 equal splits at IT, AT, T and PI with three replications. Nitrogen was applied in the form of urea whereas 60 kg P_2O_5 kg ha^{-1} as single super phosphate (SSP) and potassium @ 40 kg K_2O ha^{-1} as muriate of potash (MOP) were applied to all the treatments uniformly as basal. The long duration (150 days) variety BPT 5204 was used in the experiment and was machine transplanted on 23rd June and 11th July in 2014 and 2015 respectively using 15 days old seedlings spaced at 30 x 16 cm. Individual plots were of size 7.2 m x 3.0 m and borders were made 30 cm high and wide using soil levees to avoid N contamination between plots.

RESULTS AND DISCUSSION

Plant height

The use of increasing N levels was found to increase plant height where it was maximum (97.5 cm) with application of 200 kg N ha^{-1} and was at par with 160 kg N ha^{-1}. Both 160 and 200 kg N ha^{-1} recorded significantly taller plant height as compared to 120 kg N ha^{-1} (94.7 cm). Similar results were obtained by Babu*et al.* (2013) . Significantly maximum plant height (97.0 cm) was observed with 3 equal splits, then followed by 4 equal splits and least by 2 equal splits. Similar trend of observations were made by Islam *et al.* (2009). The interaction effect between N levels and split schedules was not significant on plant height.

Number of tiller m^{-2}

Significant and linear increase in number of tillers m^{-2} was observed with increasing N levels. About 99.9% of the variation in number of tillers was due to N levels and the highest number of tillers (410) was observed with the application of 200 kg N ha^{-1}, then followed by 160 kg N ha^{-1} (392) and least with 120 kg N ha^{-1} (376). Regarding split schedules, application of N in 3 equal split recorded highest (401) number of tillers m^{-2} and were at par with 4 equal splits, both significantly higher as compared to 2 equal splits which recorded least (381) number of tillers m^{-2}. Islam *et al.* (2009) found increasing number oftillers m^{-2} when nitrogen was applied in more than two splits. The interaction effect between N levels and split schedules did not significantly influenced the plant height.

Number of panicle m^{-2}

About 95.6% of the variation in number of panicles m^{-2} was due to N levels. The highest (395) number of panicles m^{-2} was produced with 200 kg N ha^{-1} which was statistically comparable to the application of 160 kg N ha^{-1} (390). The lowest number of panicle m^{-2} (343) was obtained from 120 kg N ha^{-1}. Cellular activities during panicle formation and development were favoured due to high N levels. Split schedules accounted for 61.9% of the variation in number of panicles m^{-2} where application of nitrogen in 3 equal split recorded maximum (382) number of panicles m^{-2} and were statistically similar to that of 4 equal split (380). Lowest number of panicles m^{-2} (366) was recorded with 2 equal splits. The interaction effect between N levels and split schedules was found to be non-significant.

Panicle length

The panicle length (21.7cm) was maximum with the application of 200 kg N ha^{-1} while shortest panicle (20.5cm) was with 120 kg N ha^{-1}. Application of 160 kg N ha^{-1}gave panicle length that was comparable to both 120 and 200 kg N ha^{-1}. Panicle length increased with N levels may be due to its role in panicle formation and elongation. Panicle length was not significantly affected by split schedules, similarly its interaction with N levels was found to be non-significant.

Number of filled grains panicle^{-1}

The highest number of filled grains panicle^{-1} (237.0) was obtained with 160 kg N ha^{-1} which was comparable to that of 200 kg N ha^{-1} (232.6). The lowest number of filled grains panicle^{-1} (219.7) was obtained with 120 kg N ha^{-1}. Number of filled grains panicle^{-1} was not significantly affected by split schedules, similarly its interaction with N levels was found to be non-significant.

Table 1. Growth, yield attributes and yield as influenced by N levels and split schedules from pooled means.

Treatment		Plant height (cm)	No. of tillers m^{-2}	No. panicle m^{-2}	Panicle length (cm)	No. of filled grains $panicle^{-1}$	Sterility (%)	1000-grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index	N uptake (kg ha^{-1})
Nitrogen levels (N)												
N_1 - 120		94.7	376	343	20.5	219.7	11.3	14.7	5,707	7,596	0.43	122.8
N_2 - 160		96.2	392	390	21.2	237.0	11.7	14.8	5,992	8,017	0.43	134.8
N_3 - 200		97.5	410	395	21.7	232.6	15.7	15.1	6,119	8,597	0.42	144.2
SEm±		0.4	2.4	4.1	0.2	5.8	0.8	0.3	49	102	0.01	2.7
CD at 5%		1.2	6.8	11.3	0.7	10.2	2.1	NS	137	284	NS	7.5
Stages of application												
S_1 - 2 equal split at AT and PI		95.2	381	366	21.1	224.4	13.2	14.8	5,875	7,924	0.43	129.8
S_2 - 3 equal split at IT, AT and PI		97.0	401	382	21.2	231.6	12.8	14.9	6,028	8,184	0.42	136.4
S_3 - 4 equal split at IT, AT, T and PI		96.2	397	380	21.3	233.3	12.7	14.9	5,914	8,102	0.42	134.2
SEm±		0.3	1.8	2.1	0.1	4.2	0.4	0.1	38	39	0.01	1.5
CD at 5%		0.7	4.0	4.6	NS	NS	NS	NS	82	84	NS	3.3
N x S	SEm±	0.5	3.2	3.6	0.2	7.4	1.8	0.2	65	67	0.03	2.6
	CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S x N	SEm±	0.6	3.6	5.0	0.3	8.4	1.9	0.4	73	116	0.06	3.5
	CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

IT = initial tillering, AT = active tillering, T = tillering, PI = panicle initiation

Sterility %

Maximum sterility (15.7%) was obtained with the application of 200 kg N ha^{-1} and was significantly higher as compared to 120 (11.3) and 160 kg N ha^{-1} (11.7). The sterility % was comparable with the application of 120 and 160 kg N ha^{-1}. Hussain *et al.* (2015) also observed similar results. Sterility % decreased with increase in number of split schedules but was not significant. Interaction effect between N levels and split schedules were found to be non-significant.

1000-grain weight

Though the 1000-grain weight increased slightly with increase in N levels, it was not significant. Split schedules did not significantly influencethe 1000-grain weight. The interaction between N levels and split schedules was also not significant on test weight. Because of being a genetically fixed character, test weight was not affected by N levels and split schedules. Similar results were obtained by Iqbal *et al.* (2008).

Grain yield

Maximum grain yield (6,119 kg ha^{-1}) was obtained with 200 kg N ha^{-1} and was comparable to 160 kg N ha^{-1} (5,992 kg ha^{-1}), both were significantly higher as compared to 120 kg N ha^{-1} (5,707 kg ha^{-1}). Similar results were obtained by Babu *et al.* (2013). Nitrogen levels accounted for 95.3% variation in grain yield. Significant ($p<0.05$) correlation between grain yield and number of tillers m^{-2} (0.874**), number of panicles m^{-2} (0.887**) and dry matter production (0.825**) was observed. Regression coefficient (R^2) between grain yield and plant height, tillers m^{-2}, dry matter production at harvest, panicles m^{-2}, filled grains panicle^{-1}, test weight and N uptake were 96.9, 93.8, 94.3, 95.6, 98.5, 72.4, 77.1 and 97.8 as influenced by nitrogen levels.

Split schedules significantly affected the grain yield where application of nitrogen in 3 equal splits gave maximum grain yield (6,028 kg ha^{-1}) and was significantly higher as compared to 2 and 4 equal splits which yielded 5,875 and 5,914 kg ha^{-1} respectively, both being at par. These results are in confirmity with the findings of Chaudhary*et al.* (2013). Regression coefficient (R^2) between grain yield and plant height, tillers m^{-2}, dry matter production at harvest, panicles m^{-2}, filled grains panicle^{-1}, 1000-grain weight and N uptake were 9.4, 72.1, 96.0, 61.9, 6.0, 31.0, 48.6 and 79.8 as influenced by split application. Interaction effect between N levels and split schedules on grain yield was found to be non-significant.

Straw yield

Straw yield increased linearly and significantly with increasing N levels where 200 kg N ha^{-1} recorded maximum (8,597 kg ha^{-1}), then followed by 160 (8,017 kg ha^{-1}) and least with 120 kg N ha^{-1} (7,596 kg ha^{-1}). Similar findings were made by Kumar *et al.* (2013). With respect to split schedules, maximum straw yield (8,184 kg ha^{-1}) was recorded with 3 equal splits and was statistically similar to 4 equal splits (8,102 kg ha^{-1}). However, both 3 and 4 equal split applications recorded significantly higher straw yield as compared to 2 equal split which recorded 7,924 kg ha^{-1}. Interaction effect between N levels and split schedules on straw yield was found to be non-significant.

Harvest index

The individual effect of N levels and split schedules and their interaction did not significantly affect the harvest index. Kamruzzaman*et al.* (2013) found no significant effect on harvest index as influenced by N levels and split schedules.

Nitrogen uptake

Total nitrogen uptake increased linearly and significantly with increasing N levels where application rate of 200 kg N ha^{-1} observed highest nitrogen uptake (144.2 kg ha^{-1}), then followed by 160 kg N ha^{-1} (134.8 kg ha^{-1}) and least with 120 kg N ha^{-1} (122.8 kg ha^{-1}). The higher nitrogen uptake with 200 kg N ha^{-1} may have directly related to the higher grain and straw yield obtained at that N level. Panday*et al.* (2007) also observed higher uptake with 200 kg N ha^{-1}. Split schedules produced significant changes in nitrogen uptake where 3 equal splits recorded maximum (136.4 kg ha^{-1}) uptake and was at par with 4 equal splits (134.2 kg ha^{-1}). Both 3 and 4 equal split applications registered significantly higher nitrogen uptake as compared to 2 equal split applications (129.8 kg ha^{-1}). Similar findings were made by Chaudhry*et al.* 2013) . Interaction effect between N levels and split schedules on nitrogen uptake was found to be non-significant.

Economics

Interaction effect between N levels and B:C ratio was non-significant however, highest net returns (56, 286 Rs. ha^{-1}) and B:C ratio (1.21) was obtained with the combination of 200 kg N ha^{-1} applied in 3 equal splits, then followed by 200 kg N ha^{-1} applied at 4 equal splits (55,355 Rs. ha^{-1} and 1.19) and then by 160 kg N ha^{-1} with 3 equal splits (54,490 Rs. ha^{-1} and 1.18).

Table 2. Interaction effect of N levels and split schedules on grain yield, net returns and B:C ratio.

Interaction		Grain yield	Net returns	B:C ratio
(N level x split schedule)		**(kg ha^{-1})**	**(Rs. ha^{-1})**	
120 kg N ha^{-1} x 2 equal split@ AT and PI		5,640	47,831	1.05
120 kg N ha^{-1} x 3 equal split@ IT, AT and PI		5,803	50,135	1.10
120 kg N ha^{-1} x 4 equal split@ IT, AT, T and PI		5,678	48,204	1.06
160 kg N ha^{-1} x 2 equal split@ AT and PI		5,948	51,964	1.13
160 kg N ha^{-1} x 3 equal split@ IT, AT and PI		6,095	54,490	1.18
160 kg N ha^{-1} x 4 equal split@ IT, AT, T and PI		5,932	51,991	1.13
200 kg N ha^{-1} x 2 equal split@ AT and PI		6,037	53,777	1.16
200 kg N ha^{-1} x 3 equal split@ IT, AT and PI		6,187	56,286	1.21
200 kg N ha^{-1} x 4 equal split@ IT, AT, T and PI		6,132	55,355	1.19
N x S	**SEm±**	65	1,070	0.05
	CD at 5%	NS	NS	NS
S x N	**SEm±**	73	1,003	0.06
	CD at 5%	NS	NS	NS

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EFFECT OF PRICES ON MARKETING BEHAVIOR OF FARMERS- A DISTRIBUTED LAG MODEL APPROACH

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ABSTRACT

Present study was undertaken in the year 2011-12 in Nalgonda district of Andhra Pradesh to study the determinant of net income of farmers and effect of lagged prices on arrivals and current prices. Samples of 15 farmers were selected for collecting primary data. Secondary data includes prices and arrivals collected from Suryapet Agricultural Market Committee. Multiple linear regression analysis and autoregressive distributed lag models were used to analyze the data. In multiple linear regression analysis the coefficient of multiple determination was 97. Area, expenses on production material and expenses on marketing services were found significantly influencing the income of the farmers by Rs. 26704, Rs. 0.96 and Rs.0.22 respectively. Autoregressive distributed lag models for factors effecting arrivals, the coefficient of multiple determination showed that 83 percent of variation was explained by the variables in the model. Current prices and lagged prices P_{t-1} (one month lag) were found significantly influencing the arrivals of paddy by 0.374 and 1.339 quintal. Similarly, Autoregressive distributed lag models for factors effecting current arrivals, the coefficient of multiple determination showed that 86 percent of variation was explained by the variables in the model. Lagged prices P_{t-1} (one month lag), P_{t-2} (two months lag) were found significantly influencing the current price of the paddy. The current prices of the farmer would have been more by Rs. 0.525 and 0.430 if the lagged prices (P_{t-1} and P_{t-2}) were higher by one rupee.

Rice (Oryza sativa L.) is one of the most important principal crops in the country. The area under paddy cultivation in India was 39.16 M ha and production was 85.59 MT in India in 2012. In Andhra Pradesh the area under paddy cultivation was 3.2 lakh hectares and production was 104.88 lakh tones in 2012. Paddy is the most important crop in respect of production and marketing in Andhra Pradesh. Income from paddy not only depends on production but also an efficient marketing. A dynamic and vibrant marketing system with adequate supply chain infrastructure has been felt necessary to keep pace with the changing agricultural production and growing marketable surplus. Most agricultural commodity markets generally operate under the normal forces of demand and supply. However, with a view to protecting farmers' interest and to encourage them to increase production, the government also fixes minimum support prices and makes arrangements for their purchase on state account whenever their price falls below the support level. Prices in the market are formed based on supply and demand principles rather than production costs. (Erdal *et al.,* 2009) Low supply elasticity of agricultural produces in short term makes the demand critical factor to determine the price. Farmers are not well organized in input and produce markets. Education level of farmers is low. All these factors make price uncertainties for the farmers. Farmers consider the previous years' price when planning the production. Such a planning causes price and production fluctuations in agricultural production markets. As paddy is the most important crop in respect of production and marketing in Andhra Pradesh an attempt is made to study the income determinants of farmers and the effect of lagged prices on arrivals and current prices.

MATERIAL AND METHODOLOGY

The present study was carried out in Nalgonda district of Andhra Pradesh. The Suryapet Agricultural Market Committee was selected for present study. A samples of 15 farmers were selected to know the determinants of income. Secondary data was collected on prices and arrivals to assess the impact of lagged prices on arrivals and current prices.

For the present study, Multiple Linear Regression model was used to know the factors determining income of the farmers. The model included one dependent variable and five explanatory variables. The following linear model was used to determine the income of the farmer for individual crops.

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$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + u_i$

Y= Net income of the farmer (Rs)

X_1 (ACROP) = Area of the crop under consideration (ha)

X_2(MCCROP) = Material costs (Rs)

X_3 (LCCROP) = Labour costs (Rs)

X_4 (MRCCROP) = Marketing costs (Rs)

X_5 (PCROP) = price (Rs)

u_i = disturbance term

Here β_0 is the intercept term, giving average effect of Y when all the included variables were absent. The stochastic term u_i reflect intrinsic randomness in the data. β_1 to β_5 are partial regression coefficients. The partial regression coefficient, (β_1 to β_5) measures change in the mean value of Y per unit change in X_i holding other variables constant.

Autoregressive Distributed lag Models (ARDL)

Time series data was collected over a period of time. A time series is a set of observations on the values that a variable takes at different times. For the present study, monthly intervals of prices and arrivals were collected for analysis. Numbers of observations for paddy crop was 130. Time period is from April 2001 to march 2012. In regression analysis involving time series data, the regression model includes not only the current but also the lagged (past) values of the explanatory variables (the *X*'s), then it is called a Distributed-lag model (Gujarathi, 2010). If the model includes one or more lagged values of the dependent variable among its explanatory variables, it is called an Autoregressive model.

Thus, $Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + u_t$ ...... (1)

Equation (1) represents a distributed-lag model.

$Y_t = \alpha + \beta Xt + \lambda Y_{t-1} + u_t$ ....(2)

Equation (2) represents an autoregressive model.

ARDL model is an econometric dynamic model in which the independent variables influence the dependent variable with a time lag and at the same time the dependent variable is correlated with lag(s) of itself. The simplest form of an ARDL model (Baltagi, 2008) is

$Y_t = \alpha + ëY_{t-1} + â_0 X_t + â_1 X_t + u_t$ ....(3)

Equation (3) represents an autoregressive distributed lag model.

The estimation of ARDL model may result in residuals that violate the assumption of normality of the error term. This is a simplifying assumption of the classical normal linear regression model, and must be satisfied for the method of ordinary least squares to the best linear unbiased estimator (BLUE) (Muchapondwa, 2008). Autoregressive distributed lag model was formulated to study the factors determining the prices of the farmers. An ARDL (2,1) model would have 2 lags on dependent variable and one lag on independent variables. The model included one dependent variable and four explanatory variables (two lagged dependent variables, one lagged independent variable). The model was lagged once and the lag length of the model was determined by the Akaike Information Criteria (AIC). Kavinya (2013). The model was estimated using least squares method as presented below:

$P_t = \alpha + \lambda_0 P_t + \lambda_1 P_{t-2} + \beta_0 A_t + \beta_1 A_{t-1} + u_t$ ...... (5)

Where,

P_t = Prices of the crop (Rs/q)

P_{t-1} = Lagged price with one month period

P_{t-2} = Lagged price with two months period

A_t = Arrivals(q)

A_{t-1} = Lagged arrivals of produce (q)

Validity of the estimated coefficients need to be done with the help of't' test and 'F' test. Durbin-Watson statistic, d test for autocorrelation was employed to allow a decision to be made regarding the presence of autocorrelation among the residuals.

RESULTS AND DISCUSSION

Multiple linear regression and autoregressive distributed lag models were used to analyze data.

Table 1. Multiple linear regression for factors effecting income of the farmers for paddy

S.No	Variables	Coefficients	t- value
	Intercept	1619	
1.	Area (ha)	26704.25*** (1628.19)	16.401
2.	Expenses on production material	0.959*** (0.284)	3.373
3	Labour costs	0.179 (0.101)	1.761
4.	Expenses on marketing services	0.219*** (0.064)	3.405
5.	Price (Rs)	1.665 (2.990)	0.556
	R^2	0.97	
	Adj. R^2	0.95	
	F- table	65.39	
	N	15	

Note: 1) Expenses on production material include seed, FYM, fertilizers, plant protection chemicals.2)Labour costs include ploughing, sowing, manures, fertilizers and plant protection chemical application and harvesting costs. 3) Expenses on marketing services consists of bagging, hamali, chatavali, weighing, storage and commission charges.4) Figures in parenthesis are standard errors 5) **Significant at 5 % level, ***Significant at 1% level

It is observed from Table 1 that the coefficient of multiple determination R^2 for paddy farmers showed 97 percent of variation which was explained by the variables included in the model. Area, expenses on production material and expenses on marketing services were found significantly influencing the income of the farmers. One unit increase in area i.e one hectare will increase the income of farmers by Rs. 26704. Similarly one rupee increase in expenses on production material and expenses on marketing services will increase the income of the farmer by Rs. 0.96 and Rs.0.22 respectively. Large quantity of material is required for producing more quantity of produce which increases the income of the farmer. Expenses on marketing services will increase when quantity of produce was more which increases the income of the farmers.

Table 2. Autoregressive distributed lag models for factors effecting arrivals of paddy

S.No	Variables	Coefficients	t- value
	Intercept	169.94	
1.	Prices (Rs/q)	0.374*** (0.08)	4.62
2.	Lagged prices P_{t-1} (Rs/q)	1.339** (0.65)	2.04
3.	Lagged prices P_{t-2} (Rs/q)	-7.407 (6.85)	-1.08
4.	Lagged arrivals A_{t-1} (q)	-15.76 (65.19)	-0.24
	R^2	0.83	
	Adj. R^2	0.82	
	F- ratio calculated	153.82	
	N	130	
	Period	April 2001 to March 2012	
	Durbin –Watson ‘d’ statistic	1.74	

Note: 1) P_{t-1} : Lagged price (one month lag); $P_{t-2:}$Lagged price (two months lags); A_{t-1}:Lagged arrivals (one month lag 2) Figures in parenthesis are standard error 3) **Significant at 5 % level, ***Significant at 1% level

It is observed from (Table 2) that the coefficient of multiple determination R^2 for paddy showed that 83 percent of variation which was explained by the variables in the model. Current prices and lagged prices P_{t-1} (one month lag) were found significantly influencing the arrivals of paddy. One rupee increase in current prices will increase the market arrivals by 0.374 quintal. Similarly one rupee higher in lagged prices P_{t-1} (one month lag) would have increased market arrivals by 1.339 quintal. It explains the price behavior of the farmers. When the prices are high farmer's bring more produce to sell in the market. Lagged arrivals exhibited a negative sign though it was not statistically significant. It shows that if the lagged arrivals are more the current arrivals will be less. Durbin- Watson'd' statistic was employed to detect the presence of autocorrelation. It was 1.74 for sample data pertaining to paddy crop and concluded that there is no evidence of first order serial correlation.

This analysis explains the price behavior of the farmer that if the last month prices are high, brings more produce to the market to dispose his produce at high price. If last month arrivals are high, brings less produce to the market. The foregoing analysis indicates that the previous month prices were significantly influencing the current arrivals of paddy. Similarly current prices as well as lagged prices are influencing market arrivals.

It was observed from (Table 3) that the coefficient of multiple determination R^2 for paddy farmers showed that 86 percent of variation was explained by the variables in the model. Lagged prices P_{t-1} (one month lag), P_{t-2} (two months lag) were found significantly influencing the current price of the paddy. The current prices of the farmer would have been more by Rs. 0.525 and 0.430 if the lagged prices (P_{t-1} and P_{t-2}) were higher by one rupee. The Durbin- Watson'd' statistic was employed to detect the presence of autocorrelation. It was 1.85 for sample data pertaining to paddy crop and concludes that there is no evidence of first order serial correlation.

Table 3. Autoregressive distributed lag models for factors effecting current prices of paddy

S.no	Variables	Coefficients	t- value
	Intercept	42.972	
1	Lagged prices P_{t-1} (Rs/q)	0.525*** (0.08)	6.405
2	Lagged prices P_{t-2} (Rs/q)	0.430*** (0.08)	5.190
3	Arrival A_t (q)	0.00 (0.00)	-0.241
4	Lagged arrivals A_{t-1} (q)	0.00 (0.00)	0.306
	R^2	0.86	
	Adj. R^2	0.85	
	F- ratio calculated	193.90	
	N	130	
	Period	April 2001 to March 2012	
	Durbin –Watson 'd' statistic	1.85	

Note:.1) P_{t-1}: Lagged price (one month lag); P_{t-2}: Lagged price (two months lags); A_{t-1}: Lagged arrivals (one month lag) 2) Figures in parentheses are standard error 3) **Significant at 5 % level, ***Significant at 1% level

The analysis indicates that the previous month prices were significantly influencing the current prices of paddy. Similarly lagged prices as well as lagged arrivals are influencing current prices.

Prices in the market are formed based on supply and demand principles rather than production costs. The present study was carried out to know the income determinants of farmers and impact of lagged prices on arrivals and current prices. Area, expenses on production material and expenses on marketing services were found significantly influencing the income of the farmers. Current prices and lagged prices P_{t-1} (one month lag) were found significantly influencing the arrivals of paddy. Lagged prices P_{t-1} (one month lag), P_{t-2} (two months lag) were found significantly influencing the current price of the paddy. The price received by the farmers was lower in the post harvest period. Farmer who could withhold their produce and sold in later period will receive higher prices.

CONCLUSION

Prices in the market are formed based on supply and demand principles rather than production costs. The present study was carried out to know the income determinants of farmers and impact of lagged prices on arrivals and current prices. Area, expenses on production material and expenses on marketing services were found significantly influencing the income of the farmers. Current prices and lagged prices P_{t-1} (one month lag) were found significantly influencing the arrivals of paddy. Lagged prices P_{t-1} (one month lag), P_{t-2} (two months lag) were found significantly influencing the current price of the paddy.

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EVALUATION OF CERTAIN TUBEROSE (*Polianthes tuberose* L.) DOUBLE GENOTYPES FOR ASSESSING THE YIELD AND QUALITY TRAITS UNDER AGRO CLIMATIC CONDITIONS OF TELANGANA

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ABSTRACT

An experiment on the Evaluation of certain Tuberose double genotypes was conducted for four consecutive years from 2010 to 2014 at Floricultural Research Station, Hyderabad for the identification of a suitable variety for the cultivation in Telangana State. Maximum average plant height (43.2 cm), spike length (88.2 cm), no. of spikes / plant (2.7), rachis length (41.3cm), vase life (7.3 days), no. of bulbs/plant (72.8) and minimum days to flowering (66.5) were recorded in Calcutta double over check Hyderabad double. No. of leaves per plant (29.9) and floret length (5.8 cm) were recorded maximum in Vaibhav over check. No. of florets/spike (40.0) and floret diameter (4.3 cm) were recorded maximum in Suvasini over control. Size of bulb was recorded maximum in Hyderabad double (1.7).

Tuberose (*Polianthes tuberose* L.) is one of the most important cut flower in India along with other cut flowers like rose, gladiolus, chrysanthemum etc. There are only two types of Tuberose (Single and Double) cultivated in the world. Among these two types, single types are used as loose flowers whereas double varieties are highly preferred for cut flower purpose and bouquets because of the longer keeping quality of flower spikes. It is widely grown as a specimen for exhibition and for cut flower. Tuberose impregnates the atmosphere with their sweet fragrance. Valuable natural aromatic oil is extracted from the flowers for the high cost perfume industry. Its essential oil is exported to other countries at an attractive price. Double types of Tuberose is cultivated on a large scale in Karnataka, Tamil Nadu to a lesser extent it is cultivated in Andhra Pradesh. Varieties which perform well in one region may not do well in other regions of varying climatic conditions. Since there is no information available on the performance of tuberose genotypes grown well especially in Telangana, it is important to study morphological variation and performance of genotypes in Telangana location to enhance the efficiency. Present experiment has been conducted with an objective to test the promising cultivars evolved at different centres for their highest flower production and market acceptability in Telangana.

MATERIAL AND METHODS

The present investigations of Performance of Genotypes of Tuberose of certain double types was done on different genotypes of Tuberose i.e. Calcutta double, Suvasini, Vaibhav along with check Hyderabad double was carried out for four consecutive years from 2010-2014 at Floricultural Research Station, Hyderabad. The experiment was laid out in Randomised Block Design (RBD) with four replications. The bulbs were sown with spacing of 30 x 30 cm. The regularly and standard cultural operations were carried out throughout the experiment as per our recommendations.

The observations pertaining to twelve different parameters of plant height, no. of leaves/ plant, spike length, no. of spikes/plant, rachis length, days to flowering, no. of florets/spike, floret length, floret diameter, vase life, no. of bulbs/plant, size of bulb were recorded from five randomly selected plants from net plot area at regular intervals.

RESULTS AND DISCUSSION

With regard to growth characters studied among the lines, for the evaluation of four different genotypes of Tuberose for their vegetative and floral characters along with check Hyderabad double, it was observed that, Calcutta double recorded maximum

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plant height (43.2 cm) followed by Suvasinin (43.1 cm) over check Hyderabad double (40.0 cm). No. of leaves per plant was recorded maximum in Vaibhav (29.9) followed by Calcutta double (29.7) over check (27.3). These results are in accordance with the findings of P.Rachana et al., (2012). Highest spike length (88.2 cm) was recorded in Calcutta double over control (87.0 cm). The earlier findings of Vijayalaxmi *et al* (2010) are in conformity with our present study. Maximum no. of spikes / plant (2.7) was recorded in Calcutta double followed by vaibhav (2.3) over Hyderabad double (1.9) (Table–1). Maximum rachis length (41.3cm) was recorded in Calcutta double followed by Vaibhav (34.1 cm) over Hyderabad double (31.4 cm). Minimum days to flowering (66.5) were recorded in Calcutta double followed by Vaibhav (69.0) over check Hyderabad double (70.0). No.of florets / spike (40.0) were recorded maximum in Suvasini followed by Vaibhav (38.6) over control (35.7). These findings are in ascendance with the findings of Patil et al. (2009). Floret length (5.8 cm) was recorded maximum in Vaibhav over check (5.6 cm) (Table–2). Highest floret diameter (4.3) was recorded in Suvasini over control (4.1). Maximum vase life (7.3 days) was recorded in Calcutta double followed by check (6.9 days). No.of bulbs/plant (72.8) was recorded maximum in Calcutta double followed by Hyderabad double (66.7). Size of bulb was recorded maximum in Hyderabad double (1.7 cm) (Table–3). The findings of Ramachandrudu K and Thangam M(2009) in tuberose are also in line with our present study.

CONCLUSION

Four genotypes of Tuberose along with check Hyderabad double were evaluated at Floricultural Research Station, Rajendranagar and found that, maximum average plant height (43.2 cm), spike length (88.2 cm), no.of spikes / plant (2.7), rachis length (41.3 cm), vase life (7.3 days), no.of bulbs/plant (72.8) and minimum days to flowering (66.5) were recorded in Calcutta double over check Hyderabad double. No. of leaves per plant (29.9) and floret length (5.8 cm) were recorded maximum in Vaibhav over check. No. of florets / spike (40.0) and floret diameter (4.3 cm) were recorded maximum in Suvasini over control. Size of bulb was recorded maximum in Hyderabad double (1.7).

The economical characters *viz*., spike length, rachis length, no. of spikes/plant, days to flowering, no. of florets/spike, vase life are very important in Tuberose double variety. Hence, the genotypes like Calcutta double, Suvasini can be recommended for the cultivation in Telangana region.

Table 1. Evaluation of certain Tuberose (*Polianthes tuberose* L.) double genotypes for Identification of suitable variety in Telangana

S. No	Varieties	Plant height (cm)					No. of leaves plant^{-1}					Spike length (cm)					No. of spikes plant^{-1}				
		2010 - 11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG
1	Calcutta double	54.4	29.0	34.2	55.3	43.2	25.1	32.0	26.0	35.6	29.7	92.9	92.1	84.6	83.2	88.2	1.9	3.6	2.8	2.3	2.7
2	Hyderabad double	45.5	30.4	44.0	40.2	40.0	22.5	32.6	25.8	28.3	27.3	91.1	89.7	82.2	85.2	87.0	1.5	2.4	2.0	1.7	1.9
3	Suvasini	52.1	33.1	37.6	49.7	43.1	22.2	32.0	23.8	31.1	27.3	73.6	100.5	71.3	88.1	83.4	2.1	3.4	1.5	1.9	2.2
4	Vaibhav	52.7	36.7	40.5	38.1	42.0	32.7	32.8	26.6	27.3	29.9	84.7	90.5	81.2	87.3	85.9	2.2	4.3	1.4	1.5	2.3
5	Sem ±	0.8	2.9	1.2	3.4		1.3	1.5	1.2	1.2		0.9	1.5	0.1	1.3		0.3	0.8	0.3	0.3	
6	CD at 5%	2.4	3.9	4.2	7.3		3.8	5.7	NS	3.6		2.6	4.7	0.3	9.2		NS	0.4	0.1	NS	

Table 2. Evaluation of certain Tuberose double genotypes Identification of suitable variety in Telangana

S. No	Varieties	Rachis length (cm)					Days to flowering					No. of florets spike^{-1}					Floret length (cm)				
		2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG
1.	Calcutta double	42.1	39.5	45.3	38.2	41.3	66.6	68.4	66.7	64.5	66.5	26.9	31.2	37.1	40.7	34.0	5.2	5.4	5.4	5.3	5.4
2.	Hyderabad double	32.1	33.1	30.8	29.6	31.4	66.5	78.3	73.2	62.1	70.0	32.1	37.0	34.3	39.5	35.7	5.6	6.2	5.5	5.1	5.6
3	Suvasini	28.2	33.2	27.1	30.2	29.7	89.8	75.2	71.0	85.7	80.4	32.5	46.8	37.5	43.2	40.0	5.2	4.1	5.6	6.5	5.3
4.	Vaibhav	35.6	32.8	33.2	34.6	34.1	75.6	73.5	61.3	65.4	69.0	27.7	36.4	43.7	46.5	38.6	5.2	6.3	5.4	6.2	5.8
5.	Sem ±	2.7	1.4	0.9	0.7		0.8	3.5	1.2	4.2		0.8	1.5	0.7	1.5		0.1	0.2	0.1	5.3	
6	CD at 5%	8.4	4.3	2.8	2.2		2.2	9.3	4.0	7.6		2.3	7.5	2.6	3.6		0.2	0.4	NS	0.6	

Table 3. **Evaluation of certain Tuberose double genotypes Identification of suitable variety in Telangana**

S. No	Varieties	Floret Diameter (cm)					Vase life (days)					No. of bulbs plant $^{-1}$					Size of bulb (cm)				
		2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG	2010-11	2011-12	2012-13	2013-14	AVG
1	Calcutta double	3.1	4.2	4.3	3.8	3.9	6.7	8.3	7.2	6.9	7.3	77.0	73.2	68.7	72.2	72.8	1.5	1.8	0.9	1.3	1.4
2	Hyderabad double	3.4	5.0	4.4	3.6	4.1	7.0	7.3	6.5	6.8	6.9	69.7	65.7	70.1	61.2	66.7	1.4	1.9	2.2	1.2	1.7
3	Suvasini	4.5	4.3	4.4	3.9	4.3	6.7	5.2	5.0	6.2	5.8	39.0	38.5	47.3	51.2	44.0	1.5	1.7	1.1	0.5	1.2
4	Vaibhav	2.6	4.0	4.5	3.2	3.6	6.3	6.1	4.9	4.6	5.5	50.3	55.3	35.1	48.1	47.2	1.4	1.5	2.2	1.0	1.5
5	Sem ±	0.1	0.2	0.1	0.3		0.3	1.9	4.2	2.6		2.0	2.9	3.4	1.3		0.1	0.8	1.3	0.2	
6	CD at 5%	0.2	2.8	NS	2.2		NS	8.2	7.6	9.0		6.1	7.3	4.2	3.9		0.2	0.4	0.6	0.5	

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STUDIES ON EFFECTIVENESS OF PLANT GROWTH RETARDANTS IN RETARDING THE GROWTH OF ORNAMENTAL FOLIAGE PLANTS

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ABSTRACT

A pot culture study was undertaken at Floricultural Research Station, Rajendranagar, Hyderabad for two years during 2012-13 and 2013-14 to study the effect of growth retardants on growth and suitability of two ornamental foliage plants i.e *Aglaonema* Cv Ernesto's Favourite and *Schefflera arboricola* 'Trinetta'. During first year with the application of paclobutrazol @ 0.25 mg/pot the increase in plant height was drastically restricted to 1.18 cm and 1.91 cm in Aglaonema and Schefflera respectively. While in long run *i.e* at the end of second year ancymidol @ 1.00 mg/pot was found effective in restricting the plant height to 56.16 cm and 43.00 cm in *Aglaonema* and *Scheffelera* respectively. During second year, in *Aglaonema*, the soil drench with ancymidol @ 1.00 mg/pot was found effective in significantly retarding the growth of the plant with minimum number of leaves (8.66), leaf length (20.66cm), width (7.50 cm), petiole length (8.09 cm) and stem diameter (1.23 cm). While in *Schefflera*, paclobutrazol @ 0.25 mg/pot showed good response in retarding all the growth characters which was on par with ancymidol @ 1.00 mg/pot.

With the increasing population in cities and towns, houses with garden space are becoming limited. To add beauty to a house and to get immense pleasure and fun, a city dweller can grow a wide range of ornamental foliage plants in every corner of a house. Foliage plants are not only restricted to residential houses, there has a tremendous scope in the use of these plants in beautifying offices, hotels, hospitals and almost all public places. Because of their various growth habits, multitude of foliage designs, brilliant patterns of leaf variegation and texture, elegant flower shapes and colours, as well as tolerance to low light levels, foliage plants have become an integral part of contemporary design for building interiors and play an important role in our daily lives. Interiorscapes with foliage plants bring beauty and comfort to our surroundings, contribute to the psychological well-being of people (Manaker, 1997).The aesthetic and psychological enhancement of interior environments and the purification of indoor air have become catalysts in promoting the production of foliage plants and increasing their use indoors (Chen *etal.*, 2005). Indoor plants impose a wide variety of demands on light, temperature, air humidity, potting media, nutrition, water and of these availability of space is an important factor to be considered.

In producing potted plants, height control is often necessary to achieve desirable plant size and shape (Chen and Meister, 2006; Milandri *et al.*, 2008). The successful reduction of plant height through the use of growth retardants will determine whether a particular species can be manipulated and produced as a potted plant (Menhenett,1984). For several years commercial plant growers have used chemical growth retardants to modify crop growth and to obtain full and compact plants that are visually desirable to the consumer, as well as easier and less expensive to ship. The growth response to any PGR is affected by many factors including species, method of application and rate. This project explored the use of two different chemicals at different concentrations and investigates the influence of growth retardants on growth and quality of two ornamental foliage plants Aglaonema and Schefflera.

MATERIAL AND METHODS

Two separate experiments were taken up at Floricultural Research Station, Hyderabad, Telangana for two years during 2011-13 with two popular foliage plants Aglaonema and Schefflera. The experiments were laid out in Completely Randomised Design with three replications. Earthen pots of size 12" X 12" were

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filled with potting mixture containing red soil, sand and vermicompost in 2:1:1 proportion. Six month old plants of *Aglaonema* Cv Ernesto's Favourite and *Schefflera arboricola* 'Trinetta' were planted in the pots and were kept under partial shade. Immediately after planting the plants were watered with rose can. Prior to potting, all the potting mixtures were amended with Basacote (19:19:19) at the rate of 5g per pot as a basal dose and also at every two months. Growth retarding chemicals viz., paclobutrazol (Bonzi) at 0.0625 mg, 0.125mg, 0.1875mg and 0.25mg/pot and ancymidol (A-rest) at 0.25mg, 0.50mg, 0.75mg and 1.00mg/pot were applied as drench applications and the control group was treated with water. The first application of growth hormones was done at 3 weeks after the plant establishment and the subsequent applications were done at fortnight interval after the first application by the method of substrate drench (direct application to growing media) at the rate of 100ml of solution per pot. The drench method of application is said to be safer, as there is considerably less possibility of causing damage to plants (Pearse, 1974). The observations on growth parameters like plant height, number of leaves /plant, canopy width were recorded at monthly intervals from 30 to 150 DAP. Finally at the end of 2nd year, observations on other growth parameters were recorded. The data was statistically analysed by adopting the procedure of Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Application of growth retardants at different concentrations showed gradual reduction in all the growth attributes of both the ornamental foliage plants as compared to that of control. In Aglaonema the fig 1 regarding the plant height recorded at 30, 60, 90, 120 and 150 days after planting (DAP) indicated that there was a significant reduction in increase in plant height from initial stage to 150 DAP in all the treatments except control. Among the growth retardants, paclobutrazol at higher concentration of 0.25 mg pot^{-1} was more effective in controlling the plant height with an increase of only 1.18 cm during 5 months period when compared to control (6.46 cm) (Table – 1). These reports were in confirmation with the findings of Mansour and Poole (1987) in Diffenbachia and Peperomia. Ruter (1994) observed decreased shoot elongation in Juniperus sps with soil drenched paclobutrazol. Not only in ornamental foliage plants, but in ornamental bedding plants like Zinnia also the paclobutrazol drench at higher rates (0.5, 0.75 and 1.0 mg a.i. pot^{-1}) resulted in shorter plants with shorter internodes (Pinto et al., 2005).

Similarly the number of leaves developed at different stages of plant also showed gradual decrease in values with slight increase in concentration of both the growth retardants (fig- 2). The increase in number of leaves from 30 to 150 DAP in Aglaonema was only 1.83 with the soil drench of paclobutrazol @ 0.25 mg pot^{-1} which was on par with Ancymidol @ 1.00 mg pot^{-1} (2.67), while the highest number of leaves were produced in the control plants (5.70) without any treatment with growth retardants. In Aglonema, the canopy width (Table – 1) also showed similar pattern with minimum increase of 2.8 cm with the higher concentration ancymidol @ 1.00mg pot^{-1}, which was on par with Paclobutrozol @ 0.25 mg pot^{-1} (3.6cm). On contrary , the lower concentration of Ancymidol (0.25mg pot^{-1}) resulted in maximum increase in canopy width of 15.6 cm over a period of 5 months duration. This may be due to check in apical dominance, which could be due to lower levels of endogenous production of auxins and in turn induced the sprouting of lateral buds thereby resulted in increased canopy width.

The data pertaining to growth characters during 2nd year after planting revealed that in Aglaonema all the growth parameters were drastically retarded with higher concentration of Ancymidol @ 1.00 mg pot^{-1} showing minimum values of plant height (56.16 cm), number of leaves/plant (8.66), leaf length (20.66 cm) and width (7.50 cm), diameter of stem (1.23 cm) and petiole length (8.09 cm), while the application of growth retardants showed non significant influence on petiole girth. This treatment showed on par results with Paclobutrazol @ 0.25 mg pot-1 in all the growth characters of Aglaonema except diameter of stem. In Pinaceae species also 69% of reduction in shoot growth for up to six months was noticed with ancymidol at 100 µl/l as foliar spray(Duck *et al.*, 2004). Bodie (2014) also reported that A-Rest i.e ancymidol at the rate of 2.0 mg a.i. resulted in 21 percent shorter plants of Alternanthera compared to non-treated plants.

In 2nd experiment, the most widely used ornamental foliage plant *Schefflera* also showed significant difference in its growth parameters with the application of growth retardants at different concentrations (Table -2). The plant height observed at 30, 60, 90 and 120 DAP showed gradual reduction in increase in plant height over a period of four months (Fig 4) and among the treatments, the plants treated with soil drench Paclobutrazol @ 0.25mg pot^{-1} showed minimum increase in plant height (1.91cm)which was on par with Ancymidol at 1.00mg pot^{-1} (2.11cm), Paclobutrazol at 0.1875mg pot^{-1} (2.29 cm) and the same chemical at 0.125mg pot^{-1} (2.92cm). Similar pattern of production of less number of leaves per plant with the application of growth retardants was also noticed at different stages of plant (fig 5). Over a period of four months after planting, only 1.67 leaves were developed in Paclobutrazol(0.25mg pot^{-1}) treated plants when compared to control plants (6.83). The observations from Table - 2 confirm that during 2nd year after planting, the data collected on different growth parameters revealed significant reduction in plant height (43.00cm), number of leaves/plant (18.83), leaf length (14.25cm), leaf width (17.36cm) and petiole length (9.50cm) in the plants treated with Paclobutrozol at 0.25mg pot^{-1}. Paclobutrazol is a anti gibberillin compound which inhibit cell elongation. Suppression of growth by Paclobutrazol occurs due to blockage of three steps in the terpenoid pathway for the production of gibberllins by binding with compounds and inhibiting the enzymes that catalyse the metabolic reactions (Chaney, 2004). Similar results were reported by Li et al. (2009) in *Pachira aquatica*. The production interval between the leaves was maximum with 64.50 days in the Paclobutrazol (0.25mg pot^{-1}) treated plants thereby very less number of leaves were produced in the same treatment, while in control plants it took minimum of 53.17 days for the production of leaves. This may be due to no retardation of its growth cycle due to non-application of any growth retardant. It is in conformity with Hanaa and Samia(2014) who reported reduced shoot length, shoot diameter and leaf area with the foliar spray of Paclobutrazol on five year old pear trees. The soil drench of growth retardants at different concentrations showed no significant influence on petiole girth of the plant.

From the present investigation the results confirm that, out of the two growth retardants tested at different concentrations Paclobutrazol at higher concentration of 0.25mg pot^{-1} and Ancymidol at 1.00mg pot^{-1} were found to be effective in retarding the growth attributes of both the ornamental foliage plants there by giving the compact and bushy appearance of the plant suitable for interiorscaping.

Growth characters of *Aglaonema* at different dates of planting as influenced by growth retardants

Fig 1. Plant height (cm)

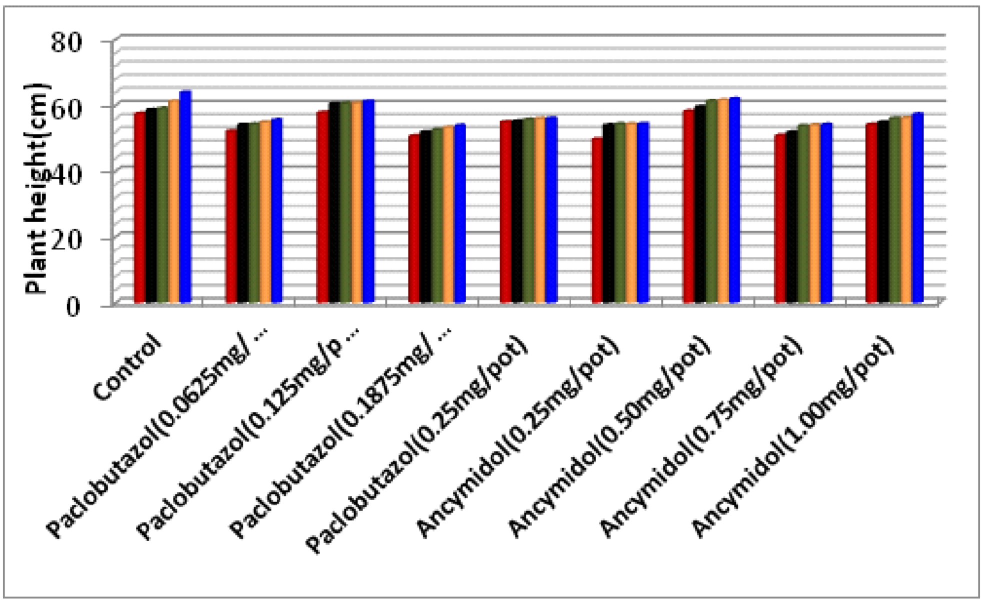


Fig 2. No. of leaves/plant

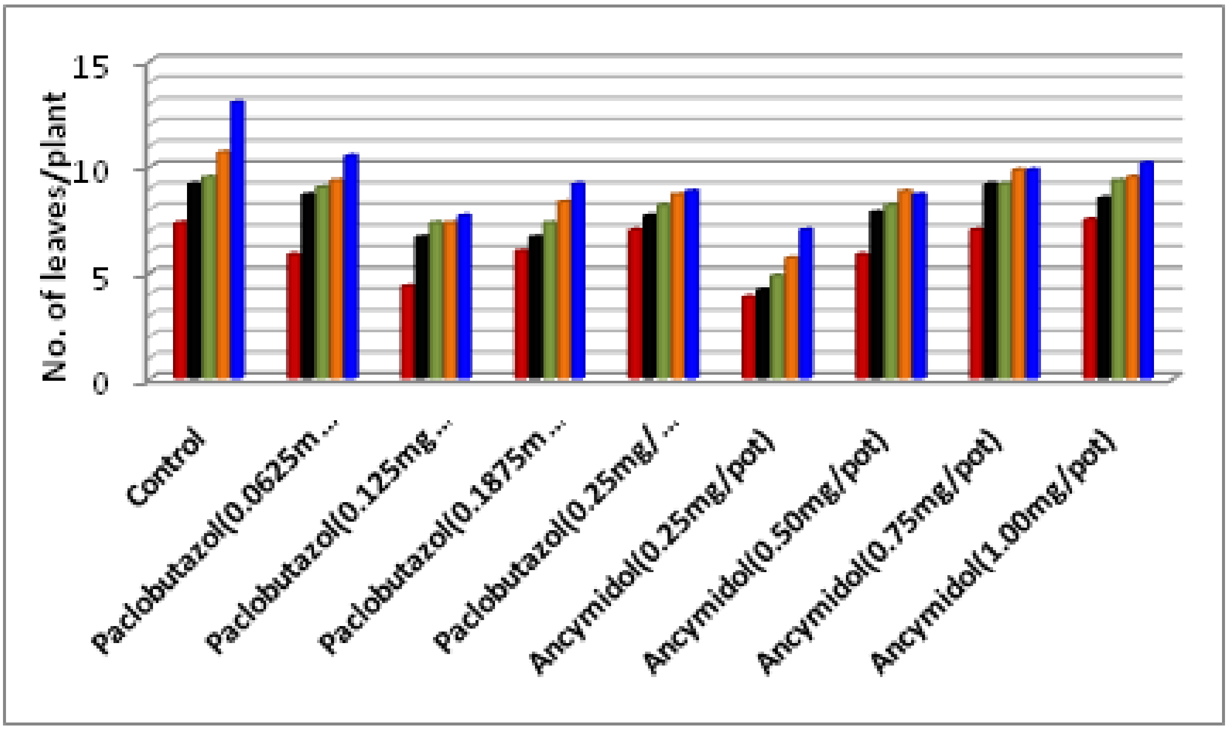
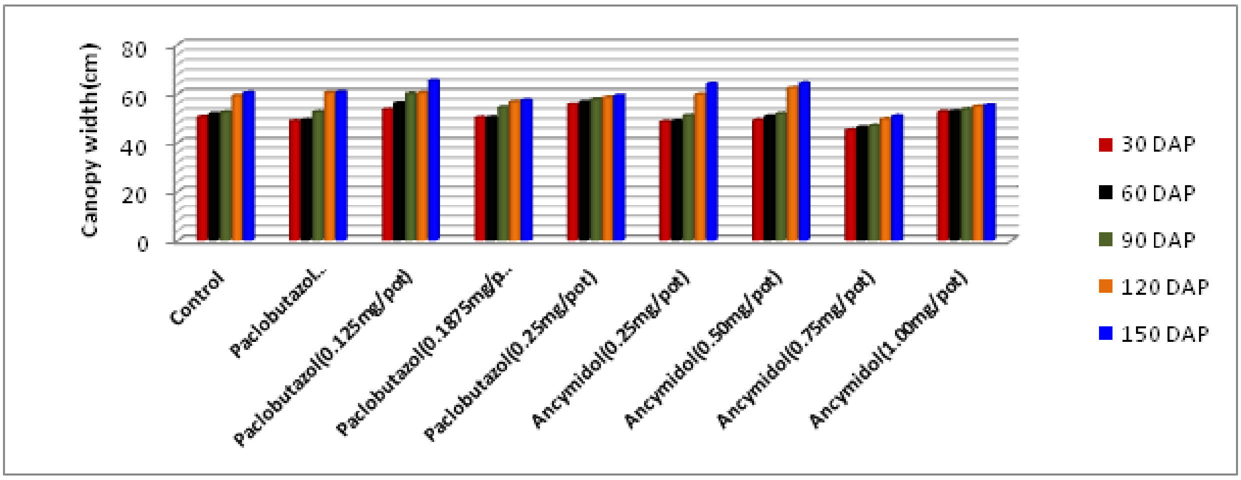


Fig 3. Canopy width(cm)



Growth characters of *Schefflera* at different dates of planting as influenced by growth retardants

Fig 4. Plant height(cm)

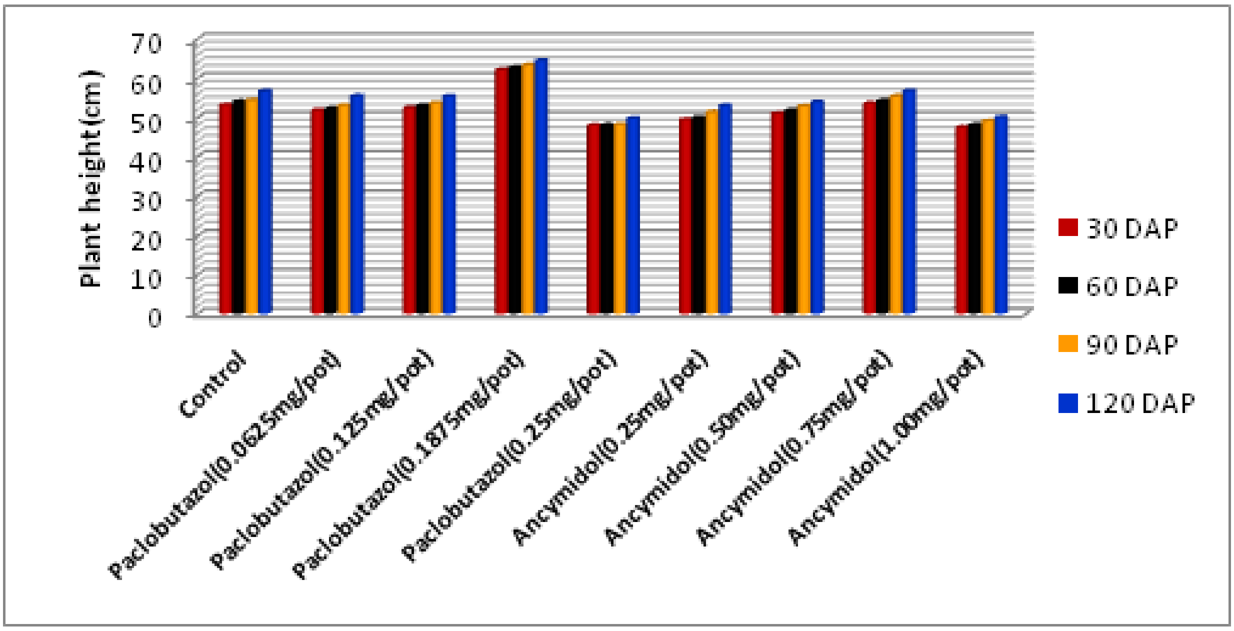


Fig 5. No. of leaves/plant

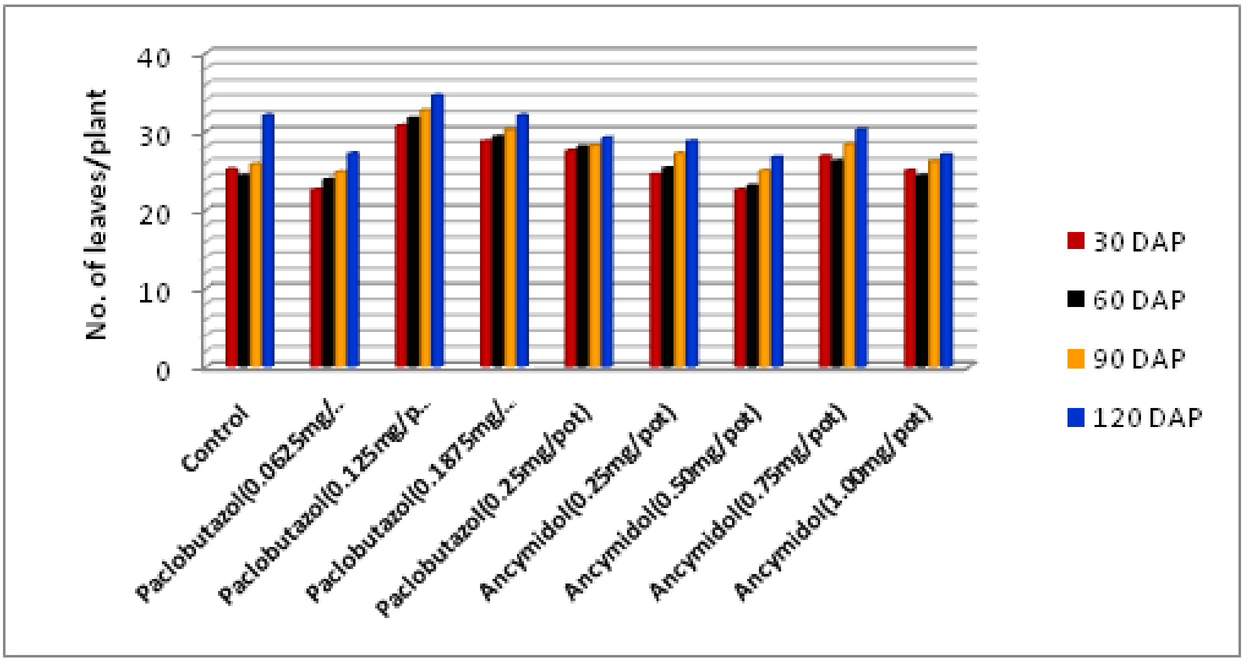


Table 1. Effect of growth retardants on growth response of *Aglaonema* at different stages of plant

Treatments	Increase in plant height from 30 to 150 DAP (cm)	Increase in no. of leaves from 30 to 150 DAP	Increase in canopy width from 30 to 150 DAP (cm)	During 2nd year after planting						
				Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf width (cm)	Diameter of stem (cm)	Petiole length (cm)	Petiole girth (mm)
Control	6.46	5.70	9.8	72.16	11.83	26.50	8.80	1.80	10.66	4.49
Paclobutazol (0.0625mg/pot)	3.50	4.67	11.8	68.66	11.50	26.16	8.50	1.47	10.33	4.46
Paclobutazol (0.125mg/pot)	3.40	3.34	12.0	68.00	10.66	24.83	8.35	1.72	10.00	4.40
Paclobutazol (0.1875mg/pot)	3.10	3.17	7.2	66.00	10.16	24.66	7.83	1.57	10.00	4.14
Paclobutazol (0.25mg/pot)	1.18	1.83	3.6	62.83	8.66	24.33	7.53	1.52	9.90	3.96
Ancymidol (0.25mg/pot)	4.52	3.17	15.6	66.33	11.33	26.16	8.50	1.43	10.16	4.31
Ancymidol (0.50mg/pot)	3.83	2.84	15.1	65.00	11.00	24.00	8.26	1.93	9.50	4.15
Ancymidol (0.75mg/pot)	3.24	2.83	5.8	56.66	9.00	23.00	7.79	1.60	8.50	3.78
Ancymidol (1.00mg/pot)	3.23	2.67	2.8	56.16	8.66	20.66	7.50	1.23	8.09	3.74
SEm±	0.31	1.25	0.32	2.88	1.17	1.09	0.35	0.07	0.65	0.197
CD at 5%	0.90	3.76	0.97	8.40	3.42	3.20	1.023	0.23	1.88	NS

Table 2. Effect of growth retardants on growth response of *Schefflera* at different stages of plant

Treatments	Increase in plant height from 30 to 120 DAP (cm)	Increase in no. of leaves from 30 to 120 DAP	During 2nd year after planting						
			Plant height (cm)	No. of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf Production interval (days)	Petiole length (cm)	Petiole girth (mm)
Control	3.52	6.83	61.50	26.33	16.66	18.46	53.17	11.50	2.56
Paclobutazol (0.0625mg/pot)	3.63	4.67	59.16	32.33	15.75	17.95	52.67	11.33	2.39
Paclobutazol (0.125mg/pot)	2.92	3.83	54.50	24.33	15.16	17.88	59.67	10.86	2.35
Paclobutazol (0.1875mg/pot)	2.29	3.33	50.73	22.16	15.06	17.70	61.83	10.00	2.30
Paclobutazol (0.25mg/pot)	1.91	1.67	43.00	18.83	14.25	17.36	64.50	9.50	2.16
Ancymidol (0.25mg/pot)	3.53	4.17	52.66	25.66	15.61	18.40	54.83	13.26	2.45
Ancymidol (0.50mg/pot)	3.00	4.17	49.33	24.83	14.60	18.13	61.67	10.50	2.44
Ancymidol (0.75mg/pot)	3.15	3.34	53.50	22.16	14.40	17.50	61.00	10.17	2.24
Ancymidol (1.00mg/pot)	2.11	2.00	43.16	19.83	14.31	17.46	62.00	10.00	2.21
SEm±	0.40	0.53	3.73	2.02	0.49	0.16	0.17	0.55	0.082
CD at 5%	1.19	1.60	11.19	6.00	1.47	0.49	0.51	1.65	NS

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INFLUENCE OF HARVESTING DATES ON RATE OF DRYING, RECOVERY, QUALITY AND SENSORY EVALUATION OF RAISINS PREPARED FROM SEEDLESS VARIETIES OF GRAPE (*Vitis vinifera* L.)

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ABSTRACT

A study was conducted at Grape Research Station, Hyderabad, to study the effect of harvesting dates on rate of drying, recovery, quality and sensory evaluation of raisins prepared from five seedless varieties of grapes. Selected grape bunches of Thompson Seedless, 2A Clone, Sonaka, Manik Chaman and Merbein Seedless were manually harvested on 9th, 12th, 14th, 17th and 21st March, respectively as first harvest date was chosen as simultaneous with the beginning of the 20 days before local harvest. Succeeding harvests *i.e.* second (10 days before local harvest), third (local harvest), fourth (10 days after local harvest) and fifth (20 days after local harvest) was done with 10 days interval following the first harvest date. The grapes were dried in ventilated rooms after pre-drying treatment with alkaline emulsion of ethyl oleate (2.4% K_2CO_3 + 1.5% ethyl oleate) with ascorbic acid 1000 ppm. Results showed that the raisins prepared from well matured grapes *i.e.* harvested between 19th April to 1st May (20 days after local harvest) recorded maximum rate of drying and average raisin weight. Significantly highest raisin recovery of 26.20% was recorded in Thompson Seedless variety harvested on 19th April (20 days after local harvest). The sensory attributes and quality parameter like brix-acid ratio, ascorbic acid, sugar (total, reducing and non-reducing) content of raisins increased with successive harvest dates and highest values recorded in late harvest. Thompson Seedless raisins were superior compared to all other varieties. From this finding it can be concluded that the raisins prepared from fully ripened grapes *i.e.* Thompson Seedless harvested on 9th to 19th April and Manik Chaman on 17th to 27th April (between fourth and fifth harvest) in Hyderabad conditions were superior for studied characters

Grape (*Vitis vinifera* L.) belongs to the family vitaceae, is an important commercial fruit crop of India, which grows in a wide range of climatic conditions. In India, about 78% of grape production is used for table purpose, nearly 17 to 20% is dried for raisin production, while 1.5% is used for juice and only 0.5% is used in manufacturing wine. Raisins are mainly produced in Sangli, Solapur and Nasik districts of Maharashtra and Bijapur district of Karnataka state by using the varieties *viz.*, Thompson Seedless and its clones *viz.*, Tas-A-Ganesh, Sonaka and Manik Chaman (Adsule *et al.*, 2008). In the world largest dried grapes are produced in USA and Turkey. The raisin production in India is about 1, 60,000 tonnes (DFTS, 2013). Raisins are a good source of fiber, K, Fe, Ca and vitamin B and are free from fat and cholesterol. They contain only natural sugars as a source of energy. The technique of raisin production in India is mostly based on the dipping of the grape bunches in emulsion having 2.5% potassium carbonate and 1.5% ethyl oleate for a duration of 2 to 4 minutes, and subsequent shade drying in open tier system (Adsule *et al.*, 2012).

The varied physical characteristics of raisins are may be due to the result of cultivars, cultural practice followed and processing differences. Telangana State falls under semi-arid tropical region wherein the major grape cultivation is confined to surrounding the Hyderabad *i.e.* Ranga Reddy, Mahabubnagar and parts of Nalgonda district. Since the harvest period (February to May) is during summer with low relative humidity, it is an excellent for raisin making in this area. The different varieties of seedless grapes grown here are vigorous and highly productive. The physico-chemical qualities of these grapes are also highly suitable for raisin making. The quality of raisins was affected by such pre-harvest operations as irrigation, nutrition, pruning, crop per vine, bunch growth condition, pest and disease control methods and the proper harvest time (Arzani *et al.*, 2009) as well as such postharvest factors as proper handling of bunches, applying a suitable method for raisin production, environmental conditions and the duration of drying time (Jalili Marandi, 1996).

MATERIAL AND METHODS

The experiment was conducted at Grape Research Station, Rajendranagar, Hyderabad in Ranga Reddy district during 2012–14. The Grape Research Station is located at 77°85' East longitude and 18°45' North latitude and at an altitude of 542.6 m above mean sea level. The experimental location falls under semi-arid tropical climatic zone, having

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annual rainfall of 800 mm. Selected grape bunches were manually harvested on 9th, 12th, 14th, 17th and 21st March for (V_1) Thompson Seedless, (V_2) 2A Clone, (V_3) Sonaka, (V_4) Manik Chaman and (V_5) Merbein Seedless, respectively as first harvest date (H_1) was chosen as simultaneous with the beginning of the 20 days before local harvest. Succeeding harvests *i.e.* second (H_2–10 days before local harvest), third (H_3–local harvest), fourth (H_4–10 days after local harvest) and fifth (H_5–20 days after local harvest) was done with 10 days interval following the first harvest date. The total soluble solids of fresh berries were increased from 18.50 to 24.34, 18.22 to 24.04, 18.19 to 23.98, 18.24 to 24.05 and 18.22 to 24.00 °Brix from the first to fifth harvest with an average increase of 0.15, 0.15, 0.14, 0.15 and 0.14 °Brix per day for Thompson Seedless, 2A Clone, Sonaka, Manik Chaman and Merbein Seedless, respectively. The harvested bunches were cleaned, washed in soap water followed by washing in pure water and dipped in solution containing 2.4% potassium carbonate, 1.5% ethyl oleate and ascorbic acid 1000 ppm for 3 minutes, and then kept for shade drying in trays. Under shade drying, the trays of pre-treated bunches were placed in well ventilated room at ambient conditions. Moisture testing was done frequently for a preserved level (approximately 15%).

After imposition of pre-drying treatment, the weight of the grapes was recorded every three days intervals during the drying period. The rate of drying was obtained by loss of moisture during the drying period (Sharma *et al.*, 2013a). Before pre-treatments, the weight of fresh grapes was recorded and after the completion of drying, the actual weight of raisins was noted. Then the percentage weight of raisins was calculated by w/w basis. The per cent weight of raisins obtained was determined as the recovery of raisins under each variety and harvesting date (Adsule *et al.*, 2008). The weight of 100 raisins was taken and calculated to obtain average weight of raisins (Adsule *et al.*, 2008).

Acidity of raisins was estimated adopting the procedure given by Ranganna (1977). Ascorbic acid content was determined by 2,6-dichloro phenolindophenol visual titration method as suggested by Ranganna (1977). Reducing sugars, total sugars and non-reducing sugars of raisins were estimated adopting the Lane and Eyon method (Ranganna, 1977). Sensory evaluation was done by panel of 15 personnel of both the genders at College of Horticulture and Grape Research Station for standard organoleptic attributes using the 5 point hedonic scale (Adsule and Banerjee, 2003). Score card contains various raisin quality attributes *viz.*, color and appearance, flavour, texture, taste and overall acceptability. The experimental data were subjected to analysis of variance (ANOVA) using factorial completely randomized design as per the procedure out lined by Panse and Sukhatme (1985). Least significant differences (Fisher's protected LSD) were calculated following significant F-test (p=0.05).

RESULTS AND DISCUSSION

The rate of drying was significantly different among harvesting dates and varieties during drying period. It was evident from Figure 1 that the water loss was gradually increased with the succeeding harvesting dates on 3rd, 6th, 9th, 12th and 15th days after pre-drying treatment. On all the days after pre-drying treatment, significantly maximum water loss was recorded in Merbein Seedless and lowest in Sonaka (Figure 2). The interaction effect on rate of drying between harvesting dates and varieties was not significant. The water loss increased with delayed harvesting in our finding might be due to permeability of skin (Christensen and Peacock, 2000). On all the days of observation, there wasn't much oscillation between the values of water loss in different varieties of grapes. Comparatively, Merbein Seedless berries were smallest and thin skin might be the result of early drying compared to other varieties (Chadha and Shikhamany, 1999). Martin and Stott (1957) also found that smaller berries of dipped Sultanas had faster drying rates than larger berries. As mentioned earlier, Grncarevic and Radler (1971) and Ramming (2009) also observed differences in drying rate between the cultivars Fiesta and Thompson Seedless and suggested that cultivar differences in berry cuticle and skin influence drying rate.

There was significant difference observed among the harvesting dates and varieties with respect to recovery of raisins (Figure 4). Significantly maximum raisin recovery of 24.70% was recorded in fifth harvest (H_5–20 days after local harvest) which was on par with fourth harvest (24.67%), whereas the lowest (21.15%) was recorded in first harvest (H_1–20 days before local harvest). It was observed to be highest in Thompson Seedless (24.65%) followed by Manik Chaman (23.80%), Sonaka (23.44%) and 2A Clone (23.12%), whereas Merbein Seedless (21.97%) recorded minimum raisin recovery. The interaction effect between harvesting dates and varieties on recovery of raisins was also significant. The recovery of raisins was significantly highest in fifth harvest of Thompson Seedless (26.20%) which was comparable with fourth harvest of Thompson Seedless (26.16%) and lowest in first harvest of Merbein Seedless (20.23%). It was evident from data that the raisin recovery showed an increasing trend with each succeeding harvest date in all the varieties. The highest raisin recovery was recorded in late harvested (H_5–20 days after local harvest) fruits which might be due to high total soluble solids and sugar accumulation in fresh berries as mentioned previously by Arzani *et al.* (2009) and Nejatian (2004). Similarly, Christensen *et al.* (1995) showed increasing raisin recovery with delayed harvest date in Thompson Seedless and mentioned that this effect can be largely attributed to increased soluble solids. The TSS of fresh berries increased from 18.50 to 24.34 °Brix in Thompson Seedless, 18.22 to 24.04 °Brix in 2A Clone, 18.19 to 23.98 °Brix in Sonaka, 18.24 to 24.05 °Brix in Manik Chaman and 18.22 to 24.00 °Brix in Merbein Seedless from the first to fifth harvest date in this finding. Obviously, Winkler (1962) reported that greater the rate of sugars in fresh grapes, greater will be the raisin recovery, which may be relatively the same for Thompson Seedless berries.

Comparison of means of an average weight of raisin showed a gradual increase from the first to fifth harvest date (Figure 3). Average raisin weight was significantly highest (0.499 g) in fifth harvest (H_5–20 days after local harvest) which was comparable with fourth harvest (0.486 g), whereas lowest (0.375 g) recorded in fifth harvest (H_1–20 days before local harvest). It was observed to be significantly highest recorded in Sonaka (0.474 g) which was on par with Manik Chaman (0.470 g) whereas it was minimum in Merbein Seedless (0.399 g). The interaction between harvesting dates and varieties on average weight of raisin was not significant. Maximum raisin weight recorded in the late harvested (H_5–20 days after local harvest) fruits which can be largely attributed to increased soluble solids as reported by Christensen *et al.* (1995). In a previous study, Adsule *et al.* (2008) explained that the average weight of raisin ranged from 0.33 to 0.98 g. There was less difference among the varieties in terms of raisin weight. In this study, maximum raisin weight recorded in Sonaka which could be due to the high moisture content in raisins (Ramming, 2009). Nejatian (2004) also reported that late harvests resulted in the highest 50-raisin weight in white seedless grapes.

It was evident from Table 1 that the acidity of raisins was influenced by harvesting dates and varieties but not their interactions. The acidity of raisins significantly decreased from first (2.23%) to fifth (0.67%) harvest dates. Regarding varieties, it was significantly lowest in Thompson Seedless (1.26%) which was on par with Manik Chaman (1.29%), whereas Sonaka recorded a maximum of 1.50% which was on par with Merbein Seedless (1.46%). The acidity of raisins gradually decreased with each successive harvesting dates. The grapes that are harvested before complete ripeness had a relatively high amount of acidity and so hence will result in an undesirable product of raisins (Sharma *et al.*, 2013b). Winkler (1962) also noted that the acid content of raisins is about the same as the assumed acid content of the grapes.

Significantly maximum brix-acid ratio of 127.89 was recorded in fifth harvest and minimum of 29.52 in first harvest which was on par with second harvest (37.34). It was recorded to be significantly highest in Thompson Seedless (79.50) which was comparable with Manik Chaman (77.72) and minimum in Sonaka (59.32). The interaction between harvesting dates and varieties was not significant.

The raisin brix-acid ratio significantly increased with each successive harvesting date, which might be due to increased TSS and decreased acidity in fresh grapes on delayed harvesting dates (Sharma *et al.*, 2013b). Winkler (1962) also noted that the brix-acid ratio of raisins is about the same as that assumed in fresh grapes. Due to higher TSS and lower acidity of raisins prepared from Thompson Seedless, it showed higher brix-acid ratio than other varieties. Nejatian (2004) also reported that raisins prepared from late harvested white seedless grapes resulted in the highest brix-acid ratio.

Table 1. Effect of harvesting dates on acidity, brix-acid ratio, ascorbic acid and sugar (total, reducing and non-reducing) of raisins prepared from seedless varieties of grapes

Harvesting dates (H)	Acidity (%)	Brix-acid ratio	Ascorbic acid (mg/100g)	Sugar (%)		
				Total	Reducing	Non-reducing
H_1 – 20 days before local harvest	2.23^{e}	29.52^{d}	24.31^{a}	57.70^{e}	55.90^{e}	1.81^{e}
H_2 – 10 days before local harvest	1.85^{d}	37.34^{d}	23.93^{b}	60.70^{d}	58.54^{d}	2.17^{d}
H_3 – Local harvest	1.32^{c}	57.38^{c}	22.04^{c}	67.06^{c}	64.58^{c}	2.49^{c}
H_4 – 10 days after local harvest	0.84^{b}	96.12^{b}	20.42^{d}	70.55^{b}	67.64^{b}	2.92^{b}
H_5 – 20 days after local harvest	0.67^{a}	127.89^{a}	19.70^{e}	74.10^{a}	71.03^{a}	3.07^{a}
S.Em±	0.03	3.02	0.07	0.67	0.64	0.04
CD at 5%	0.09	8.60	0.19	1.91	1.83	0.11
Varieties (V)						
V_1 – Thompson Seedless	1.26^{a}	79.50^{a}	22.60^{a}	69.09^{a}	66.40^{a}	2.69^{a}
V_2 – 2A Clone	1.37^{bc}	68.82^{b}	22.09^{b}	65.76^{b}	63.28^{b}	2.48^{bc}
V_3 – Sonaka	1.50^{d}	59.32^{c}	21.64^{c}	63.44^{c}	61.14^{c}	2.30^{d}
V_4 – Manik Chaman	1.29^{ab}	77.72^{a}	22.20^{b}	66.41^{b}	63.84^{b}	2.57^{b}
V_5 – Merbein Seedless	1.46^{cd}	62.89^{bc}	21.86^{c}	65.42^{b}	63.02^{b}	2.40^{cd}
S.Em±	0.03	3.00	0.07	0.67	0.64	0.04
CD at 5%	0.09	8.51	0.19	1.91	1.83	0.11
Interaction (H x V)	NS	NS	NS	NS	NS	NS

Figure with different alphabet within harvesting dates and varieties are significantly different at $p \leq 0.05$; NS- Not Significant.

Ascorbic acid content of raisins is significantly influenced by harvesting dates and varieties, but not their interactions (Table 1). It was evident from the data that the ascorbic acid of raisins significantly decreased with each successive harvesting, which might be due to increased TSS and decreased acidity in fresh grapes on delayed harvesting dates (Sharma *et al.*, 2013b). It was significantly highest in Thompson Seedless (22.60 mg 100 g^{-1}) raisins and lowest in Sonaka (21.64 mg 100 g^{-1}) raisins which were on par with Merbein Seedless (21.86 mg 100 g^{-1}) raisins. Raisins prepared from the Thompson Seedless showed highest ascorbic acid content might be due to highest ascorbic acid in fresh berries and the same was applicable to Sonaka.

Analysis of sugar (total, reducing and non-reducing) as effected by harvesting dates for raisin making in seedless varieties of grapes are shown in Table 1. There was significant difference observed among the harvesting dates and varieties with respect to sugar (total, reducing and non-reducing). It was evident from the data, that the sugar (total, reducing and non-reducing) of raisins significantly increased with each successive harvesting dates, which was observed to be directly proportional to the total soluble solids and sugars contained in the fresh grapes. In

Table 2. Effect of harvesting dates on sensory evaluation of raisins prepared from seedless varieties of grapes

Harvesting dates (H)	Color and appearance	Texture	Flavour	Taste	Overall acceptability
H_1 – 20 days before local harvest	3.13^{d}	2.55^{c}	2.53^{d}	2.56^{e}	2.57^{e}
H_2 – 10 days before local harvest	3.68^{c}	3.60^{b}	3.58^{c}	3.61^{d}	3.62^{d}
H_3 – Local harvest	3.79^{b}	3.71^{b}	3.69^{b}	3.72^{c}	3.73^{c}
H_4 – 10 days after local harvest	3.91^{a}	3.83^{a}	3.81^{a}	3.84^{b}	3.85^{b}
H_5 – 20 days after local harvest	3.97^{a}	3.89^{a}	3.87^{a}	4.09^{a}	3.96^{a}
S.Em±	0.03	0.04	0.03	0.03	0.03
CD at 5%	0.09	0.11	0.09	0.10	0.09
Varieties (V)					
V_1 – Thompson Seedless	3.76^{ab}	3.58^{ab}	3.56^{ab}	3.62^{a}	3.60^{ab}
V_2 – 2A Clone	3.69^{bc}	3.52^{abc}	3.49^{bc}	3.56^{ab}	3.54^{bc}
V_3 – Sonaka	3.60^{c}	3.43^{c}	3.40^{d}	3.47^{b}	3.45^{d}
V_4 – Manik Chaman	3.80^{a}	3.62^{a}	3.60^{a}	3.66^{a}	3.64^{a}
V_5 – Merbein Seedless	3.65^{c}	3.47^{bc}	3.45^{cd}	3.51^{b}	3.49^{cd}
S.Em±	0.03	0.04	0.03	0.03	0.03
CD at 5%	0.09	0.11	0.09	0.10	0.09
Interaction (H x V)	NS	NS	NS	NS	NS

Figure with different alphabet within harvesting dates and varieties are significantly different at $p \leq 0.05$; NS-Not Significant.

this experiment, the total, reducing and non-reducing sugars among the harvesting dates ranged from 57.70% to 74.10%, 55.90% to 71.03% and 1.81% to 3.07% respectively. Several authors also reported similar results in grapes (Christensen *et al.*, 1995 and Christensen, 2000). Arzani *et al.* (2009) studied different harvest dates on 'Paycamy' *Vitis vinifera* for green raisin production and results showed that raisin sugar content ranged from 53% to 62%.

Regarding varieties, the total, reducing and non-reducing sugar content ranged from 63.44% to 69.09%, 61.14% to 66.40% and 2.30% to 2.69%, respectively and this variation may be due to genotypic differences (Winkler, 1962 and Ramming, 2009). The varieties Thompson Seedless and Manik Chaman were found to retain high sugars in our finding, which might be due to their richness in TSS. Raisins, when dried down to 15% water, will contain about 74% sugar by weight as reported by Rosenstock (2007).

Sensory evaluation (5 points scale)

Effect of harvesting dates on sensory score (5 points scale) for color and appearance, texture, flavour, taste and overall acceptability of raisins prepared from seedless grape varieties are presented in Table 2.

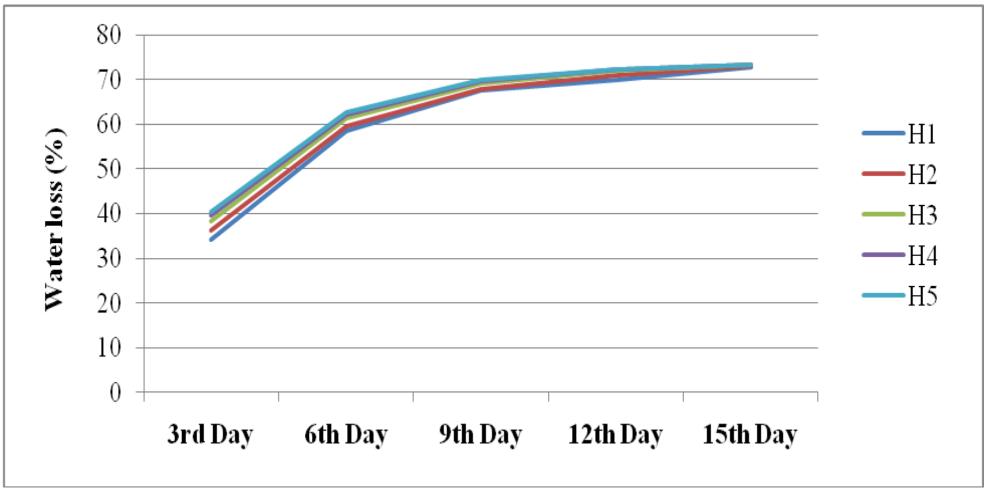


Figure 1. Rate of drying (per cent water loss during drying period) of grapes as affected by harvesting dates.

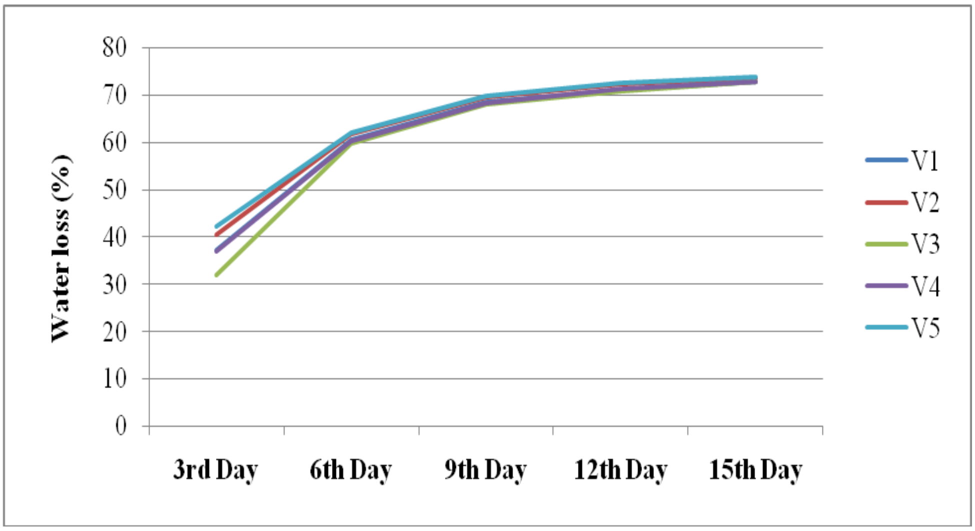
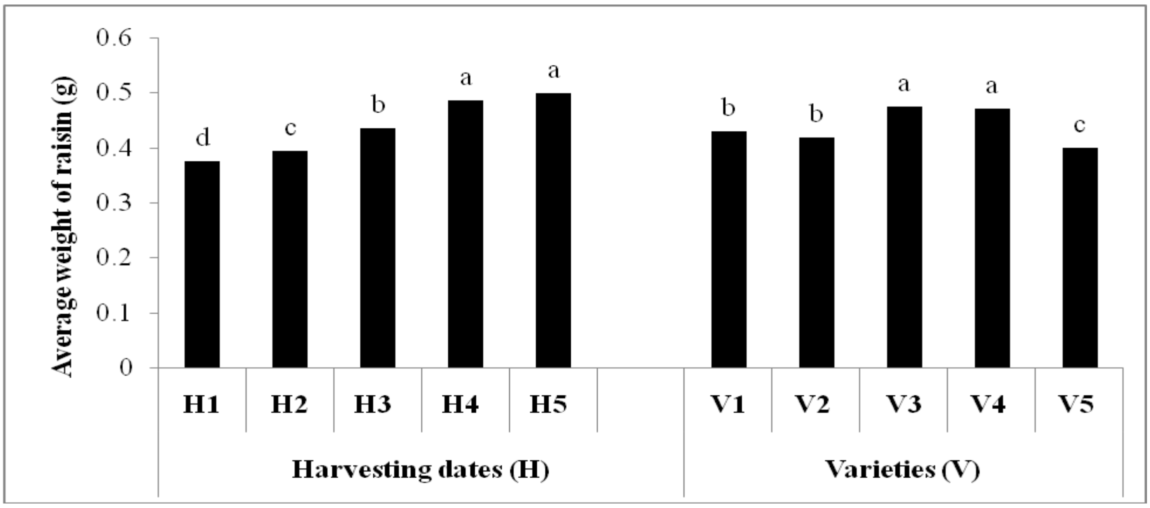
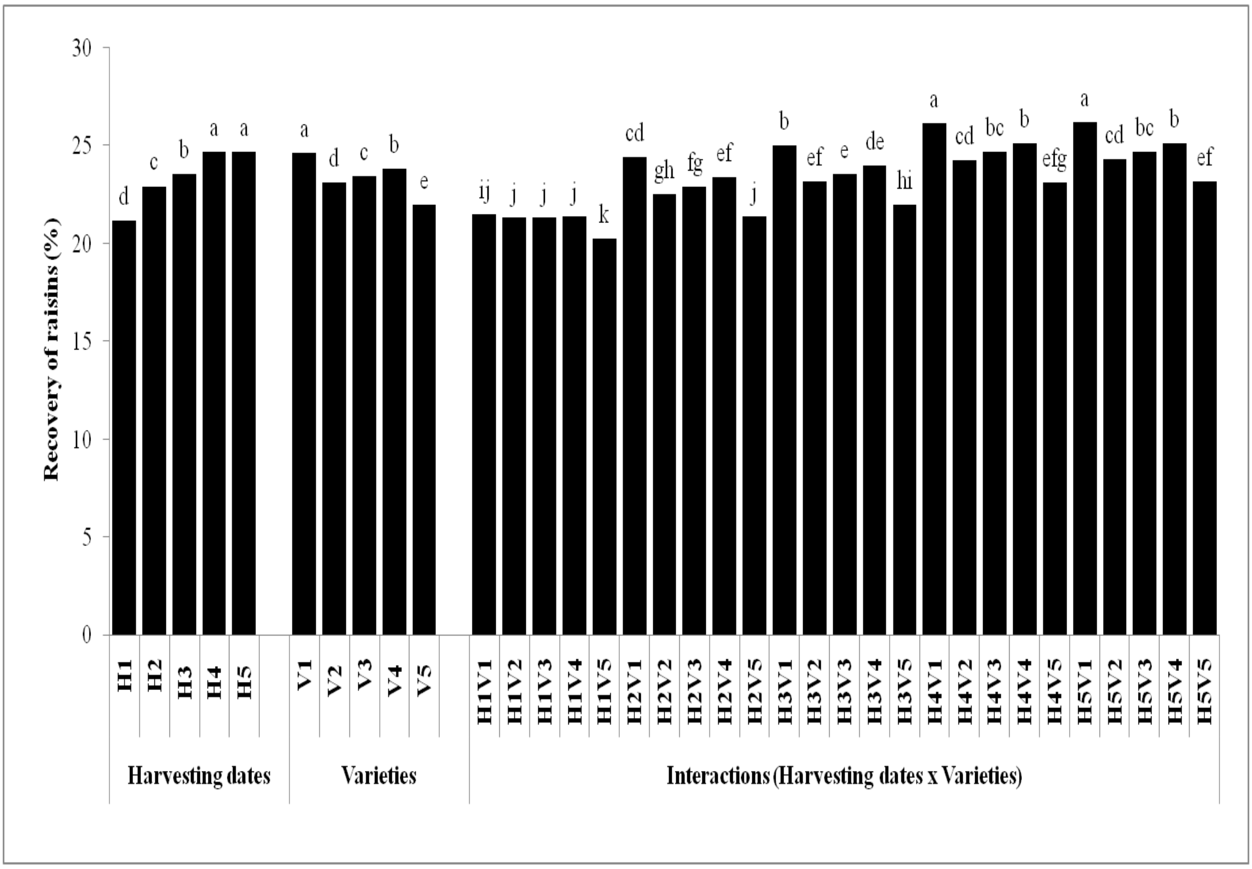


Figure 2. Rate of drying (per cent water loss during drying period) of seedless varieties of grapes.



Bars labelled with the same alphabets within harvesting dates and varieties were not significantly different at p∠0.05.

Figure 3. Average weight of raisin (g) prepared from seedless varieties of grapes as affected by harvesting dates.



Bars labelled with the same alphabets within harvesting dates, varieties and their interactions were not significantly different at p∠0.05.

Figure 4. Recovery of raisins (%) prepared from seedless varieties of grapes as affected by harvesting dates

The sensory attributes *viz.*, color and appearance texture, flavour, taste and overall acceptability of raisins gradually increased with successive harvesting dates and was recorded to be highest in fifth harvest (H_5–20 days after local harvest), whereas it was lowest in first harvest (H_1–20 days before local harvest). In terms of the overall assessment, the results obtained from the late harvests indicate that all varieties evaluated by the sensory panel generally were rated as good (Inês Almeida *et al.*, 2013). The raisins prepared from the late harvesting on 27th April for Manik Chaman and 19th April for Thompson Seedless were superior in their sensory attributes in our study, which might be due to the genetic differences in skin, and phenol content may also affect pigmentation (Angulo *et al.*, 2007). Thimma Reddy (1986) reported similar results and stated that the color of grapes was retained better when dried under shade. Scoring to maximum taste in these varieties might be due to high free sugar content (Gee, 1980). The interaction between harvesting dates and varieties was not significant with respect to all sensory attributes of raisins.

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EFFECT OF PRE AND POST EMERGENCE HERBICIDES ON GROWTH PARAMETERS IN TOMATO (*Lycopersicon esculentum* L.) CV. ARKA VIKAS

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ABSTRACT

A filed experiment was conducted to find out the best weed management practices in Tomato cv.Arka vikas during rabi 2011-12 and 2012-13. The experiment consisted of 10 treatments of Pre and post emergence (Pendimethalin, Oxyflourfen, Imazethapyr and Quizalofop ethyle) herbicides and their combination which were replicated thrice in Randomized block design. All the weed control treatments significantly influenced the growth attributes and yield such as plant height, No. of branches per plant, Leaf area Index (LAI), Plant dry matter and Yield. Hand weeding has recorded the maximum values for these attributes, however application of Pre emergence herbicides coupled with Quizalofop ethyle as post emergence found to be on par with Hand weeding. Imazethapyr applied as post emergence herbicide alone and combined with pre emergence herbicides recorded lower values than Weedy check as it is found to be extremely toxic to the crop.

Tomato (*Lycopersicon esculentum* L.) is one of the most popular and widely grown vegetables in the world, ranking second in importance to potato in many countries. The fruits are eaten raw or cooked. Tomato supplies vitamin C and add variety of colours and flavours to the foods. Tomato is also rich in medicinal value. The pulp and juice are digestible, promoter of gastric secretion and blood purifier. It is also considered to be intestinal antiseptic. It is one of the richest vegetables which keeps our stomach and intestine in good condition.

At present, the production share of tomato is 11.2 per cent of the total vegetable production with 9.6 percent of the total vegetable area in the country. In India it is being grown in an area of 8.7 lakh hectares with a production of 182.2 lakh tonnes and the productivity is 20.7 tonnes per hectare. Andhra Pradesh is leading state in tomato production, it accounts 28.63 percent of total tomato production in India. In Andhra Pradesh it is cultivated in an area of 2.60 lakh hectares with a production of 52.18 lakh tonnes and the average productivity is 20tonnes per hectare. (Indian Horticultural Database, 2013)

Tomato being a cash vegetable crop brings good income to farmers and particularly around big cities. Weeds in tomato pose a serious problem and as such weed competition is severe during early stages of the crop. Wider spacing, frequent irrigations and liberal use of manures and fertilizers in the cultivation of tomato provide favourable conditions for the luxuriant weed growth particularly during early stages of the crop (Govindra Singh *et al.,* 1984). Manual weeding is a common practice and herbicides are hardly used for the purpose. Hence, commonly used herbicides can find a place in vegetable cultivation. Therefore the present investigation was undertaken to find out the performance of pre and post emergence herbicides alone and their combination on growth attributes and yield of tomato crop.

MATERIAL AND METHODS

An experiment was conducted at Horticultural college and Research Institute, Dr.Y.S.R Horticultural University, Venkataramannagudem, Tadepalligudem, West Godavari District, A.P during Rabi season of 2011-12 and 2012-13. The experimental farm is situated at 16.83^0N latitude and 81.5^0E longitude. The soil was acidic in reaction and medium in NPK availability. The texture of the soil was sandy loam. The experiment was laid out in Randomised block design with three replications in a plot size of 4X3 m^2.

The seeds of Tomato cultivar "Arka vikas" was sown for nursery raising and transplanting was done on ridge and furrow system by adopting spacing of 60X45 cm. The ten treatments consists of T_1- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application, T_2- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application, T_3- Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_4- Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_5- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application + Imazethapyr @ 100 g a.i / ha as post emergence application (20

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DAT), T_6- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application+ Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_7- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_8- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_9- Weed free (Hand weeding) and T_{10}- Weedy check.

Twenty five days old seedlings were used for transplanting. All the package of practices to raise the good crop was done in the experimental field and weed control treatments applied as per the treatments. Bio metric observations such as plant height (cm), number of branches per plant, Plant dry matter (g plant $^{-1}$) and fruit yield (t ha^{-1}) were recorded at various stages of crop growth.

RESULTS AND DISCUSSION

Plant height (cm)

During both the years (table-1) at 30, 60 and 90 DAT, the treatment T9 (Weed free -Hand weeding at 20, 40 and 60 DAT) produced the tallest plants. But it was comparable with T8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE), and T6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE). Lowest plant height was observed with T3 (Imazethapyr @ 60 g a.i / ha as POE) treatment, remained on par with T5(Pendimethalin @ 0.75 kg a.i / ha as PE **+** Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE).

Number of branches per plant

All the treatments (table-2) had significantly influenced the number of branches per plant at various stages of crop growth. Number of branches per plant increased continuously from 30 DAT to 90 DAT. Significantly higher number of branches per plant were observed in T9 (Weed free-Hand weeding at 20, 40 and 60 DAT) at all stages of crop growth over the weedy check (T10) in both the years of experimentation. Lowest number of branches were recorded in T10 (weedy check) treatment.

Leaf area index:

Leaf area index (table-2) was significantly influenced by different weed management practices at various stages of crop growth. During both the years at 30, 60 and 90 DAT, significantly higher leaf area index was noticed with T9 (Weed free -Hand weeding at 20, 40 and 60 DAT) treatment. Treatment T9 (Weed free -Hand weeding at 20, 40 and 60 DAT) remained statistically on par with T8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE) andT6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE). The treatments, T3 (Imazethapyr @ 60 g a.i / ha as POE), T5(Pendimethalin @ 0.75 kg a.i / ha as PE **+** Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE) recorded lower values than T10 (weedy check) control. Similar trend was observed in both the years.

Plant dry matter (g plant $^{-1}$)

The dry matter accumulation (table-2) in tomato plant increased with the age of crop reaching maximum at 90 DAT. At all the growth stages, the treatment T9 (Weed free -Hand weeding at 20, 40 and 60 DAT) recorded significantly highest plant dry matter over T10 (weedy check), which was comparable with T8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE) and T6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE) treatments. At 60 and 90 DAT, the treatments T3 (Imazethapyr @ 60 g a.i / ha as POE) T5(Pendimethalin @ 0.75 kg a.i / ha as PE **+** Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE) recorded lower plant dry matter than weedy check (T 10) during both the years of experimentation.

The results revealed that maximum plant height, number of branches per plant, LAI and plant dry matter were recorded in T9 (Weed free -Hand weeding at 20, 40 and 60 DAT), followed by T8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE) and T6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE). The superiority of these treatments over other treatments may be due to no competition between weeds and crop for light, nutrients, moisture and space resulting into increased availability of assimilates for growth and development. These results corroborate with those of Bhayan *et al.* (1985) and Kajod Mal Yadav and Paliwal (2005). Plots applied with Imazethapyr @ 60 g a.i / ha as POE recorded lower values for these attributes, as imazethapyr found to be extremely toxic to the tomato crop

Fruit Yield (t ha $^{-1}$)

All the weed management practices (table-2) except T3 (Imazethapyr @ 60 g a.i / ha as POE), T5(Pendimethalin @ 0.75 kg a.i / ha as PE **+** Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE) produced significantly higher yield of tomato per ha over weedy check (T10).

Among the treatments, maximum fruit yield of tomato per ha was recorded in T9 (Weed free - Hand weeding at 20, 40 and 60 DAT) treatment which was statistically on par with T8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE).

Treatments T6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE), T1(Pendimethalin @ 0.75 kg a.i / ha as PE), T2 (Oxyfluorfen @ 0.125 kg a.i / ha as PE) and T4 (Quizalofop ethyl @ 75 g a.i / ha as POE) produced significantly higher yield over weedy check (T10) during both the years of study. Significantly lower yield in weedy check may be due to severe competition for plant nutrients, water and light between crop and weeds. Similar results were also reported by Balraj Singh (1994), Ram *et al.* (1994), Muniyappa*et al.*(1995), Tumbare and Ilhe (2004) and Warade *et al.* (2008). T3 (Imazethapyr @ 60 g a.i / ha as POE), T5 (Pendimethalin @ 0.75 kg a.i / ha as PE**+**Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE) produced lower fruit yield than weedy control during both the years of study as Imazethapyr found to be phytotoxic to the tomato crop.

Table-1 Plant height (cm) and No. branches plant $^{-1}$ at various growth stages of Tomato crop as influenced by weed management practices

	Treatment	Plant height (cm)						No. of branches plant^{-1}					
		30 DAT		60 DAT		90 DAT		30 DAT		60 DAT		90 DAT	
		2011-2012	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1	Pendimethalin @ 0.75 kg a.i / ha as PE	22.78	27.25	72.45	76.56	84.11	89.85	14.04	12.83	20.05	19.32	27.85	23.56
T_2	Oxyfluorfen @ 0.125 kg a.i / ha as PE	23.25	28.71	74.16	81.13	90.55	95.67	14.39	13.07	20.59	19.42	29.21	25.09
T_3	Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	17.84	17.56	35.35	36.28	40.81	39.77	11.44	11.16	13.72	12.80	20.12	20.53
T_4	Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	21.86	24.15	71.63	72.39	83.26	84.17	12.57	11.88	19.51	18.23	27.77	22.81
T_5	Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	18.33	19.13	36.28	36.42	42.97	42.51	11.57	10.60	16.94	15.03	20.45	21.16
T_6	Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	23.75	28.86	76.16	82.43	91.56	97.22	14.67	13.20	23.04	21.30	31.84	28.91
T_7	Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT)	19.62	21.23	41.52	39.53	46.33	42.98	11.64	11.57	17.01	15.40	23.87	19.31
T_8	Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	24.07	30.88	77.23	83.00	93.52	99.28	14.80	13.63	24.37	21.72	33.26	30.40
T_9	Weed free (Hand weeding at 20, 40 and 60 DAT)	24.59	31.66	83.51	83.57	95.12	99.45	15.71	15.10	26.42	24.25	36.76	32.32
T_{10}	Weedy Check	20.18	22.72	65.80	63.85	81.16	82.14	10.42	9.60	18.02	16.00	25.00	23.14
	S.Em$\pm$	1.19	2.59	4.63	5.63	4.15	5.26	1.07	0.97	1.74	1.46	1.90	2.12
	CD at 5%	3.57	7.71	13.75	16.84	12.33	15.76	3.22	2.91	5.22	4.37	5.70	6.37

Table 2. Weed control efficiency (%), Weed index (%) and Fruit yield (t ha^{-1}) at various growth stages of Tomato crop as influenced by weed management practices

	Treatment	Weed control Efficiency (%)								Weed Index (%)		Fruit yield (t ha^{-1})	
		19 DAT		30 DAT		60 DAT		90 DAT					
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1	Pendimethalin @ 0.75 kg a.i / ha as PE	94.10	93.88	87.35	86.03	73.81	75.35	57.10	51.68	30.11	30.67	18.52	20.24
T_2	Oxyfluorfen @ 0.125 kg a.i / ha as PE	94.92	94.15	88.32	86.83	77.04	76.90	53.96	49.89	28.80	28.54	18.87	20.86
T_3	Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	13.21	14.73	76.50	76.89	59.00	69.29	35.65	39.94	85.36	87.05	3.88	3.78
T_4	Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	10.11	7.93	86.02	85.59	71.27	74.69	51.98	47.52	36.15	38.90	16.92	17.84
T_5	Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	94.44	94.02	80.21	80.73	62.25	71.02	41.66	41.35	83.96	85.85	4.25	4.13
T_6	Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	94.82	94.11	90.03	90.19	80.05	81.00	58.66	59.67	18.52	19.78	21.59	23.42
T_7	Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT)	95.31	94.74	84.56	82.62	67.31	72.93	42.47	43.67	82.42	84.28	4.66	4.59
T_8	Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	95.55	95.11	91.34	91.15	81.99	82.17	59.99	62.47	17.08	18.09	21.98	23.91
T_9	Weed free (Hand weeding at 20, 40 and 60 DAT)	6.53	5.03	93.16	93.97	86.79	86.26	71.61	72.33	--	--	26.50	29.20
T_{10}	Weedy Check	--	--	--	--	--	--	--	--	51.52	54.64	12.85	13.24
	S.Em±											1.38	1.16
	CD at 5%											4.12	3.46

PE- Pre emergence POE- Post emergence

DAT- Days after transplanting

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Research Note
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DEVELOPMENT AND EVALUATION OF READY TO DRINK FLAVOURED RICE MILK BEVERAGE WITH FLOOD AFFECTED RICE (*Oryza sativa* L.)

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Rice (*Oryza sativa* L.) is one of the most important staple food for more than half of the world's population and influences the livelihood and economies of several billion people. Suzanne *et al.* (2013) reported that in 2010, approximately 154 million ha of rice was harvested worldwide, of which 137 million ha (88.0%) of the global rice harvested was in Asia. In this 48 million ha (31.0% of the global rice harvested) was harvested in Southeast Asia alone. Paddy loss due to flooding in Bangladesh and India alone amounts to an estimated 4.0 million tons per year, which might be sufficient to feed 30 million people. Much of this paddy is therefore wasted or it deteriorates due to microbial attack. Such produce is often sold at low price causing economical loss to the farmers, especially small and marginal farmers. It does not offer any value-added benefit or incorporate available technology in ways to improve their value. Therefore, the present study was carried out to evaluate the sensory properties of value added product i.e. flavoured rice milk formulated with flood affected rice in comparison with normal rice.

Rice samples were collected from farmers of Ravulapalem, West Godavari district, Andhra Pradesh when fully matured paddy field was damaged by floods. The same variety of normal paddy was collected from the same location from un-flooded fields. After drying up to 14 % moisture level, the paddy samples were subjected to milling and rice was powdered for further processing of flavoured rice milk. Flavoured rice milk was prepared with both normal rice and flood affected rice for which normal rice milk was considered as control. Rice milk was formulated and standardised with rice flour, sugar, sago flour, ragi flour, carboxy methyl cellulose, citric acid, sodium benzoate and water by adding three different flavours (vanilla, mango and elachi flavours). The prepared products were packed in plastic bottles after cooling and stored in refrigerator. Flavoured rice milk was studied for total soluble solids, pH, acidity, sensory properties by 9 point hedonic scale (Amerine *et al.* 1965) and microbial quality (Tambekar D.H., *et al.*, 2009) before and after storage for a period of 20 days. The results were statistically analyzed to test the significance of the results using percentages, means, standard deviations and analysis of variance (ANOVA) technique. (Snedecor and Cochran 1983).The results pertaining to total soluble solids, pH, acidity, sensory properties of rice milk are given in (Table 1 and 2).

The TSS of rice milk prepared with normal rice before storage ranged from 11.13 to 10.07, whereas after storage for 20 days it ranged from 12.60 to 12.07. The TSS of rice milk prepared with flood affected rice before storage ranged from 12.13 to 11.13 and after storage for 20 days, it ranged from 12.93 to 12.77. The TSS (^{o} brix) was higher for rice milk prepared with flood affected rice samples compared to that of samples prepared with normal rice. Initially on 0th day, statistically significant change between the treatments and within the treatments was not observed in the TSS of rice milk samples. Slight increase in TSS, though statistically significance ($P<0.05$), was observed in all the rice milk samples when stored for a period of 20 days (Table 1). Therefore, it could be concluded that rice milk samples prepared with both control and experimental samples and all the formulations of the same could be stored for a period of 20 days without much change in the TSS.

The pH of rice milk prepared with normal rice before storage ranged from 4.56 to 4.52 and after storage for 20 days, the pH ranged from 4.56 to 4.52. The pH of rice milk prepared with flood affected rice before storage ranged from 4.49 to 4.46 and after storage for 20 days the pH ranged from 4.54 to 4.50. (Table 1). Results of pH determination showed that all the samples were acidic in nature, with a slight

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increase towards neutral side, though not statistically significant, the pH was slightly higher in the rice milk prepared with normal rice compared to flood affected rice between and within the treatments. Statistically significant difference was not observed in the pH of all the three rice milk variations prepared with both normal and flood affected rice milk samples before and after storage for a period of 20 days.

The acidity of rice milk prepared with normal rice before storage ranged from 0.60 to 0.53 and after storage for 20 days the acidity ranged from 0.47 to 0.23. The acidity of rice milk prepared with flood affected rice before storage ranged from 0.60 to 0.50 and after storage for 20 days it ranged from 0.43 to 0.23. Decrease in acidity was observed in rice milk prepared with both normal and flood affected rice during storage for a period of 20 days. Statistically significant difference ($P<0.05$) was not observed in acidity between the treatments and within the treatments before storage

Table 1. TSS, pH and acidity of rice milk before and after storage

Sample		TSS (°brix)		pH		Acidity (%)	
Flavor	**Sample* code**	**0 day**	**20th day**	**0 day**	**20th day**	**0 day**	**20th day**
Without flavor	NRMWF	11.13±0.81	12.60±0.17	4.52±0.02	4.55±0.02	0.53±0.15	0.23±0.06
	FRMWF	12.13±1.03	12.87±0.12	4.49±0.02	4.52±0.02	0.50±0.20	0.23±0.06
Vanilla flavour	NRMVF	10.07±1.10	12.33±0.42	4.54±0.02	4.52±0.03	0.57±0.15	0.33±0.06
	FRMVF	11.20±1.31	12.77±0.25	4.49±0.01	4.54±0.05	0.57±0.15	0.43±0.06
Mango flavour	NRMMF	10.07±0.90	12.23±0.25	4.56±0.13	4.56±0.03	0.60±0.20	0.43±0.06
	FRMMF	11.13±0.81	12.93±0.12	4.46±0.02	4.50±0.05	0.60±0.20	0.43±0.06
Elachi flavour	NRMEF	10.10±0.85	12.07±0.12	4.54±0.01	4.55±0.01	0.57±0.21	0.47±0.06
	FRMEF	11.20±0.72	12.87±0.12	4.46±0.02	4.50±0.04	0.57±0.21	0.43±0.06
-	CD at 5%	N.S.	0.382	N.S.	N.S.	N.S.	0.101
-	SE (d) $\pm$	0.783	0.179	0.041	0.027	0.152	0.047
-	SE (m) $\pm$	0.554	0.126	0.029	0.019	0.107	0.033
-	CV %	8.815	1.740	1.114	0.743	33.061	15.396

NRMWF: Normal rice milk without flavour and FRMWF: Flood affected rice milk without flavour

NRMVF: Normal rice milk vanilla flavour and FRMVF: Flood affected rice milk vanilla flavour

NRMMF: Normal rice milk mango flavour and FRMMF: Flood affected rice milk mango flavour

NRMEF: Normal rice milk elachi flavour and FRMEF: Flood affected rice milk elachi flavour

The mean score for colour, appearance, taste and texture was similar in all the rice milk samples prepared with both normal rice and flood affected rice before (7.3, 7.3, 6.8 and 6.6 respectively) and after 20 days (7.2, 7.1, 6.5 and 6.3 respectively) of storage. The mean score for flavour was maximum for both rice milk beverages prepared with vanilla flavour and minimum for the beverage prepared without flavour in both normal and flood affected rice samples before and after storage of 20 days.

The mean score for overall quality of rice milk was maximum for NRMVF (7.3) and FRMVF (7.3) in the samples with vanilla flavour and minimum for NRMMF (6.8) and FRMMF (6.8) with mango flavour in both normal and flood affected rice milk samples before storage.

Table 2. Mean sensory scores of rice milk before and after storage

	Sample	Colour		Appearance		Flavor		Taste		Texture		Overall quality	
Flavour		0^{th} day	20^{th} day	0^{th} day	20^{th} day	0^{th} day	20^{th} day	0^{th} day	20^{th} day	0^{th} day	20^{th} day	0^{th} day	20^{th} day
Without flavour	NRMWF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.0±0.67	6.8±0.63	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	7.0±0.82	6.8±0.79
	FRMWF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.0±0.67	6.8±0.63	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	7.0±0.82	6.8±0.79
Vanilla flavour	NRMVF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.8±0.42	7.7±0.48	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	7.3±0.67	7.0±0.82
	FRMVF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.8±0.42	7.7±0.48	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	7.3±0.67	7.0±0.82
Mango flavour	NRMMF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.3±0.82	7.1±0.88	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	6.8±0.63	6.7±0.48
	FRMMF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.3±0.82	7.1±0.88	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	6.8±0.63	6.7±0.48
Elaichi flav-our	NRMEF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.6±0.70	7.4±0.70	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	6.9±0.88	6.8±0.79
	FRMEF	7.3±0.82	7.2±0.79	7.3±0.82	7.1±0.74	7.6±0.70	7.4±0.70	6.8±0.63	6.5±0.53	6.6±0.52	6.3±0.67	6.9±0.88	6.8±0.79
	CD at 5%	N.S.	N.S.	N.S.	N.S.	0.597	0.614	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
	SE (m) ±	0.260	0.249	0.260	0.233	0.211	0.217	0.200	0.167	0.163	0.213	0.239	0.232
	CV %	11.278	10.956	11.278	10.392	9.007	9.478	9.301	8.108	7.824	10.713	10.806	10.728

The mean score for overall quality of rice milk was also maximum for both NRMVF (7.0) and FRMVF (7.0) in the samples with vanilla flavour and minimum for NRMMF (6.7) and FRMMF (6.7) with mango flavour in both normal and flood affected rice milk samples after storage for 20 days.

The microbial (TBC &TMC) analysis of the samples revealed that the TBC count was not observed in both the samples when stored for 20 days at 4°C temp. But mold growth (1 cfu ml-^{1}) was observed at 10É^{1} and 10É^{2} dilution in both control and experimental samples on 20th day. Hence, rice milk beverages prepared both flood affected and normal rice could be stored for 15 days without any microbial contamination. Shelf-life study revealed that during 15 days storage at 4°C, pH and acidity of rice milk prepared with both normal and flood affected rice remained above 4 and lower than 1%, respectively.

Therefore, it was concluded that there was no significant difference in all the parameters studied i.e., TSS, pH, acidity, sensory properties (colour, appearance, taste, texture and overall quality) and microbial quality in rice milk samples prepared with both normal and flood affected rice within the treatments and between the treatments both before and after storage for a period of 20 days, except for TSS, acidity and flavour after 20 days of storage. Hence it was concluded that value addition can be done to flood affected rice in the form of rice milk beverage as all the physical, chemical and sensory attributes of the rice milk sample prepared with flood affected rice studies were comparable with the beverage prepared with normal rice. This study facilitates the development of new, non-dairy, nutritionally well-balanced food products with unique sensory properties.

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Research Note
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STUDY OF GENETIC DIVERSITY IN RICE (*Oryza sativa* L.)

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Rice (*Oryza sativa* L.) is an important cereal crop and food for more than half of the world population. There is a need to increase the rice production to meet the demand of ever growing population. The rice germplasm is a rich reservoir of valuable genes that plant breeders can harness for crop improvement. A thorough understanding of the genetic structure and diversity of rice varieties is crucial for efficient utilization of rice genetic resources. Genetic divergence is an efficient tool for selection of parents for hybridization programme. The more diverse the parents, the greater are the chances of obtaining higher amount of heterotic expression in F_1s and broad spectrum of variability in segregating generations (Vivekananda and Subramaniam 1993). Keeping this in view, fortyfive rice genotypes wereevaluated to assess the genetic diversity ofgenotypes forfurther utilization in breeding programmes.

The material for the present study consists of 45 genotypes collected from IRRI nurseries. The experiment was conducted in a randomized block design with three replications at Regional Agricultural Research Station, Warangal during *kharif* 2009. Each entry was planted in a row of 5 m length with a spacing of 20 cm between rows and 15 cm between plants. The recommended package of practices was followed for raising a healthy crop. Observations were recorded for ten plants selected at random per entry per replication and mean values were used for statistical analysis. Data was collected for days to 50% flowering, plant height (cm), effective tillers per plant, panicle length (cm), filled grains per panicle, test weight (g) and grain yield per plant (g).The genetic divergence was assessed by D^2 analysis as suggested by Mahalanobis (1928). Grouping of parents into different clusters was done by following Tocher method (Rao, 1952).

Diversity analysis indicated that the genotypes utilized in the study are divergent and 45 genotypes were grouped into ten clusters (Table-1). Cluster I constituted the maximum number of genotypes (32) followed by cluster IV and cluster VI had 3 genotypes each and remaining clusters had one genotype indicating high degree of heterogeneity among the genotypes. The formation of distinct solitary clusters may be due to the fact that geographic barriers preventing gene flow or intensive natural and human selection for diverse and adoptable gene complexes must be responsible for this genetic diversity. The distribution of genotypes indicated that the geographical diversity and genetic diversity were not related. This suggests that there are forces other than geographical separations such as natural or artificial selection, exchange of breeding material, genetic drift and environmental variation for such divergence. These results are in accordance with the finding of Tushara *et al*. (2012).

The inter cluster D^2 values showed a range of variation from 2.44 to 12.89 (Table-2). Among the clusters, cluster IV (2.74) has the lowest intra cluster distance while cluster IV has the highest value (3.74).The inter cluster distance was found to be highest between the clusters IV and X (12.89), followed by III and VI (12.72) and cluster IV and VII (12.49). Crosses among divergent parents are likely to produce desirable combinations for grain yield and yield components. Study indicates for selection of lines between the clusters Rampurimasuli, Radha-11, Radha 12 and ADT(R)-47 for successful crossing programme aimed to achieve desirable improvement in different traits.

Relative contribution of different characters (Table-3) towards genetic divergence among the varieties revealed that yield per plant contributed maximum (38.08) followed by plant height (33.03) and effective tillers (11.11). Ananda Kumar and Indubala

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(2005) also recorded the similar results. The traits such as grain yield per plant, plant height and effective tillers per plant were the major contributors to genetic divergence and it suggest that these traits can be consider whileselecting parents for hybridization programme. Clusters with high mean and high genetic divergence should be considered while selecting parents for hybridization programme. In this study cluster VI has recorded highest cluster mean values for grain yield per plant (Table-4). The cluster X has recorded superior cluster means for effective tillers (16.45) and filled grains per panicle (21.5). Test weight was found to be more in cluster VIII (26.50) followed by cluster VI (24.57).

From the study it was concluded that hybridization between the genotypes of clusters IV and X will be more rewarding for achieving desired benefits. It indicated that crosses involving parents belonging to maximum divergent clusters were expected to manifest maximum heterosis and also wide genetic variability. Similar results were reported by Roy and Panwar (1993) and Islam *et al.* (2014) in rice. Percentage contribution towards total divergence is highest through grain yield per plant (33.08) followed by plant height (33.03). Study suggested for the inclusion of Rampurimasuli, Radha-11, Radha-12 and ADT (R)-47 in the crossing programme in addition to popular and locally adopted varieties for getting the transgressive segregants for grain yield.

Table 1. Clustering pattern of 45 genotypes of rice by Tocher's method

Cluster No.	No of genotypes	Genotypes
1	32	IR-64, OM5627, SINGKIL, ADT(R)-48, PCT61010101-19-1-4-3-1-1-1-3-M, OM7938,OM6073, CT16659-B-1CT-1-3-5-2-1-M, OMCS2009, IR-75288-144-1-3, CT16658-4-1-1SR-3-2-1-1-1M, CIBOGO, YEZIN LONCTHME, CT15672-3-2-3-2-2-M, IR-80905-50-1-3-2, IR-71700-27-1-1-2, IR-1701-28-1-4, LONGIIANG-9, PCT6101010-19-1-4-3-1-1, OMCS2007, BINDESHWARI, IR-71720-19-3-2-3, GONGAOXIAN49, IR-72, IR21141-24-2, IR-882251-9-3-2-3, YN3103-32-1-1-1, WANJING97, HIPA-3, CT15673-8-2-3-1-1-M, PCT61010101-19-1-4-3-1-1-1-1-1M, RAMAPPA
11	1	IR83326-39-1-2
111	1	IR-50
1V	3	RAMPURI MASULI, RADHA-11, RADHA-12
V	1	YN3109-23-1-3
V1	3	CONDE, OM6161, PSBRC68
V11	1	ZAQZIAN14
V111	1	CT15809-1-2-1-1-2-SR-1-2-2-2M
1X	1	YN3107-33-2-3
X	1	ADT(R)-47

Table 2. Average intra-inter cluster distance among 10 clusters in 45 genotypes of rice

Clusters	1 cluster	11 cluster	111 cluster	1V cluster	V cluster	V1 cluster	V11 cluster	V111 cluster	1X cluster	X cluster
1 cluster	3.71	5.62	5.97	8.49	5.22	8.31	5.96	5.57	6.11	7.62
11 cluster		0.00	10.09	7.02	2.44	5.23	10.02	4.43	7.01	7.92
111 cluster			0.00	12.38	9.71	12.72	2.86	9.78	8.08	8.78
1V cluster				2.74	7.40	11.33	12.49	7.58	10.10	12.89
V cluster					0.00	4.79	9.27	3.24	5.90	7.55
V1 cluster						3.74	11.63	6.34	8.32	7.79
V11 cluster							0.00	8.73	8.84	8.27
V111 cluster								0.00	8.02	8.99
1X cluster									0.00	8.13
X cluster										0.00

Table 3. Contribution of traits towards genetic divergence in rice genotypes

Source	Times ranked 1st	Contribution(%)
Days to 50% flowering	18	1.82
Effective tillers / plant	110	11.11
Plant height (cm)	327	33.03
Panicle length (cm)	18	1.82
Filled grains / panicle	60	6.06
Test weight (g)	80	8.08
Grain yield / plant (g)	377	38.08

Table 4. Mean values of ten clusters for 45 genotypes in rice

Clusters	Days to 50% flowering	Effective tillers / plant	Plant height(cm)	Panicle length (cm)	Filled grains/ panicle	Test weight(g)	Grain yield/ plant(g)
1 cluster	103.69	14.18	77.07	20.06	103.19	21.98	18.82
11 cluster	108.50	15.25	88.20	19.30	117.00	21.75	26.08
111 cluster	96.50	15.70	64.00	19.00	75.00	17.85	11.89
1V cluster	121.17	13.05	100.37	20.92	141.50	20.15	18.16
V cluster	102.00	13.30	85.00	20.50	109.00	19.80	26.57
V1 cluster	103.23	14.45	81.57	20.40	122.33	24.57	33.38
V11 cluster	88.00	13.25	64.00	18.90	108.50	21.90	12.56
V111 cluster	114.50	11.00	84.00	19.50	106.00	26.50	23.71
1X cluster	107.50	15.50	74.10	22.80	97.50	23.50	24.92
X cluster	102.50	16.45	69.70	18.90	215.50	11.50	24.00

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Research Note
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A STUDY ON FACTORS INFLUENCING FARMERS AND DEALERS WHILE SELECTING VARIOUS BRANDS OF PESTICIDES

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Agrochemicals occupy major share in the agribusiness wing of the agriculture sector. India is the 4th largest producer of agrochemicals globally with 125 technical grade manufactures, 800 formulators, over 145000 distributors (Federation of Indian Chambers of Commerce and Industry, 2013). Thus the Indian agrochemicals market is highly fragmented in nature and witnesses fierce competition with large number of organized sector players and significant share of spurious pesticides. In this scenario, every company wants to be dynamic in the race. This study will help the companies to understand the purchasing behaviour of the farmers and dealers in selecting pesticides amongst various brands.

The study was undertaken in the Kodad region of Nalgonda district of Telangana state where five mandals were selected. About 2 villages from each mandal and 10 farmers from each village were selected randomly. Thus a total of 100 farmers formed the basis of the study. Similarly 20 dealers were also selected for the study. The data was collected with the help of pretested questionnaire and it was tabulated and analyzed by using simple statistical tools.

To find out the most significant factor which influences the respondent, Garrett's Ranking Technique was used (Rethina pandy, A and Selvakumar, M. 2013). The respondents have been asked to assign the rank for all factors listed and the outcome of such ranking have been converted into score value with the help of the following formula:

Percent position = $100\ (R_{ij} – 0.5)/N_j$

Where R_{ij} = Rank given for the i th variable by j th respondents

N_j = Number of variable ranked by j th respondents

With the help of Garrett's Table, the percent position estimated was converted into scores. Then for each factor, the scores of each individual are added and then total value of scores and mean values of score was calculated. The factors having highest mean value is considered to be the most important factor.

The purchasing behaviour of the farmers towards various brands of pesticides are often influenced by several factors. Ten factors were identified and the sampled farmers ranked the same based on the priority. It is tabulated and presented in Table1.

Table 1. Purchasing behaviour of the farmers towards various brands of pesticides

S.No	Factors	Total score	Mean score	Rank
1	Effective control	7282	72.82	I
2	Credit terms	3724	37.24	VIII
3	Brand image	6240	62.40	III
4	Price	6315	63.15	II
5	Dealer's recommendation	4901	49.01	V
6	Ready availability	4723	47.23	VI
7	Promotional campaign	4682	46.82	VII
8	Progressive farmers advice	5558	55.58	IV
9	Safety	3689	36.89	IX
10	Packaging	2656	26.56	X

It is observed from Table 1 that the most important influencing factor while purchasing of any brand of pesticide by the farmer is effective control of pests and therefore the selected farmers gave their preference as number one. The factors like price of the product and brand image were ranked as 2nd and 3rd most important factors respectively. Advice of the progressive farmers, dealer's recommendation, ready

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availability, promotional campaign and credit facility scored 4th , 5th , 6th, 7th and 8th ranks respectively. However the factors like safety and packaging confined to 9th and 10th ranks while selecting the pesticides of various brands. The results are in line with (Dharmaraj and Pratik Desai, 2013).

Dealers are the most important functionary in the market channel of pesticide business. Like the farmers, dealers also consider various factors while stocking a particular brand of pesticides.

Table 2. Factors influencing dealers in stocking the pesticides brand

No	Factors	Total score	Mean score	Rank
1	Past record of the company	1371	68.55	I
2	Price	981	49.05	V
3	Performance of the product	993	49.65	IV
4	Sales team influence	714	35.7	VIII
5	Dealer’s margin	1360	68.0	II
6	Trade credit	763	38.15	VII
7	Brand image	1256	62.8	III
8	Promotional support by the company	852	42.6	VI
9	Incentives and gift packages	684	34.2	IX

It is observed from Table 2 that the factor past record of the company which includes the long lasting business relationship with the dealers was considered as most important and therefore given the first rank by the selected dealers. Dealers margin and brand image of the product are ranked as 2nd and 3rd important factors. The factors like performance of the product, price, promotional support by the company, trade credit, sales, personnel influence and incentives and gift packages were given 4th, 5th, 6th, 7th, 8th and 9th ranks respectively. Though the factor incentives and gift packages looks lucrative but still the dealers preferred better margins and brand image of the product and therefore it was given last priority compared to the other factors. Therefore, it can be inferred that past record of the company, dealers’ margins and brand images played the key role in influencing the dealers in promoting various brands of pesticides.

It can be concluded from the study that effective control, price and brand image were the most important factors that influences farmers in selecting various brands of pesticides. Similarly, past record of the company, dealers margin and brand image were the key factors considered by dealers in selecting and stocking various pesticide brands.

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Research Note
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EVALUATION OF ALTERNATE CROPS AND INTERCROPPING SYSTEMS TO Bt COTTON (*Gossypium spp.*) IN RAINFED ALFISOLS

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India is endorsed with variety of soils ranging from poor Coastal sands to highly fertile deltaic alluviums. Alfisols denote the second largest soil groups of the country covering an area of 200,000 sq. miles. The soils are found in the states of Andhra Pradesh, Karnataka, Tamilnadu, Southern Maharashtra, Orissa and Chotanagpur plateau of Jharkhand (agri.coop.nic.in).

Of the total cotton crop area of Andhra Pradesh (20,53,611 L. ha), 84 per cent cultivated in Telangana districts mostly under rainfed Alfisols which are inheritently low in nutrient reserves, organic matter besides poor in available water holding capacity. Monsoon dependent cotton on these soils often suffers from severe moisture stress during critical stages and the crop yields are low and unstable. Sharp increase in input cost and lack of remunerative market price causing further burden on the farm sector and the studies are indicating that two of every three farm suicides, taking place where cotton is cultivated mainly in dry land areas (www.the hindu business line.com). Introduction of Bt cotton hybrids also does not changed the fate of the farmers and it is necessary that the Scientists are ought to devise strategies to minimize the risk of crop failures in this fragile ecosystems.

Intercropping with compatible crops is one of the possible approaches with a ray of hope to widen the Vist as which provide same source of substance to the peasants in such abnormal situation. Successful cultivation of greengram (Ramaswamy *et al.*, 2002) and groundnut (Subramanian, 2000) as intercrops in rainfed alfisols has been reported earlier. However, the relative superiority or otherwise of different intercrop components varies wide from region to region with varying rainfall patterns and edaphic conditions prompted the present study of evaluation of alternate crops and intercropping systems to Bt cotton in rainfed alfisols.

A field experiment was conducted at Agricultural Research Station, Warangal during *kharif* 2011 (altitude 265 m above mean sea level on 18°01'04.8" N latitude and 79°36'11.3" E longitude) in sandy loam soils having EC of 0.18 dSm^{-1} and pH 6.9. The soil was low in nitrogen (260 kg ha^{-1}), medium in phosphorus (18 kg ha^{-1}) and high in potassium (290 kg ha^{-1}). Cotton (hybrid : MRC 7201), redgram (variety : PRG 158), Castor (variety : PCS 4), maize (hybrid 900 M), greengram (variety : WGG 42) and groundnut (variety : TMV 2) were sown as sole crops, then cotton and castor were intercropped with greengram whereas redgram and maize were intercropped with both greengram and groundnut. The density of intercrop component was 66 per cent in cotton, redgram, castor and 50 per cent in maize. These 12 treatments were laid out in Randomized Block Design with 3 replications. The sole and intercrops were sown on the same day (7-7-2011) as per the recommended spacing and fertilized as per zonal recommendations in proportion to their population. During the crop growth period rainfall of 349.9 mm was received in 26 rainy days.

The vegetative crop growths were in general more under sole cropping than intercropping (Table 1).

Cotton intercropped with greengram consistently recorded lower plant height than sole cotton. Sole cotton recorded plant height of 56.5 cm, 96.4 cm and 110.5 cm at 45, 90 and at harvest. The decrease in plant height of cotton was 13.2, 9.2 and 10.8 per cent with greengram intercropping at these stages. Raghu Rami Reddy (2006) reported that the cotton succumbed to the intercrop competition and reduced its plant height. Similar trend for dry matter accumulation was observed by Jayakumar *et al.* (2007).

The monopodial and sympodial per plant were higher under sole cotton (3.6 and 24.8) and with greengram intercropping these values were only 3.1 and 20.0 indicating a decrease of 13.80 and 19.35

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per cent respectively. More boll number (45.50) with increased boll size (3.70 g) was the reason for maximum seed cotton yield of 2310 kg ha^{-1} and the reduction was 12.77 per cent when it was intercropped with greengram (2015 kg ha^{-1}). Reduction in seed cotton yield with greengram was earlier reported by Prasad *et al*. (1993) and Satish *et al*. (2012).

Sole maize recorded higher plant, dry matter and choice of intercrops reduced these growth parameters. At 60 DAS, sole maize recorded plant height of 142 cm, whereas with greengram the height reduction was 4.9 cm and with groundnut it was still higher viz., 13.8 cm. The same trend continued during 90 DAS and at harvest. Maximum phytomass was recorded at 60 DAS in the sole maize (108.4 g plant^{-1}) and the reduction was 13.09 per cent with greengram and 33.21 per cent with groundnut. Substantial reduction in dry matter accumulation of maize due to intercropping of greengram and groundnut was reported by Parvender Sheoran *et al*. (2009).

More number of cobs (71919 ha^{-1}) with better cob length (19.0 cm), girth (16.5 cm) and higher number of seeds per row (36.3) were observed with sole maize but the grain yield reduction was marginal either with intercropping of greengram (0.77 %) and groundnut (3.13 %) over sole maize (6953 kg ha^{-1}). These results are in contrast to the findings of Solanki *et al*. (2011), who reported 12.7 per cent grain yield reduction with greengram intercropping.

The mean plant height of sole redgram was 110.2 cm, 160.0 cm and 166.0 cm at 60, 90 and at harvest, respectively, whereas the reduction in plant height was 4.50, 1.89, 3.25 per cent with greengram 2.54, 3.12 and 4.60 per cent with groundnut at these stages. Dry matter was also more in sole redgram (Shanmugam, 2008).

Number of branches (15 plant^{-1}), pods (179.0 plant^{-1}), seeds per pod (3.1) and test weight (9.1) ultimately grain yield (1742 kg ha^{-1}) were higher with sole redgram and these parameters were decreased when redgram was intercropped with greengram and groundnut. Intercrops greengram and groundnut shared resources with redgram and offered competition thereby reducing the optimum growth and development of redgram was the reason for low yield attributes and grain yield.

The plant height as well as phytomass increased from 60 DAS to harvest in castor. At all the stages of observation sole castor recorded higher plant height (76, 115.9 and 140.0 cm) over castor intercropped with greengram (68, 105.2 and 128.0 cm). Similar results of decrease in plant height of castor with greengram was reported by Ganvir *et al*. (2006) whereas Basith and Shaik Mohammad (2010) observed non significant influence.

Sole castor recorded higher spikes (5.6 plant^{-1}), capsules (179.2 plant^{-1}), better spike length (25.0 cm) and ultimately more seed yield (1547 kg ha^{-1}). Intercropping greengram reduced all these yield attributes with decrease of 86 kg ha^{-1} seed yield. similar results were reported by Manoj Kumar *et al*. (2013).

The data presented in Table 3 revealed that significantly higher seed cotton equivalent yields by intercropping greengram or groundnut than their sole crops except for maize + greengram An equivalent mean seed yield of 2310 kg ha^{-1} was realized from cotton + greengram (1 : 2 row ratio) intercropping which was at par with redgram + greengram (1:2row ratio) and significantly superior over other sole and intercropping systems. Of the different intercropping systems, lowest seed cotton equivalent yield (2058 kg ha^{-1}) was realized from maize + greengram (1:1row ratio), which significantly not differed with sole cropping of cotton (2015 kg ha^{-1}), redgram (1911 kg ha^{-1}) and maize (1907 kg ha^{-1}) but superior over castor (1696 kg ha^{-1}), greengram (1025 kg ha^{-1}) and groundnut (985 kg ha^{-1}). This strategy of evaluation was studied by Reddy *et al*. (2009) in cotton + greengram, Ved Prakash *et al*. (2005) in redgram + groundnut in redgram + greengram and Manoj Kumar *et al*. (2013) in castor + greengram.

The results amply demonstrated that the intercropping of greengram or groundnut was highly compatible in rainfall alfisols. Higher seed cotton equivalent yields can be realised from cotton + greengram or redgram + greengram intercropping system. Regram + Greengram Intercropping offers additional advantage of fodder, soil enrichment and low cost of cultivation.

Table 1. Vegetative growth parameters as influenced by sole and intercropping systems in rainfed alfisols.

Crop / Intercropping Systems	Plant height (cm)			Phytomass (g plant^{-1})		
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
Cotton	56.5*	96.4	110.5	51.5*	109.5	88.3
Redgram	110.2	160.0	166.0	27.7	78.5	113.1
Castor	76.0	115.9	140.0	35.5	79.5	116.0
Maize	142.0	238.0	235.9	14.8	108.4	92.7
Greengram	42.7**	-	60.2	3.8**	-	11.4
Groundnut	31.7*	-	48.5	15.4*	-	30.6
Cotton + Greengram (1:2 row ratio)	49.0	87.5	98.6	45.2	98.2	74.2
Redgram + Greengram (1:2 row ratio)	105.2	157.0	160.6	24.5	67.5	97.4
Castor +Greengram (1:2 row ratio)	68.0	105.2	128.0	30.0	71.3	105.0
Maize + Greengram (1:1 row ratio)	137.1	238.8	233.2	20.2	94.2	80.2
Maize + Groundnut (1:1 row ratio)	128.2	233.2	231.9	16.1	72.4	93.3
Redgram + Groundnut (1:2 row ratio)	107.4	155.0	158.3	25.5	62.8	93.6

* At 45 DAS; ** At 30 DAS

Table 2. Yield attributes as influenced by sole and intercropping systems in rainfed alfisols

2a. Cotton

Parameter	Treatments	
	Sole Cotton	Cotton + Greengram (1:2 row ratio)
Number of monopodia plant^{-1}	3.6	3.1
Number of Sympodia plant^{-1}	24.8	20.0
Number of bolls plant^{-1}	45.5	37.4
Boll weight (g)	3.7	3.6

2b. Maize

Parameter	Treatments		
	Sole Maize	Maize + Greengram (1:1 row ratio)	Maize+ Groundnut (1:1 row ratio)
Number of cobs ha^{-1}	69525	71919	65823
Cob length (cm)	19.0	18.4	18.6
Cob girth(cm)	16.5	15.8	16.3
Number of seeds^{-1}	36.3	35.0	35.6
Test weight (g)	32.36	31.70	33.33

2c. Redgram

Parameter	Treatments		
	Sole Redgram	Redgram + Greengram (1:2 row ratio)	Redgram + Groundnut (1:2 row ratio)
Number of branches plant^{-1}	15.1	14.3	14.8
Number of pods plant^{-1}	179.0	162.6	158.3
Number of seeds pod^{-1}	3.1	2.9	2.8
Test weight (g)	9.1	8.9	8.7

2d. Castor

Parameter	Treatments	
	Sole Castor	Castor + Greengram (1:2 row ratio)
Number of Spikes plant^{-1}	5.6	4.8
Number of capsules plant^{-1}	179.2	133.4
Primary spike length (cm)	25.0	22.3

Table 3. Seed cotton equivalent yield (kg ha^{-1}) as influenced by crops and intercropping systems

Treatments	Base crop yield kg ha^{-1}	Inter crop yield kg ha^{-1}	Cotton equivalent yield kg ha^{-1}
Sole cropping			
Cotton	2015	-	2015
Redgram	1742	-	1911
Castor	1547	-	1696
Maize	5473	-	1907
Greengram	830	-	1025
Groundnut	985	-	985
Intercropping			
Cotton + Greengram (1:2 row ratio)	1832	387	2310
Redgram + Greengram (1:2 row ratio)	1627	349	2216
Castor + Greengram (1:2 row ratio)	1461	444	2152
Maize + Greengram (1:1 row ratio)	5348	158	2058
Maize + Groundnut (1:1 row ratio)	5276	345	2183
Redgram + Groundnut (1:2 row ratio)	1604	421	2180
SEm±	-	-	52.9
CD at 5%	-	-	156
CV (%)	-	-	4.8

Price (Rs. q^{-1}): Cotton 3100, Redgram 3400, Castor 3400, Maize 1080, Greengram 3830, Groundnut 3100

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Research Note
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INVESTMENT PATTERN AND COSTS AND RETURN STRUCTURE OF RICE MILLS IN SULTANPUR DISTRICT OF UTTAR PRADESH

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Rice (*Oryza sativa* L.) is the basic grain consumed as a food in India which is found in almost every Indian kitchen. It is the most common grain and the most common food in India. However, India is not only a big consumer of rice but also it is the second largest producer of rice in the world after China. India also holds the largest agriculture land for paddy production in the world. In the total arable land for paddy in the world was 165 million hectares with the total production of 721.4 million tonnes of paddy, out of which 44 million hectares of the area was held by India alone, which produced 104 million tonnes of paddy just second after 200.7 million tonnes by China. India leads in terms of the land holding, while the production is led by China. China and India contributed 26 per cent and 19.51 per cent respectively to the world's paddy production in 2012-2013. (Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2013). In India, Uttar Pradesh is the largest producer of paddy. In 2012-2013 the total arable land for paddy in Uttar Pradesh was 5.90 million hectares with the total production of 13.4 million tonnes of paddy and the average production of 22.71 qtls ha^{-1}, out of which 90.04 thousand hectares of area was held by Sultanpur district, which produced 21.68 lakh tonnes of paddy with the average production of 24.08 qtlsha^{-1} (Department of Agriculture, Government of Uttar Pradesh, 2013). During the year 2013, rice processing turnover was more than Rs. 25,500/- crore per annum. About 85 million tonnes of paddy is processed per year which provides staple food grain and other valuable products required by over 60 per cent of the population. The present study was conducted in Sultanpur district of Uttar Pradesh to identify the investment pattern and costs and return structure of rice mills. A total of sixteen rice mills were selected in Sultanpur district of Uttar Pradesh. Further, they were categorised into conventional units (capacity of 4400 quintals) and modern units (capacity of 30400 quintals) based on the technology adopted and capacity utilisation.

From the Table, it is seen that the total fixed capital investment was Rs 23.98 lakhs for conventional units, Rs 233.30 lakhs for modern units. The comparison o investment between the conventional and modern processing units revealed that the fixed capital requirement in the case of modern mills was 10 times higher than the conventional units.

The analysis indicated that there is a direct relationship between the total capital investment and size/capacity of the processing units. The total capital investment was higher in modern units than in the conventional units. The requirement of capital investment increased with the increase in size of the units because of the increased requirement of land, building, machinery and equipment, infrastructure and other fixtures and also increased requirement of working capital. It is observed that the fixed capital investment on the rice milling units was higher on machinery and equipment (29.90 per cent) followed by land (27.36 per cent), building (26.31 per cent), infrastructure (11.97) and other fixtures (4.46 per cent) in the case of conventional units. The capital investment in the case of modern units was much higher on machinery and equipment to the tune of 64.29 per cent followed by building (25.72 per cent), land (7.07 per cent), infrastructure (1.63 per cent) and other fixtures (1.29 per cent). The higher capital investment of Rs. 233.30 lakhs in the case of modern units which was 10 times higher than in conventional units (Rs.23.98 lakhs) was due to larger size of machinery installed, different types of machines like aspirators, separators, driers, graders, etc high-tech machinery and larger quantity of raw material handled. Higher investment on land and buildings in the case of modern units when compared to conventional units was due to more working space required for

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processing units. Since the size of modern units is very large i.e., 5 time larger than that of conventional units i,e. 20.00 quintals per hour capacity, more working space is required for machinery installation and storage structures to store raw material. The investment on machinery and equipment in the case of conventional rice mills is very small as they follow the traditional methods of processing without any separators, driers, aspirators etc. (Balasane *et al.* 2008 Joshi *et al* 1999)

In table 3 represents the cost of processing of paddy for the conventional and modern rice milling units. The three most significant components of processing cost (excluding the raw material cost) were interest on fixed capital, cost of procuring raw material and expenditure on power, fuel and water. These accounted for 6.45 per cent, 3.65 per cent and 3.46 per cent respectively in the case of conventional units. In the case of modern units the interest on fixed capital, depreciation and cost of raw material purchased were the major cost components which accounted for 7.86 per cent, 3.52 per cent and 3.43 per cent respectively. Overall, the total processing cost per quintal of paddy (excluding raw material cost) accounted to Rs. 294.14 per quintal for conventional units and Rs. 277.34 per quintal for modern units. (Shwetha *et al.* 2011)

The results also revealed that on an average the gross returns from the sale of products obtained by processing one quintal of paddy were found to be Rs. 1845.75 in both the channels for conventional units and Rs. 2088.02 in both the channels for modern units. Cost of paddy consists of paddy purchase price, paddy procurement cost and paddy inventory cost which varied across the both channels and units under the study. For conventional units, the cost of paddy per quintal was Rs. 1050 in channel-I (purchase directly from the farmer) and Rs. 1310 in channel –II (purchase through commission agents) respectively. In case of modern units, cost of paddy was Rs. 1150

Table 1. Investment pattern in the selected rice mills (Rs. in lakhs)

S. No	Particulars	Amount	Percentage	Amount	Percentage
		Conventional unit		Modern unit	
1.	Land	6.56	27.36	16.50	7.07
2.	Building	6.31	26.31	60.00	25.72
3.	Machinery and Equipment	7.17	29.90	150.00	64.29
4.	Infrastructure	2.87	11.97	3.80	1.63
5.	Other Fixtures	1.07	4.46	3.00	1.29
	Total	23.98	100	233.30	100

Table 2. Net returns realized by the selected rice mills (Rs per quintal of paddy processed)

S.No	Particulars	Rice milling process			
		Conventional unit		Modern units	
		Channel – I	Channel – II	Channel – I	Channel - II
1.	Gross return	1845.75	1845.75	2088.02	2088.02
2.	Cost of paddy	1050.00	1310.00	1150.00	1310.00
3.	Processing cost	294.14	294.14	277.34	277.34
4.	Marketing cost				
	a) Rice	84.00	111.00	91.00	107.00
	b) Husk	-	30.00	-	30.00
	c) Bran	-	-	-	-
	d) Broken	-	-	-	-
	e) Total cost	84.00	141.00	91.00	137.00
5.	Total cost	1428.14	1745.14	1518.34	1724.34
6.	Net returns	417.61	100.61	569.68	368.68

Channel – I sale of rice at mill gate.
Channel – II sale of rice in open markets.

in channel –I and Rs. 1310.00 in channel – II respectively. The total marketing costs, which consisits of cost of selling of rice, bran, husk and broken, happened to be Rs. 84.00 in channel-I (sale at mill gate) and Rs. 141.00 in channel-II (sale at open market) for conventional units. However, the total marketing costs were much higher for modern units at Rs. 91.00 for channel – I and Rs.137.00 for channel-II. The net returns varied considerably across units and channels. It is observed from the Table 2. that, the net returns from the sale of the products obtained by processing one quintal of paddy were found to be Rs. 417.61 in channel-I and Rs. 100.61 in channel-II for conventional units respectively. Similarly, in the case of modern units it was Rs. 569.68 and Rs. 368.68 respectively.

S. No	Particulars	Conventional units		Modern units	
		Amount	Percentage	Amount	Percentage
A	**Fixed cost**				
1	Salaries to permanent employees	27.00	1.83	4.71	0.31
2	Depreciation	26.74	1.81	53.00	3.52
3	Interest on fixed capital	95.15	6.45	118.42	7.86
4	Total fixed cost	148.89	10.10	176.13	11.68
B.	**Variable cost**				
1.	Cost of raw material	1180.00	80.05	1230.00	81.60
2.	Cost of procuring raw material	53.75	3.65	51.70	3.43
3.	Power, fuel charges	51.00	3.46	33.00	2.19
4.	Wages for labour	22.00	1.49	4.81	0.32
5.	Office maintenance	1.00	0.07	1.00	0.07
6.	Telephone charges	1.00	0.07	1.00	0.07
7.	Storage cost	1.75	0.12	0.90	0.06
8.	Maintenance cost	3.50	0.24	2.00	0.13
9.	Interest on working capital	11.25	0.76	6.80	0.45
10.	Total variable cost	1325.25	89.90	1331.21	88.32
	Total cost	1474.14	100	1507.34	100

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Research Note
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DEALERS' PERCEPTION ON VARIOUS BRANDS OF AGROCHEMICAL PRODUCTS AND THEIR PROMOTIONAL ACTIVITIES IN NALGONDA DISTRICT OF TELANGANA STATE

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Indian economy is largely agrarian in nature, which is contributing about one fifth of the total GDP. The occupation of nearly 58 per cent of the population is agriculture. Since a decade, India's population is on increasing note therefore, to meet the food grain requirement for the increasing population, there must be intensive agriculture with judicious use of inputs like fertilizers, pesticides, seeds, irrigation etc. In view of the fact that nearly 30 per cent of the potential food production is lost in India due to the damage caused by the insect pest, plant pathogens, weeds, rodents, birds etc., so the use of pesticides has become absolutely essential. Hence, the agrochemicals industry in India has a vital role in the economy of the country.

India is the fourth largest producer of agrochemicals globally. But the consumption of crop protection products in India is among the lowest in the world. In India, there are about 125 technical grade manufactures (10 multinationals), 800 formulators, over 145,000 distributors (Federation of Indian Chambers of Commerce and Industry, 2013). Thus the Indian agrochemicals market is highly fragmented in nature and witnesses fierce competition with large number of organized sector players and significant share of spurious pesticides. In this scenario every company wants to fight the race. This study will help in understanding the market competition and strategies adopted by companies for increasing the sales.

The study was undertaken in the Nalgonda district of Telangana state. Simple random sampling technique was used to select the sample for the study. Five clusters Viz. Suryapet, Kodad, Miryalaguda, Nakrekal and Choutuppal were selected for the study with 10 dealers from each cluster. Thus, the sample size comprised of 50 dealers. Data was collected from the selected dealers with the help of well-designed pretested questionnaire. The collected data was tabulated and analyzed by using Garrett's Ranking Technique.

Garrett's Ranking Technique

To find out the most significant factor which influences the respondent, Garrett's ranking technique was used. As per this method, respondents have been asked to assign the rank for all factors and the outcome of such ranking have been converted into score value with the help of the following formula.

Percent position = $100 (R_{ij} – 0.5) / N_j$

Where R_{ij} = Rank given for the i th variable by j th respondents

N_j = Number of variable ranked by j th respondents

With the help of Garrett's table, the percentages are estimated and converted into scores. For each factor, the scores of each individual are added and then total value of scores and mean values of score is calculated. The factors having higher mean value is considered to be the most important factor.

Dealers' perception about agrochemical products of various brands

A total of 50 randomly selected respondents were given twelve factors and asked to give their ranks of preferences. The results were analyzed using Garrett's Ranking Technique and presented in Table 1 (Rethinapandy and Selvakumar, 2013).

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Table 1. Dealers perception about agrochemicals products of various brands

S.No	Factors	Mean score	Rank
1.	Brand image	64.82	I
2.	Effectiveness of pesticide	61.42	III
3.	Time availability	59.74	IV
4.	Price	55.10	V
5.	Stock returns	40.70	X
6.	Farmers loyalty	48.48	VII
7.	Credit policy	44.68	VIII
8.	Promotional activites	53.12	VI
9.	Packaging	33.44	XI
10.	Dealers margin	43.30	IX
11.	Quality	63.32	II
12.	Gift packaging	31.28	XII

The dealers of agrochemicals have ranked each of the parameter in accordance to their perception for various competitive brands.

The analysis of the results have revealed that brand image was ranked first and quality was ranked second in their preference. The other parameters such as effectiveness of pesticide, timely availability, price and promotional measures were ranked third, fourth, fifth and sixth respectively. Farmers' loyalty, credit policy, dealers' margin, stock returns and packaging were ranked seventh, eighth, ninth and tenth in the preference order. Gift packages were given least priority by majority of the dealers (Krausova and Banful, 2010).

The effect of promotional activities of various brands on the sales of the products

In order to study the effect of promotional activities of various brands on the sales of the products, a total of 50 randomly selected respondents were given ten factors and asked to give their ranks of preferences. The responses were analyzed using Garrett's Ranking Technique and is presented in Table 2.

Table 2. The effect of promotional activities of various brands on the product sales

S. No	Factors	Mean score	Rank
1	Pamphlets	57.44	IV
2	Demonstrations	62.76	I
3	Field visits	59.24	III
4	Campaigning	61.72	II
5	Radio	30.40	X
6	Television	46.70	VII
7	Wall paintings	42.82	VIII
8	Gifts	32.20	IX
9	Monetary incentives	54.24	V
10	Discounts	51.48	VI

The analysis revealed that demonstrations were very effective in generating impact therefore was ranked first by the dealers. The campaigning in the villages and field visits were found to be effective in boosting sales hence they were ranked second and third. Pamphlets and monetary incentives for dealers played a crucial role in promoting sales and were ranked fourth and fifth in the order of their effectiveness whereas discounts stood at sixth position. Television, wall paintings, gifts and radio were ranked seventh, eighth, ninth and tenth in the order of preference (Mali *et. al,* 2012).

The conclusions drawn from the study are as follows

- Brand image and quality were the important decision making factors for the dealer to stock the commodity in their shelves since the farmer also considers them as important parameters while purchasing as it directly affects the yield or output.
- Demonstrations, pamphlets and field visits proved to be very effective to improve the sales when compared to television, radio, wall paintings, free gifts etc. farmers are keen on the concept of seeing is believing" and therefore directly reflects upon the sales performance.

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Research Note

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YIELD AND YIELD ATTRIBUTES OF *RABI* SUNFLOWER (*Helianthus annuus* L.) AS INFLUENCED BY SOWING DATES AND IRRIGATION LEVELS

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Sunflower (*Hellianthus annuus* L.) seed is an important oilseed contain good quality oil (34-52%) as well as high amount of protein (14%) as reported by Singh *et al*. (1997). Sowing times play a major role in effecting the growth and yield of sunflower. Varied sowing dates and varied rainfall at different growth stages effect the availability of water. Numerous research studies for different climates have shown that sowing date influences the growth, seed yield and quality. The best irrigation regime can not only saves the water and also regulates the impact of erratic rainfall and conserve moisture. Hence, an attempt was made to study the best sowing date and irrigation regime of sunflower in Rajendranagar, Hyderabad, climatic conditions.

An experiment was carried out at the Water Technology Centre, College Farm, College of Agriculture, Rajendranagar, Hyderabad (Latitude $17^0$19' 19.2" N, Longitude $78^0$24' 39.2" E and altitude of 534 m above mean sea level) during winter (*rabi*) season on sandy loam soil in split plot design with 3 replications. Main plots were planting dates (9th October, 6th and 21st November) and subplots were irrigation levels 80, 60 and 40 per cent available soil moisture (ASM). Sunflower cultivar DRSH-1 with duration of 100 - 105 days during *rabi* was sown with 55555 plants ha^{-1}. A uniform dose of 60:40:30 kg N, P_2O_5, and K_2O ha^{-1} in the form of urea (46 % N), single super phosphate (16 % P_2O_5) and muriate of potash (60 % K_2O), respectively were applied. Entire quantity of P and K was applied as basal, where as N was applied in two equal splits. Irrigation was scheduled by observing the available soil moisture in the root zone. The irrigation was commenced whenever the soil moisture was depleted to 20, 40 and 60 percent of available soil moisture which was as per the treatments equivalent to 80, 60 and 40 per cent of available soil moisture. When crop heads became yellow, 10 plants were selected and traits such as number of grains per head, 100 seed weight at 12 percentage moisture were measured. Water productivity was calculated seed yield to the amount of water applied. It was calculated by the following relationship.

$$\text{Water productivity kg ha}^{-1}\ \text{mm}^{-1} = \frac{\text{Seed Yield (Kg Ha}^{-1})}{\text{Water applied (mm)}}$$

The yield attributes of sunflower like number of seeds head^{-1}, head diameter and 100 seed weight were significantly influenced by the dates of sowing and irrigation levels (Table. 1). The interactions between the dates of sowing and irrigation levels were not found to be significant for all the yield attributes. Sowing on 21st November and irrigation schedules at 80 per cent ASM recorded significantly higher number of seed head^{-1}, 100 seed weight and head diameter and significantly lower values were recorded when sowing was done on 9th October and irrigated at 40 per cent ASM. The results were comparable with the findings of Al-Ghamdi *et al.* (1991) that yield attributes was recorded higher at 40 per cent depletion of available soil moisture (DASM) over 60 per cent and 80 per cent DASM.

Significantly higher seed yield was obtained at 21st November at 80 per cent ASM and was on par with 6th November at 60 per cent ASM and significantly lower seed yield was recorded on 9th October at 40 per cent ASM. Interaction effect of dates of sowing and irrigation levels was found to be non significant.

The effect of dates of sowing and irrigation levels significantly influenced the harvest index. Harvest index on 21st November at 80 per cent ASM recorded significantly higher over 9th October at 40 per cent ASM. The interaction effect was found to be non-significant between dates of sowing and irrigation levels. Yield and Harvest index was found to be higher at higher moisture availability (Mandal and Giri, 2002).

Water applied to the different dates of sowing and irrigation levels varied due to weather condition and varied rainfall. Water applied to the crop sown on early date (9th October) required less amount (217

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mm) of water when compared to the late sown crop (21st November) (290.6 mm) including the effective rainfall. This was due to the reason that early sown crop received the high amount of rainfall and the seasonal average pan evaporation in the earlier sown date was 3.0 mm per day and in later date it was 3.2 mm per day. Among irrigation treatments irrigation scheduled at 80 per cent ASM ie., 20 per cent depletion of water required number of irrigation and more quantity of water was applied compared to that of 40 per cent ASM i.e., 60 per cent depletion. The total amount of water used varied from 227.9 to 270.1 mm (Table. 2).

Water productivity was significantly affected by the dates of sowing and irrigation levels (Table 2). It was significantly higher at 6th November (6.72) and irrigation given at 80 per cent (6.48) ASM than other treatments. Similar result of increase in water productivity due to saving in water without any substantial reduction in seed yield due to planned water management was reported earlier by Unger (1983) and Mahal *et al.*, (1998)

The results of present work and analysis revealed that the influence of dates of sowing and irrigation levels on yield attributes and yield of 'DRSH-1 Hybrid' of sunflower (*Helianthus annuus* L.) was significant. Higher yield and yield attributes were found under 21st November and irrigation scheduled at 80 per cent ASM. The higher amount of irrigation water was required at 21st November due to higher temperatures and higher evaporation than earlier sowings. Increase in irrigation levels showed a positive impact on yield and yield attributes. Water productivity was higher for the crop sown at 6th November and irrigation scheduled at 80 per cent ASM.

Table 1. Effect of different dates of sowing and irrigation levels on yield and yield attributes of sunflower

Treatments	No of seed head^{-1}	100 seed weight (g)	Head diameter (cm)	Seed yield (kg ha^{-1})	Harvest index (%)
Sowing dates					
D_1: 9th October	524	4.26	9.6	1423	28.98
D_2: 6th November	575	4.38	10.5	1601	31.62
D_3 : 21st November	637	5.04	11.4	1647	33.14
SEm ±	18	0.09	0.2	31	0.45
CD (P=0.05)	72	0.37	0.7	121	1.77
Irrigation levels					
I_1 – 40% Available Soil Moisture	463	4.06	9.1	1352	28.63
I_2 – 60% Available Soil Moisture	590	4.73	10.6	1576	31.56
I_3 - 80% Available Soil Moisture	683	4.90	11.8	1744	33.56
SEm ±	15	0.07	0.2	30	0.63
CD at 5%	46	0.22	0.7	92	1.93
Interaction					
Sub treatment at same level of main treatment					
SEm ±	26	0.12	0.4	52	1.09
CD at 5%	NS	NS	NS	NS	NS
Main treatment at same/different level of sub treatment					
SEm ±	28.0	0.14	0.4	52	0.99
CD at 5%	NS	NS	NS	NS	NS

Table 2. Water productivity and water applied of sunflower under sowing dates and irrigation.

Treatments	Water productivity (kg ha mm^{-1})	Amount of water applied
Sowing dates		
D_1: 9th October	6.54	217.6
D_2: 6th November	6.72	238.0
D_3 : 21st November	5.65	290.6
SEm ±	0.13	
CD at 5%	0.51	
Irrigation levels		
I_1 – 40% Available Soil Moisture	6.05	227.9
I_2 – 60% Available Soil Moisture	6.38	248.3
I_3 - 80% Available Soil Moisture	6.48	270.1
SEm ±	0.13	
CD at 5%	0.40	
Interaction		
Sub treatment at same level of main treatment		
SEm ±	0.23	
CD at 5%	NS	
Main treatment at same/different level of sub treatment		
SEm ±	0.23	
CD at 5%	NS	

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