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IDENTIFICATION OF COTTON (*Gossypium spp.*) HYBRIDS AND THEIR PARENTAL LINES USING MICROSATELLITE MARKERS

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ABSTRACT

Microsatellite markers were used for fingerprinting of hybrids for assessing variation within parental lines in cotton. Sixteen microsatellite markers were employed for fingerprinting six hybrids and their parental lines. Five SSR markers were found polymorphic across the hybrids and produced unique fingerprint for the six hybrids. These highly informative primers not only differentiated the parent genotypes but also confirmed the parentage of their true hybrids. The microsatellite marker, BNL 3449 amplified alleles specific to differentiate parental lines of NSPHH 5 likewise BNL 3255 primer for NDLHH 240 and WGHH 2, JESPR 148 primer for LAHH 4, BNL1317 for CSH 198 and BNL 3090 for CICR 2. Our findings revealed that SSR procedures are excellent genomic tools for parentage confirmation and hybridity determination, and would also enhance efficiency of our breeding programmes.

Cotton is an important commercial crop in India and contributes a major share to the national economy. India ranks second in cotton production (22% of the global production) with the average productivity of 526 kgha-1. Varietal identification has great significance from seed production, breeding as well as intellectual property rights point of view to ensure quality seed (Rao *et al.,* 2012).For the improvement of agronomically and economically important traits, plant breeding generally recombines traits present in different parental lines of cultivated and wild species. Conventional breeding programme involved screening of phenotypes of pooled or individual plants for presence of desirable traits reach this by a process of repeated back crossing, selfing and testing. Use of molecular markers facilitated these breeding processes, since it can provide means of detecting and resolving complications and accelerate the generation of new varieties and allow association of phenotypic traits with genomic loci (Jiang *et al.,* 2000). Moreover, the molecular markers would also increase the standards of DUS testing (Shukla *et al.,* 2011).

DNA Fingerprinting is an important tool for characterization of germplasm and establishment of identity of varieties/hybrids/parental lines in plant breeding and germplasm management (Vijay *et al.,* 2011). For protecting proprietary germplasm, molecular markers have played an important role in securing plant variety rights by virtue of their unique efficiency in distinguishing even the closely related germplasm accessions. Several PCR based marker have been developed in last two decades. SSR markers are potentially powerful for DNA fingerprinting and have wide spread application in plant genome analysis (Morgante and Oliveri, 1993). Microsatellite markers have been used for DNA fingerprinting by several researchers (Belaj *et al.,* 2003).

MATERIAL AND METHODS

The studies pertaining to the DNA fingerprinting for identification of cotton hybrids using SSR marker system were carried out at the Department of Institute of Biotechnology, PJTSAU during the year 2011-12.The plant material for this study comprised of six hybrids and their female and male parents CSH 198 (CSH 19 ×CSH 8), CICR 2 (DS 5×LD 327) obtained from CICR, Nagpur, NSPHH 5 (NA 1325× L604), LAHH 4 (AB 6 ×M 2) obtained from Lam, Guntur, NDLHH 240 (NA 1325× MCU 5) obtained from RARS, Nandyal and WGHH 2 (NA1678× NA 40845) obtained from RARS, Warangal. Fresh young leaves from the plants were collected for DNA extraction.

SSR analysis

DNA was isolated following the procedure of Sharma *et al. (*2002*)*. For fingerprinting, DNA from the bulk of leaf samples of 10 individual plants was used. Quantification of DNA was accomplished by analyzing the DNA on 0.8% agarose gel using diluted uncut lambda DNA as standard. A total of 16 SSR markers were used to identify polymorphic marker among the parents. From the 16 markers that were

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found to be polymorphic, five markers were selected to test the hybridity of cotton, since they have produced clear, scorable and unambiguous polymorphic bands among the parents. PCR analysis was performed using 16 SSR primers. SSR amplification was carried out in a27ìl reaction volumes containing 10x PCR buffer, 2.5 mM dNTPs, 1.5ìl random primer and0.2 unit of Taq DNA polymerase (Bangalore Genie Pvt. Ltd., Bangalore, India) PCR amplification reaction was carried out in a thermal cycler and the programme of reaction was set as initial denaturation of template DNA at 94°C for 5 min, while the final denaturation at 94°c for 1 min, primer annealing (50-60°C) for 1 min and elongation (72°C) for 45 sec and final elongation at 72°c for 10 min. PCR products were separated on 3% Metaphor TM agarose gel using 0.5×TBE buffer. The size of the amplified fragments was determined by using size standards (50 bp DNA ladder). DNA fragments were visualized under UV light and photographed using Biorad photographic gel documentation system.

RESULTS AND DISCUSSION

The six cotton hybrids and their parental lines were analyzed for the microsatellite polymorphisms.The parental polymorphism survey identified five informative markers (BNL 3449, BNL 3255, JESPR 148, BNL 1317 and BNL 3090), which were used for fingerprinting the hybrids. The five markers together amplified a unique fingerprint for all the hybrids and therefore, were effective in distinguishing them from each other (Fig.1). Gel pictures showing amplifications in the parents and hybrids are shown in Fig. 2. The parents and the hybrids plants were carefully observed on the basis of morphology to see if they were true hybrids. The polymorphisms observed between the parents are used as markers for hybrid identification. Comparing the SSR banding pattern of parents with respective hybrids, genuine hybrids were confirmed (Fig. 2a-f).

The BNL 3449 primer had amplified an allele of size 120 bp in male parent (L 604) and hybrid (NSPHH 5). On the other hand the female parent (NA 1325) had an amplicon at 130 bp. However, hybrid (NSPHH 5) exhibited the alleles of both parents confirming the heterozygosity of the hybrid by having two bands at 120 and 130 bp. (Fig. 2a). Among six hybrids studied, two hybrids NDLHH 240 and WGHH 2 could give different allele sizes with single SSR primer BNL3255(Fig. 2b and 2c). This primer amplified a specific allele size (120 bp) in female (NA 1325) and 140 bp allele size in male (MCU 5) and presence of both the alleles in the hybrid, NDLHH240, whereas in hybrid (WGHH 2) it amplified both the alleles of 127 bp female (NA 1678) specific allele and 145 bp male (NA 4084) specific allele.

Similarly, hybrid LAHH 4, could be identified and distinguished by the JESPR 148 SSR marker (Fig. 2d). The hybrid showed complementary banding pattern of both parents. The marker had amplicon of 235 bp in its female parent (AB 6). The same marker had different amplicon of size 247 bp in male parent

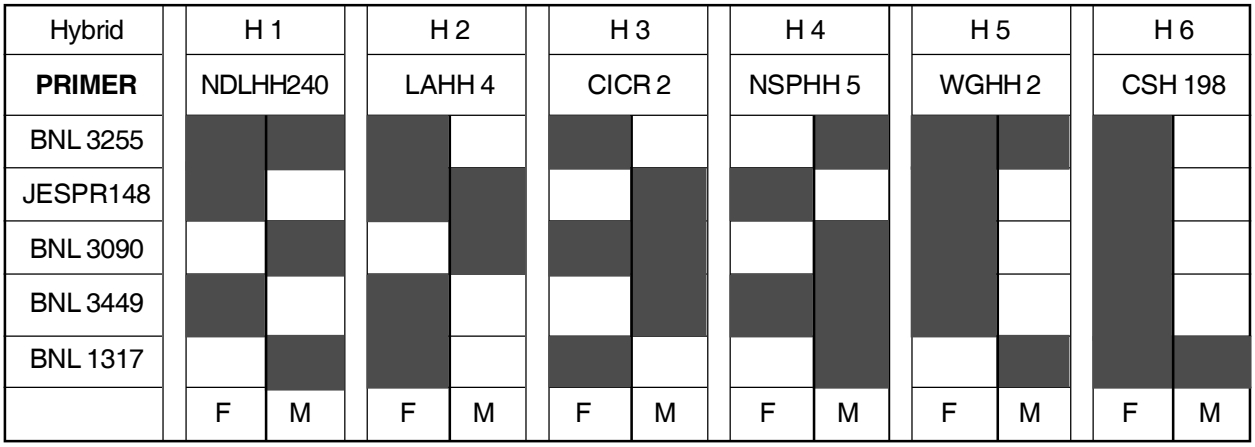

Fig 1. Schematic representation of microsatellite DNA profiling for hybrids and their parents. Each column (H) corresponds to a hybrid (above) and consists of two sub columns, F and M lines. Each row shows the allelic pattern of each SSR marker in six hybrids. The shaded blocks correspond to the presence of different allele in respected marker. H1 : NA 1325/ MCU5 H2 : AB 6/ M 2 H3 : NA1325/ L 604 H4 : NA 1678/ NA 4084.

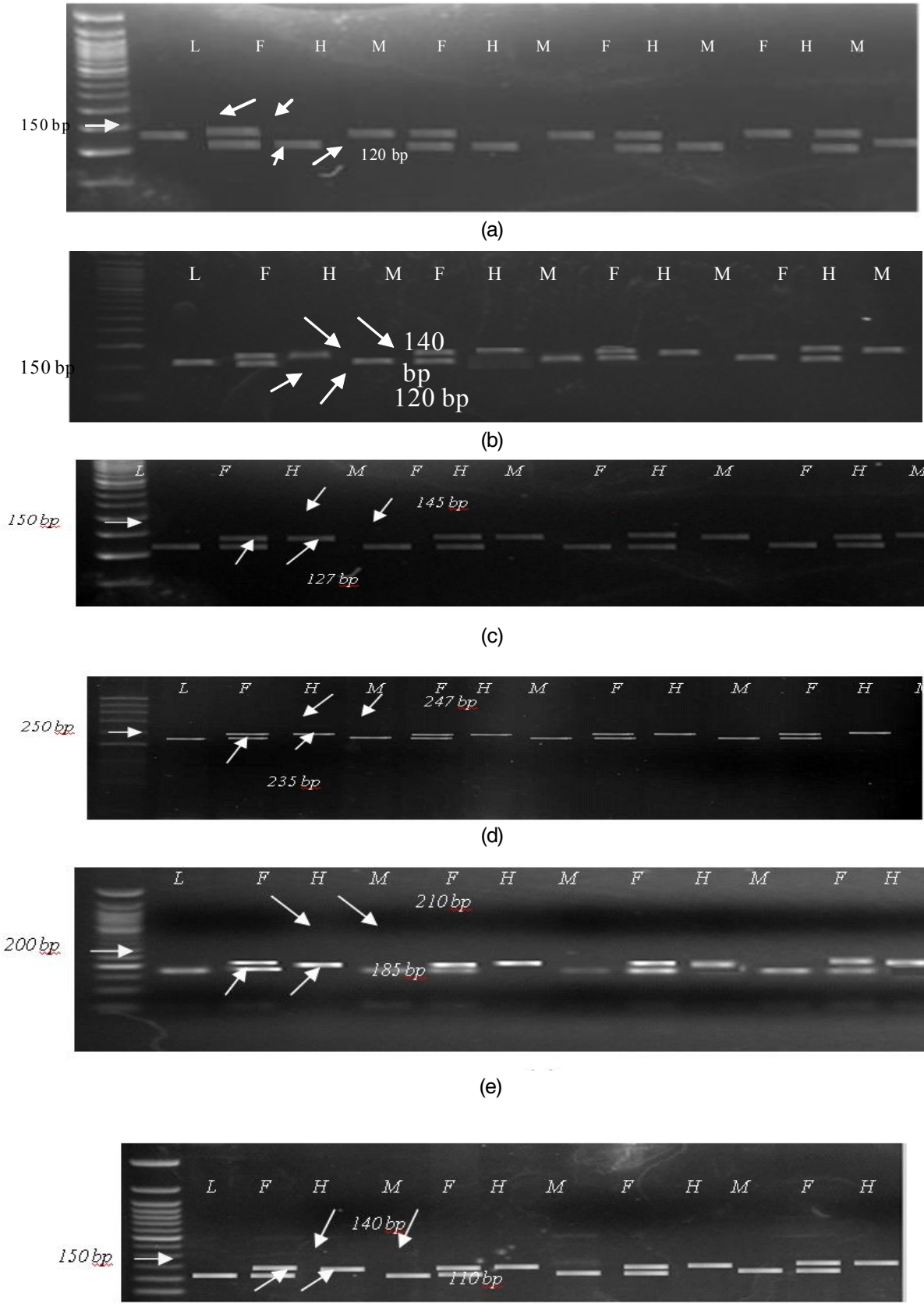

Fig 2. SSR amplifications of the NSPHH 5 (NA 1325× L604), NDLHH 240 (NA 1325 × MCU 5) WGHH 2 (NA1678 × NA 40845), LAHH 4 (AB 6 × M 2), CSH 198 (CSH 19 × CSH 8), CICR 2(DS 5 × LD 327 by the BNL 3449 (2a), BNL 3255 (2b), BNL 3255 (2c), JESPR 148(2d), BNL 1317 (2e) and BNL 3090 (2f). The sequence of lanes is female, hybrid and male in 4 replications.

(M 2). The hybrid showed both the amplicons at 235 and 247 bp. Thus, it confirmed the genuine nature of hybrid.

The primer BNL 1317 amplified a specific allele size of 210 bp in hybrid (CSH 198) and male parent (CSH 8) but not in its female parent (CSH 19). However, the BNL 1317 amplified different allele of size 185 bp in female parent. The same allele size of 185 bp was expressed in hybrid, but not in its male parent (CSH 8). Thus, it confirmed that the allele of size 210 bp was very specific to the male parent of CSH 198 and therefore, the presence of both female and male parent alleles noticed was the result of crossing between two parents (hybrid). The observed banding pattern was highly specific to hybrid CSH 198 and was not observed in any other hybrids included in this study. (Fig. 2e).

The primer BNL 3090 had amplified allele of size 110 bp in female parent (DS 5). On the other hand the male parent (LD 327) had an amplicon at 140 bp. However, hybrid (CICR 2) exhibited the alleles of both parents confirming the heterozygosity of the hybrid by having two bands at 110 and 140 bp. This SSR primer can safely be employed for testing hybrid seed purity of CICR 2. (Fig. 2f).

The SSR markers have an advantage of co-dominance inheritance, easy scoring of the alleles, reproducibility and accessibility to laboratories (Paniego *et al.,* 2002). These polymorphic markers produce unique banding patterns, due to the presence of female and male specific alleles in the hybrids resulted in purity determination (Nandakumar *et al.,* 2004) in rice , (Zhang *et al.,* 2005) in cotton and (Kumar *et al.,* 2009) in rice.

The success of identification of a true hybrid can be established using morphological basis at maturity. It is necessary to select true hybrids for establishing a breeding program but it is difficult before flowering and bolls formation. By the use of SSR technique, it is easier to identify true hybrids at early stages. This technique can be adopted for large scale screening of hybrids in cotton. A set of five markers (BNL 1317, BNL 3090, BNL 3255, BNL 3449 and JESPR 148) differentiated all the hybrids from each other, which can be used as referral markers for unambiguous identification and protection of these hybrids.

Assessment of seed purity is one of the most important quality control components in hybrid seed production. Traditionally, GOT has been employed to assess the purity of hybrid seeds using morphological traits. The traits such as petal colour, petal spot, anther colour, boll shape, leaf colour were studied to distinguish the hybrids. Though GOT is used to determine genetic purity of cotton hybrids, it is tedious, space demanding and time consuming and often does not allow the unequivocal identification of genotypes. Hence, a recent development in molecular markers has been suggested for genetic purity testing since they are used to assess precisely the genotype and not the phenotype (Sundaram *et al.,* 2008). Among different types of molecular markers, SSR markers found to be very useful for testing genetic purity since they are co-dominant and using SSR the heterozygous state can be easily discerned from the homozygous state.

In summary, it is concluded from this study that it is possible to differentiate the cotton hybrids more accurately and efficiently from its parental lines using molecular markers. These molecular markers would be more efficient than GOT, since DNA markers would be more accurate for determining hybrid seed purity. Further, marker analysis will also result in considerable savings for the seed industry as this technique may avoid the cost of storage for a whole season and cost of acquiring land and cultivation.

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COMBINING ABILITY STUDIES FOR GRAIN YIELD AND ITS COMPONENTS IN RICE (*Oryza sativa* L.) UNDER COASTAL SALINE SOIL CONDITIONS

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ABSTRACT

Combining ability studies on yield contributing characters through diallel analysis with eight genotypes (RPBio-226, Swarna, CSR-27, CSR-30, CSRC(S)7-1-4, SR26-B, CST-7-1 and CSRC(S)5-2-2-5) was carried out during *kharif,* 2010 under salt affected soils of Agricultural Research Station, Machilipatnam. The study revealed the presence of higher specific combining ability (*sca)* variance for all the characters studied, suggesting the significant role of non-additive gene action. Based on *gca* effects, the genotypes CSRC(S)5-2-2-5, SR26B and CSRC(S)7-1-4 were identified as good combiners for yield attributing traits *viz*., number of tillers per plant, number of productive tillers per plant, panicle length, number of filled grains per panicle, 1000-grain weight, including yield. Hence, these parents could be exploited for development of salt tolerant high yielding varieties. Among the hybrids, Swarna x CSRC(S)7-1-4 was considered to be the best cross combination for seven traits *viz*., days to 50 per cent flowering, panicle length, panicle weight, number of filled grains per panicle, spikelet fertility, 1000-grain weight and grain yield per plant as per the sca effects and *per se* performance. The other hybrids with good specific combining ability for majority of the traits were SR26-B x CST-7-1, RPBio-226 x CSRC(S)7-1-4 and RPBio-226 x CSR-30 under saline soil conditions.

Rice (*Oryza sativa* L.) is the most important food crop in the world, which accounts for more than 21% of the calorific needs of the world's population and up to 76 per cent of the calorific intake of the population of South East Asia (Melissa *et al.,* 2009). Though significant improvement in productivity has been achieved over the years, a series of biotic and abiotic stresses limits its productivity worldwide.

High salt concentration in soil is the major constraint to rice production in Bangladesh and India (Mohammadi-Nejad *et al*., 2008). Nearly 20 per cent of the world's cultivated area (800 M ha) and nearly half of the world's irrigated lands are affected by salinity (Maser *et al*., 2002).The area is still increasing as a result of secondary salinization and land clearing (FAO, 2005). In India, nearly 8.5 M ha are salt affected and in Andhra Pradesh it is estimated to be 2.74 lakh ha (Source : National Remote Sensing Centre).Several workers reviewed the concept of breeding for salt tolerance and opined that its sensitivity is found to vary depending on growth stage. Therefore, increasing the yield potential of rice in saline soils is essential for ensuring the food security in India.

MATERIAL AND METHODS

The experiment was conducted during the year 2010 at Directorate of Rice Research, Hyderabad, to classify the 24 rice genotypes for salt tolerance based on differential reaction to salinity stress for using in the crossing programme. Fifty seeds of each cultivar for each treatment were allowed to germinate on a filter paper in nine cm diameter petri-dishes. Each filter paper was moistened with salt solution (NaCl) at three concentrations of salinity (4, 8 and 12 dS/ m) of electrical conductivity and distilled water as control) created by mixing 2.57, 5.14 and 7.70 g of sodium chloride per litre of water. The observations were recorded on ten random plants in three replications for different seedling parameters on 15 days old seedlings. The salt injury score was recorded based on Standard Evaluation Score (IRRI, 1986) and the varieties were classified accordingly.

Based on salt injury score, the 24 rice genotypes were categorized into three classes. The cultivars *viz*., RPBio-226, Swarna, Krishna Hamsa, Sampada, NLR-3042, NLR-145, BPT-5204, BPT-2231, BPT-2270 and Dhanarasi were graded as susceptible as they showed salt injury score of more than 5, while the genotypes namely, CSR-27, CSR-30, CST7-1, CSRC(S)2-1-7, Santhi, NLR-33359, Varadan, NLR-3041, NLR-33892 and NLR-34449 were found to be moderately tolerant by virtue of their salt injury score being less than five. Similarly, the cultivars *viz*., SR26B, CSRC(S)5-2-2-5, CSR-4 and SCRC(S) 7-1-4 were identified for good tolerance to salinity as the score was less than three.

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Eight saline tolerant genotypes *viz.,* RPBio-226, Swarna, CSR-27, CSR-30, CSRC(S)7-1-4, SR26-B, CST-7-1 and CSRC(S)5-2-2-5 were crossed in diallel fashion (without reciprocals) and the resulting 28 hybrids along with parents were evaluated during *kharif,* 2012 under salt affected soils of Agricultural Research Station, Machilipatnam in a randomized block design replicating thrice.

Seedlings of 30 days old were transplanted in the main field (Saline soils) which was of sandy loam type in texture with an average electrical conductivity of 6.3 dS/ m and pH of 7.9. The parents and F_1s were transplanted in three rows of 1.5 metre length with a spacing of 20x15 cm. The recommended agronomic practices were adopted to raise the crop. The results obtained on gene effects through diallel analysis following model I and method II of Griffing (1956) were presented trait wise for ten yield parameters in eight parents and 28 F_1 hybrids.

RESULTS AND DISCUSSION

Mean squares due to general combining ability (*gca*) for yield components were significant indicating that all the parents differed significantly for their general combining ability for all the traits studied (Table 1). The specific combining ability (*sca*) variances were higher than *gca* variances for all the characters studied which indicated the preponderance of non- additive gene action. These findings are in agreement (for days to 50 per cent flowering, plant height, number of productive tillers per plant and panicle length) with the earlier reports of Karthikeyan and Anbuselvam (2006), Sanjeevkumar *et al.*(2007) Senguttuvel (2008) and Kumar Babu *et al.* (2010). The non-additive gene effects were reported by earlier researchers *viz.,* Shukla and Pandey (2008) and Kumar Babu *et al.* (2010) for test weight; Saidaiah *et al.* (2010) for number of filled grains per panicle ; Senguttuvel (2008) for spikelet fertility; Kumar Babu *et al.* (2010) for grain yield.

The parent, SR26B was adjudged as the best combiner for total tillers per plant and productive tillers per plant, panicle length, panicle weight, number of filled grains per panicle, 1000-grain weight and grain yield, followed by CSRC(S) 7-1-4 for number of tillers per plant, panicle weight, number of filled grains per panicle and test weight (Table 2).

Among the hybrids, Swarna x CSRC(S)7-1-4 was considered to be the best one for seven traits *viz*., days to 50 per cent flowering, panicle length, panicle weight, number of filled grains per panicle, spikelet fertility, 1000-grain weight and grain yield per plant (Table 3) as per the *sca* effects and *per se* performance. The other hybrids with good specific combining ability for majority of the traits were SR26-B x CST-7-1, RPBio-226 x CSRC(S)7-1-4 and RPBio-226 x CSR-30.

There was no relation to predict that parents with high positive *gca* effects would always combine to give rise hybrids with high positive *sca* effects, as most of the cross combinations that recorded significant positive *sca* effects were involved the parents with high x low *gca* effects. The promising crosses with such high x low combinations were CSR-30 x CSRC(S)7-1-4 (Plant height); CST-7-1 x CSRC(S)5-2-2-5 (Days to 50 per cent flowering); Swarna x CSRC(S) 5-2-2-5 (Number of total as well as productive tillers per plant); SR26B x CST7-1 (Panicle length, number of filled grains per panicle, test weight and grain yield per plant) and Swarna x CSRC(S)7-1-4 (Panicle weight, number of filled grains per panicle, test weight and grain yield per plant). The desirable performance of these combinations may be attributed to the interaction of dominant alleles from good combiners and recessive alleles from poor combiners (Saidaiah *et al*., 2010) and such crosses could be better exploited through population improvement methods.

Further, parents with poor combining ability also produced superior hybrids with high *sca* and *per se* (CSR-27 x CSRC(S)7-1-4 for dwarfness; Swarna x CSRC(S)7-1-4 for earliness and spikelet fertility per cent; RPBio226 x CSR-30 for panicle length, panicle weight and number of filled grains per panicle) in the present study. Mostly prevalence of over dominance and epistatic interactions, as suggested by Dalvi and Patel (2009) might be the reasons for such results.

On over all basis, it can be concluded that genotypes, SR26B, CSRC(S)7-1-4 and CSRC(S) 5-2-2-5 were the good general combiners for yield and majority of yield attributes and SR26-B x CST-7-1, RPBio-226 x CSR-30 and CSR-27 x CSRC(S)5-2-2-5 were the most promising hybrids under saline soils. For improvement of yield and its attributes, based on *sca* effects, better *per se* of hybrids and the corresponding parents *gca*, recurrent selection, biparental matings and use of heterosis would be the perspective approaches.

Table 1. ANOVA for combining ability for yield and its components in rice (Oryza sativa L.) under saline soil conditions

Geno-types	df	PHT (cm)		DFF		TT		PT		PL (cm)		PW (g)		NFG/P		SF (%)		TW (g)		GY (g)	
		S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N
GCA	7	150.89**	69.03**	75.74**	66.11**	8.34**	12.33**	4.84**	13.54**	19.31**	4.94**	1.56**	1.06**	1447.20**	2286.41**	93.05**	27.83**	13.75**	10.20**	72.76**	30.36**
SCA	28	94.06**	33.19**	31.39**	26.48**	2.05**	12.85**	2.26**	13.78**	6.73**	4.37**	0.75**	0.50**	693.37**	582.81**	59.86**	44.32**	5.14**	2.77**	19.55**	14.52**
Error	70	5.10	7.12	1.93	5.11	0.46	0.55	0.25	0.50	0.74	0.96	0.04	0.03	40.49	86.96	8.53	5.89	0.25	0.59	1.78	2.27
$\sigma^2 gca$		14.58	6.19	7.38	6.10	0.79	1.18	0.46	1.30	1.86	0.40	0.15	0.10	140.67	219.95	8.45	2.19	1.35	0.96	7.10	2.81
$\sigma^2 sca$		88.96	26.07	29.46	21.37	1.59	12.29	2.01	13.28	5.99	3.42	0.71	0.46	652.87	495.85	51.33	38.43	4.89	2.18	17.78	12.25
$\sigma^2 gca$ / $\sigma^2 sca$		0.16	0.24	0.25	0.29	0.49	0.10	0.23	0.10	0.31	0.12	0.21	0.22	0.22	0.44	0.16	0.06	0.28	0.44	0.40	0.23

* Significant at p=0.05; ** Significant at p=0.01; S (Saline soils); N (Normal soils)

PHT (cm) : Plant height; DFF : Days to 50% flowering; TT : Number of tillers plant^{-1}; PT : Number of productive tillers plant^{-1}; PL (cm) : Panicle length; PW(g) : Panicle weight; NFGP^{-1} : Number of filled grains panicle^{-1}; SF (%): Spikelet fertility per cent; TW (g): 1000-grain weight; GY (g): Grain yield (g plant^{-1}).

Table 2. General Combining Ability effects of parents for yield and its components in rice (Oryza sativa L.) under saline soil conditions

Genotypes	PHT (cm)		DFF		TT		PT		PL (cm)		PW (g)		NFG/P		SF (%)		TW (g)		GY (g)	
	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N
RPBio-226	-2.08**	-1.81*	-2.95**	-1.70*	-1.32**	-0.23	-0.76**	-0.59**	-1.91**	-1.07**	-0.09	0.01	-11.90**	-1.22	-0.11	2.67**	-2.17**	-1.94**	-2.72**	0.80
Swarna	-5.65**	-2.91**	3.72**	3.57**	0.08	-0.17	0.07	0.11	-0.45	-0.13	-0.43**	-0.23**	-3.57	2.98	-5.18**	0.10	-0.99**	-0.71**	-1.84**	1.07*
CSR-27	-1.12	-1.00	-1.02*	-1.87**	-0.59**	-0.30	-0.26	-0.36	-0.31	0.68*	-0.04	-0.02	1.13	-9.18**	-0.66	0.63	0.76**	0.31	-2.47**	-1.23**
CSR-30	-4.56**	-0.25	-3.98**	-4.07**	-1.06**	-2.17**	-1.16**	-2.13**	-1.37**	-0.83**	-0.65**	-0.61**	-20.50**	-32.22**	-2.96**	-3.17**	-0.35*	-0.36	-2.31**	-3.61**
CSRC(S) 7-1-4	3.22**	4.42**	2.12**	1.77*	0.97**	-0.27	0.64**	-0.46*	0.34	0.22	0.43**	0.52**	6.77**	11.25**	0.10	-0.70	0.76**	0.80**	2.37**	0.07
SR26-B	4.51**	3.66**	0.58	1.30	1.04**	1.57**	0.81**	1.57**	1.53**	0.11	0.41**	0.14**	11.90**	4.62	1.62	-0.64	1.01**	0.71**	3.82**	2.00**
CST-7-1	2.40**	-1.51	-1.18**	-1.13	0.14	0.70**	0.07	0.74**	-0.12	-0.03	0.01	0.02	0.37	7.55**	3.00**	0.12	-0.27	-0.05	0.23	-0.05
CSRC(S) 5-2-2-5	3.29**	-0.59	2.72**	2.13**	0.74**	0.87**	0.57**	1.11**	2.29**	1.05	0.35**	0.16**	15.80**	16.22**	4.18**	1.00	1.26**	1.23**	2.91**	0.94*
S.E±g_i	0.67	0.79	0.41	0.67	0.20	0.22	0.15	0.21	0.25	0.29	0.06	0.05	1.88	2.76	0.86	0.72	0.15	0.23	0.39	0.45
S.E±g_i-g_j	1.01	1.19	0.62	1.01	0.30	0.33	0.22	0.32	0.38	0.44	0.08	0.08	2.84	4.17	1.30	1.09	0.23	0.34	0.60	0.67
CD at 5%	1.58	1.66	0.97	1.58	0.47	0.52	0.35	0.49	0.60	0.68	0.13	0.13	4.45	6.52	2.04	1.70	0.35	0.54	0.93	1.05

* Significant atp=0.05; ** Significant at p=0.01; S (Saline soils); N (Normal soils)

PHT (cm): Plant height; DFF: Days to 50% flowering; TT: Number of tillers plant^{-1}; PT: Number of productive tillers plant^{-1}; PL (cm): Panicle length; PW(g): Panicle weight;NFGP^{-1}: Number of filled grains panicle^{-1}; SF (%): Spikelet fertility per cent; TW (g): 1000-grain weight; GY (g): Grain yield (g plant^{-1}).

Table 3. Specific combining ability effects for yield and its components in rice under saline soil conditions

Hybrids	Plant height (cm)		Days to 50% flowering		No. of total of tillers plant^{-1}		No. of productive tillers plant^{-1}		Panicle length (cm)	
	Saline	Normal	Saline	Normal	Saline	Normal	Saline	Normal	Saline	Normal
RPBio-226 × Swarna	1.05	-4.52*	-4.34**	-3.76*	-0.37	3.88**	-0.05	2.27**	-1.39*	-1.70*
RPBio-226 × CSR-27	-2.21	-7.50**	7.73**	6.01**	0.96	0.31	0.29	1.74**	-0.37	-0.60
RPBio-226 × CSR-30	11.96**	5.79*	-2.64*	-4.79*	1.76**	1.84**	1.85**	1.17*	3.83**	1.34
RPBio-226 × CSRC(S)7-1-4	18.34**	5.92*	-5.41**	-4.29*	2.06**	2.28**	2.05**	2.50**	-0.42	-1.84*
RPBio-226 × SR26-B	6.56**	-3.46	3.46**	1.84	0.33	0.11	-0.45	1.80**	-1.87*	-2.26**
RPBio-226 × CST-7-1	4.42*	-0.35	-4.11**	-8.39**	-0.77	0.64	-0.72	0.64	-1.46*	0.47
RPBio-226 × CSRC(S)5-2-2-5	-2.53	3.83	1.33	0.99	-1.37*	-2.86**	-1.22**	-4.06**	-0.79	-0.04
Swarna × CSR-27	-11.88**	-1.90	-5.94**	-2.92	0.23	2.58**	0.12	3.04**	-1.86*	-1.30
Swarna × CSR-30	3.33	3.35	-3.97**	-6.06**	0.03	-4.22**	0.35	-2.53**	0.77	-0.54
Swarna × CSRC(S)7-1-4	14.78**	3.72	-8.74**	-4.56*	0.33	-1.46*	-0.12	-1.20**	1.53*	-0.58
Swarna × SR26-B	8.83**	3.48	-5.21**	-4.76*	-1.07	1.04	-0.95*	1.77**	-0.63	0.20
Swarna × CST-7-1	-2.41	1.12	1.23	1.01	-0.17	3.24**	-0.22	4.94**	-2.38**	0.40
Swarna × CSRC(S)5-2-2-5	-5.19**	3.13	1.66	-0.26	3.23**	1.41*	2.62**	0.57	0.61	1.99*
CSR-27 × CSR-30	-2.03	0.65	-6.91**	-3.62	-0.30	6.91**	1.02*	7.60**	-1.01	2.13*
CSR-27 × CSRC(S)7-1-4	-13.88**	-8.59**	-0.34	0.21	-0.67	-1.99**	-0.45	-2.73**	-3.61**	-2.38**
CSR-27 × SR26-B	5.27**	6.47**	5.19**	6.01**	-1.74**	-0.49	-2.28**	-0.43	0.00	1.86*
CSR-27 × CST-7-1	6.37**	4.98*	9.96**	3.44	1.50*	3.04**	1.79**	1.40*	1.01	1.10
CSR-27 × CSRC(S)5-2-2-5	2.78	-1.24	-5.27**	-4.82*	0.23	2.21**	-1.38**	3.04**	1.03	0.52
CSR-30 × CSRC(S)7-1-4	-21.85**	8.23**	-1.37	-0.59	-0.20	2.54**	-1.88**	1.70**	-0.96	1.56
CSR-30 × SR26-B	-14.20**	-0.18	2.16	-2.46	1.06	3.04**	-1.72**	4.34**	-4.31**	-4.47**
CSR-30 × CST-7-1	5.67**	1.26	3.59**	8.64**	0.96	-1.09	1.02*	-0.83	-0.90	0.84
CSR-30 × CSRC(S)5-2-2-5	9.25**	1.97	-2.31*	-1.62	-0.30	1.41*	0.19	0.47	1.13	0.32
CSRC(S)7-1-4 × SR26-B	-1.95	-1.15	3.73**	3.38	0.36	-1.86**	1.15**	-1.66**	0.95	4.42**
CSRC(S)7-1-4 × CST-7-1	2.12	12.39**	1.16	2.14	-2.74**	1.01	-2.78**	2.17**	-7.14**	-5.18**
CSRC(S)7-1-4 × CSRC(S)5-2-2-5	0.64	-1.53	1.26	-2.79	2.00**	3.51**	1.39**	2.47**	1.79*	1.71*
SR26-B × CST-7-1	0.54	0.85	-2.64	-3.39	2.20**	3.84**	2.05**	-0.53	4.31**	1.60*
SR26-B × CSRC(S)5-2-2-5	-3.05	-1.84	2.13	5.01**	-1.74**	2.34**	-1.12**	2.77**	-0.53	-1.01
CST-7-1 × CSRC(S)5-2-2-5	1.25	-6.76**	-7.44*	-4.22*	-1.17*	1.21*	-2.05**	2.94**	1.21	-0.18
SE±(S_{ij})	2.05	2.40	1.26	2.05	0.61	0.67	0.45	0.64	0.78	0.89
SE±($S_{ij} - S_{ik}$)	3.03	3.58	1.86	3.03	0.91	1.00	0.67	0.95	1.15	1.31
SE±($S_{ij} - S_{kl}$)	2.86	3.37	1.75	2.86	0.85	0.94	0.63	0.89	1.08	1.24

*Significant at p=0.05; **Significant at p=0.01

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Hybrids	Panicle weight (g)		No. of filled grains panicle^{-1}		Spikelet fertility (%)		1000-grain weight (g)		Grain yield (g plant^{-1})	
	Saline	Normal	Saline	Normal	Saline	Normal	Saline	Normal	Saline	Normal
RPBio-226 × Swarna	-0.26	0.39*	3.43	8.47	-10.18**	8.13**	-3.90**	-2.47**	-1.88	-2.31
RPBio-226 × CSR-27	0.44**	0.14	-3.27	-7.36	3.47	2.23	-2.17**	0.68	-2.19*	3.00*
RPBio-226 × CSR-30	1.24**	0.75**	28.36**	8.67	1.24	-13.47**	1.69**	0.62	4.02**	2.36
RPBio-226 × CSRC(S)7-1-4	0.89**	-0.29	3.43	-37.79**	8.57**	5.70**	1.20**	1.62*	1.98	-0.72
RPBio-226 × SR26-B	-0.90**	-0.29*	-9.04	-14.16	-9.21**	-4.97*	-0.97*	-1.00	-6.05**	-4.02**
RPBio-226 × CST-7-1	0.37*	-0.01	-3.50	-11.09	1.84	1.78	2.90**	2.53**	1.31	0.73
RPBio-226 × CSRC(S)5-2-2-5	0.37*	-0.29	-4.27	-2.09	4.23	3.09	4.29**	1.07	1.74	-0.88
Swarna × CSR-27	-1.08**	-0.32*	17.40**	-11.23	-5.12*	5.56**	-1.55**	-1.19	-4.36**	-5.77**
Swarna × CSR-30	0.03	0.01	2.36	0.81	2.41	3.36	1.14**	1.21	1.01	-2.52*
Swarna × CSRC(S)7-1-4	0.93**	0.68**	53.43**	8.01	11.21**	1.40	3.73**	1.05	9.47**	5.61**
Swarna × SR26-B	-0.20	-0.17	2.63	3.31	1.13	-4.93*	-0.17	0.15	1.10	-1.26
Swarna × CST-7-1	-0.47**	-0.76**	-27.17**	-5.63	-3.45	-15.95**	-2.67**	-1.39*	-3.85**	-0.14
Swarna × CSRC(S)5-2-2-5	-1.02**	-0.30	-14.27**	7.71	-10.77**	-10.04**	-1.22**	-0.21	-2.51*	-1.73
CSR-27 × CSR-30	-1.14**	-540.00**	1.00	13.64	-6.07*	-1.90	0.39	0.87	0.52	-0.33
CSR-27 × CSRC(S)7-1-4	-0.94**	-1.36**	-7.60	30.84**	-11.50**	-5.27*	1.56**	1.84**	-7.80**	-6.50**
CSR-27 × SR26-B	0.37*	0.01	-44.40**	-42.53**	1.61	0.80	0.82*	0.20	-2.69*	-0.30
CSR-27 × CST-7-1	0.41**	-0.01	10.80*	18.21*	3.73	0.95	-0.11	-0.71	3.81**	4.27**
CSR-27 × CSRC(S)5-2-2-5	0.56**	0.81**	20.70**	6.54	4.15	-0.30	-1.75**	-0.35	7.52**	5.54**
CSR-30 × CSRC(S)7-1-4	-1.13**	-1.21**	-27.97**	-4.13	-9.20**	-3.90	-2.71**	0.26	-1.19	0.38
CSR-30 × SR26-B	-1.24**	-1.27**	-37.10**	-20.16*	13.15**	-8.50**	-0.34	-1.88**	-3.08**	-2.35
CSR-30 × CST-7-1	0.16	-0.72**	-5.90	-1.43	5.37*	5.91**	-0.12	0.05	-3.35**	0.13
CSR-30 × CSRC(S)5-2-2-5	-0.08	-0.25	-2.00	-13.43	1.62	4.36*	-0.47	0.39	-3.29**	-0.49
CSRC(S)7-1-4 × SR26-B	0.51**	0.39*	14.63**	7.04	4.65	4.10*	-2.33**	0.58	3.23**	2.68*
CSRC(S)7-1-4 × CST-7-1	-1.48**	1.02**	-62.50**	4.77	-15.83**	-9.88**	-4.28**	-3.44	-7.30**	-7.94**
CSRC(S)7-1-4 × CSRC(S)5-2-2-5	0.72**	0.32*	-5.60	43.11**	-2.28	0.63	0.90*	0.88	-0.92	1.40
SR26-B × CST-7-1	0.81**	0.68**	57.03**	61.74**	8.25**	8.82**	2.77**	2.69**	7.92**	8.07**
SR26-B × CSRC(S)5-2-2-5	-0.43**	-0.08	-13.40*	-3.26	-2.46	0.20	-2.51**	-0.21**	-1.47	-0.49
CST-7-1 × CSRC(S)5-2-2-5	0.35*	0.20	25.46**	17.14*	3.76	0.05	0.62	3.02**	4.28**	2.64*
SE±(S_{ij})	0.17	0.16	5.77	8.46	2.64	2.20	0.46	0.70	1.21	1.37
SE±(S_{ij} – S_{ik})	0.25	0.24	8.54	12.51	3.92	3.26	0.67	1.03	1.79	2.02
SE±(S_{ij} – S_{kl})	0.24	0.22	8.05	11.79	3.69	3.07	0.64	0.97	1.68	1.91

*Significant at p=0.05; **Significant at p=0.01

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INFLUENCE OF PLANT CANOPY AND WEATHER PARAMETERS ON INCIDENCE OF THRIPS (*Thrips tabaci* Lindemann) IN *BT* AND NON-*BT* COTTONS

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ABSTRACT

Studies on influence of plant canopy and weather parameters on the incidence of cotton thrips, *Thrips tabaci* Lindemann were carried out at Regional Agricultural Research Station, Lam, Guntur during two seasons, *kharif* 2009-10 and *kharif* 2010-11. Significantly higher thrips population was recorded at top canopy level followed by middle and bottom irrespective of cotton hybrids/variety. The thrips population was higher during 39th to 41st standard weeks with peak population (no./top 3 leaves/plant) of 7.48, 15.40 and 14.80 in RCH 2 BG II, Mallika BG II and L 604 non-*Bt*, respectively recorded during 41st std. week. The favourable weather parameters that influenced the buildup of high population of thrips during 39th to 41st std. weeks ranged from 31-35 ^{O}C (maximum temperature) and 23-24^{O}C minimum temperatures, morning and evening relative humidities of 77 to 87 and 55 to 74 per cent and the rainfall was 3.00 to 39.00 mm. The population of thrips showed significant positive correlation with maximum and minimum temperatures (r=0.721** and 0.736**), evening relative humidity (r=0.295*) and rainfall (r=0.277*), while a significant and negative association with morning relative humidity (r= -0.605**). The multiple linear regression analysis indicated that all the weather variables together contributed to 69.7 per cent variation in thrips population significantly (R^2=0.697*). However, minimum temperature and morning relative humidity exerted significant positive and negative influence, respectively on the variation of thrips population independently.

Cotton (*Gossypium hirsutum* L.) is one of the most commercially important crops in the world. Production of cotton is limited by various factors among which insect pests are also important. 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* Lindemann 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). Among the sucking insect pests, thrips are one of the most injurious ones which destroys the cotton plant by sucking the sap from the leaves and transmits certain viral diseases resulting in arrest of crop growth. Thrips are highly polyphagous and have been recorded on a very wide range of cultivated and wild plants. However, the magnitude of infestation and the nature and extent of injury vary with plant species, seasons and localities. 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 distribution of thrips within plant canopy and population fluctuation in field in relation to the weather parameters would help in developing an appropriate strategy for their 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* 2009-10 and *kharif* 2010-11. 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. The morphological characters *viz*., hair density [leaf lamina discs (10 mm diameter) from each test cotton plant from the terminal leaves using cork borer were collected and counted under stereo zoom microscope (Olympus SZ-61) and presented as no. per one mm diameter], hair length [length of the hairs present on the leaf lamina discs collected was measured with the help of ocular micrometer and expressed in µm (micrometers)] and leaf thickness [average leaf thickness (mm)] was measured using micrometer from the leaf discs collected from the first, third and fifth nodal leaves at 75 days after sowing (DAS)] of the test cottons were observed by maintaining seven replications.

Regarding within plant distribution, population count of thrips was taken from three leaves one each at top, middle and bottom portions from two monopodials and also from top three leaves of the main stem from 60 DAS to last picking at weekly interval on 25 randomly selected plants in bulk plot

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of each cotton type. The population data was averaged from all the weeks to arrive at the pest incidence at top, middle and bottom level of crop canopy and analyzed through Split Plot Design using Microsoft Excel. Regarding population dynamics, population count of thrips from top three leaves of the main stem was recorded on a total of 25 plants from 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

Incidence pattern within plant canopy

Significant variation in the incidence pattern of thrips was observed within plant canopy at different heights and among the hybrids/variety (Table 1). Significantly higher thrips population was recorded at top canopy level followed by middle and bottom irrespective of cotton hybrids/variety. Mallika BG II recorded high thrips (1.89 thrips/leaf/plant) at top foliage followed by L 604 (1.45 thrips/leaf/plant) and RCH 2 BG II (1.06 thrips/leaf/plant). Whereas, L 604 recorded significantly higher thrips population at middle and bottom canopy level with population of 0.94 and 0.79 thrips per leaf per plant, respectively followed by Mallika BG II (0.79 and 0.71 thrips/leaf/ plant at middle and bottom canopy level, respectively) and RCH 2 BG II (0.54 and 0.50 thrips/leaf/plant at middle and bottom canopy level, respectively). However, mean thrips population of all the three levels of the plant canopy indicated that L 604 was on par with Mallika BG II. The present findings were in agreement with reports of Parajulee *et al*. (2006), who recorded more cotton thrips in upper one-third vertical stratum (51%) followed by middle (33%) and lower strata (16%).

Seasonal incidence

Thrips population started infesting the plant during 39th std. week (Sept. 24-30) and continued up to 4th std. week (Jan. 22-28) in all the three cotton hybrids/variety (Table 2). Similar continuous occurrence was reported on desi cotton variety (PA 225) during 2006-07 in Maharashtra (Chavan *et al*., 2010). The population of thrips was below the ETL (24-30/ 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/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 (16.88/3 leaves/plant) recorded in 41st std. week at RARS, Lam, Guntur, during 2009-10. While 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 is at variance with present findings possibly due to the prevailing climatic conditions and hybrids chosen for research work.

Thrips population was high during initial stages of crop growth period i.e. between 39th to 41st std. weeks when population per three leaves per plant ranged from 6-7 thrips in RCH 2 BG II, 13-15 thrips in Mallika BG II and 10-15 thrips in L 604, which might be due to favourable of maximum temperature (31-35^{o}C) and minimum temperatures (23-24^{o}C), morning and evening relative humidities of 77 to 87 and 55 to 74 per cent, respectively and rainfall of 3.00 to 39.00 mm (Table 2). This observation is in accordance with the reports of Prasad *et al*. (2008) and Rohini (2010) who stated that maximum and minimum temperatures in the range of 30 to 36 and 20 to 26^{o}C, respectively, morning and evening relative humidities of 79-87 and 49-75 per cent, respectively and rainfall of 0-73 mm were favourable for buildup of thrips population. Dry spell with high temperature and low humidity were reported optimum for population buildup of thrips (Vennila *et al*., 2007).

High population of thrips with reference to std. weeks can as well vary depending up on the favourable weather factors. The mean thrips population of both years of 2009-10 and 2010-11 indicated that high population was recorded between 39th (Sept. 24-30) - 41st (Oct. 8-14) std. weeks. This falls in line with the observations of Rohini (2010) who stated that thrips population was high (10.36-15.40 no./3 leaves/plant) during 38th-42nd std. weeks at RARS, Lam, Guntur. High incidence of thrips between 15.36-21.02 thrips was reported during 36th to 38th std. weeks in stacked *Bt*, *Bt* and non-*Bt* hybrids of TCH4 and TCH 117 by Soujanya *et al.* (2010) at RARS, Lam, Guntur. Thus, it could be concluded that the coincidence of occurrence of higher incidence of thrips in different std. weeks in different studies indicates the occurrence of favourable weather during those respective std. weeks.

Further, the variation in thrips population among the cotton hybrids/varieties can be attributed to the morphological characters of cotton leaves. In the present study, thrips preferred Mallika BG II and L 604 which have more number of hairs per unit area

(17.7 and 25.3 no./mm diameter) and more hair length (645.8 and 580.4 µm) compared to RCH 2 BG II having less number of hairs per unit area (3.1 no./ mm diameter) and low hair length (161.0 µm) (Table 4). The results of the present investigation are in corroboration with findings of Bashir *et al.* (2001) who reported that thrips showed positive correlation with hair density and length of hair on leaf lamina. However, the present observations are contrary with those of Arif *et al*. (2006) who stated that length of hair on upper and bottom leaves played a negative and significant role in relation to thrips population.

Influence of weather parameters on incidence of thrips

The weather parameters being density independent and are uniform to all the insect pests irrespective of cotton hybrids/variety, correlations and multiple linear regression (MLR) analysis was followed to assess the influence of weather parameters on mean incidence of the thrips from the two crop seasons. The results are presented in the Table 3.

Correlation coefficients

The weather parameters *viz*., maximum and minimum temperatures (r= 0.721** and 0.736**), evening relative humidity (r= 0.295*) and rainfall (r=0.277*) had significant and positive influence on the incidence of thrips population. The present results are in accordance with the reports of Soujanya *et al*. (2010) who reported that all the weather parameters except morning relative humidity had significant positive influence on thrips incidence at RARS, Lam, Guntur. Similarly, Shivanna *et al*. (2009), Rohini (2010), and Khan *et al*. (2008) reported that the population of thrips had significant positive association with the maximum temperature, minimum temperature and rainfall, respectively in cotton. Whereas morning relative humidity exerted strong significant negative impact on thrips population (r= -0.605**) in the present study, which is in conformity with the reports of Rohini (2010) and Sitaramaraju *et al.* (2010) who reported morning relative humidity had significant negative influence on thrips population at RARS, Lam, Guntur.

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 69.7 per cent variation in thrips population which was significant (R^2=0.697*). The present findings are in line with the report of Sitaramaraju *et al.* (2010) who stated that the total population variation in thrips due to all the weather variables was significant and it was 70 per cent in cotton hybrids at RARS, Lam, Guntur.

Of the five variables, minimum temperature and morning relative humidity were found to have significant influence on variation of thrips population. One degree raise in minimum temperature is expected to increase thrips population by 1.057 when all other variables are at their mean level. Similarly, one degree raise in morning relative humidity is expected to bring down the population by 0.32. The results of the present investigation are in corroboration with findings of Khan *et al*. (2008) who reported temperature has significant positive influence on thrips population.

Table 1. Incidence pattern of thrips within plant canopy (Mean of two seasons kharif 2009-10 & 2010-11)

Leaf position	Thrips/top 3 leaves/plant			
	RCH 2 BG II	**Mallika BG II**	**L 604 non-*Bt* variety**	**Mean**
Top leaf	1.06(1.25)	1.89(1.54)	1.45(1.40)	1.47(1.40)[a]
Middle leaf	0.54(1.02)	0.79(1.14)	0.94(1.20)	0.76(1.12)[b]
Bottom leaf	0.50(1.00)	0.71(1.10)	0.79(1.14)	0.67(1.08)[c]
MEAN	0.70(1.09)[2]	1.13(1..26)[1]	1.06(1.24)[1]	
	F Test	**SEM**	**CD at 5%**	
Main treatments (M)	SIG	0.01	0.05	
Sub treatments (S)	SIG	0.01	0.02	
Interaction (MxS)	SIG	0.01	0.03	
(SxM)	SIG	0.01	0.03	

Table 2. Population dynamics of thrips, *Thrips tabaci* Lindeman on *Bt* and non-*Bt* cottons (Mean of two seasons kharif 2009-10 & 2010-11 at Lam, Guntur)

Std. week	Period	Number/top 3 leaves/plant			Max. temp. (°C)	Min. temp. (°C)	Morning R.H. (%)	Evening R.H. (%)	Rainfall (mm)
		RCH 2 BG II	Mallika BG II	L 604 non-*Bt* variety					
39	24 to 30 Sept.	6.30	13.11	10.00	32.90	24.30	83.30	64.95	38.70
40	1 to 7 Oct.	5.85	13.02	9.70	31.15	23.30	86.80	74.10	37.00
41	8 to 14 Oct.	7.48	15.40	14.80	34.60	23.40	77.40	55.85	3.50
42	15 to 21 Oct.	4.31	9.38	6.45	32.70	22.75	85.20	68.65	15.80
43	22 to 28 Oct.	4.96	8.88	7.46	32.85	22.40	85.75	59.60	31.15
44	29 Oct. to 4 Nov.	6.84	11.58	10.22	31.25	21.65	87.45	71.10	24.40
45	5 to 11 Nov.	3.62	6.62	5.96	29.50	21.55	90.85	75.15	25.20
46	12 to 18 Nov.	0.90	2.20	2.10	29.85	22.10	90.05	86.35	28.00
47	19 to 25 Nov.	0.12	1.52	0.93	30.60	21.30	90.80	72.90	40.00
48	26 Nov. to Dec. 2	0.04	0.96	0.72	31.40	19.10	88.00	59.30	5.40
49	3 to 9 Dec.	0.12	0.84	0.56	28.20	18.90	89.10	64.45	57.65
50	10 to 16 Dec.	0.05	0.42	0.32	29.95	19.35	89.40	57.40	0.00
51	17 to 23Dec	0.16	0.30	0.36	28.65	16.80	86.65	52.25	4.70
52	24 to 31Dec.	0.43	0.86	0.84	30.70	18.55	91.25	55.90	0.00
1	1 to 7 Jan.	1.02	0.68	0.52	29.45	16.90	87.50	53.40	0.00
2	8 to 14 Jan.	0.44	1.17	0.48	29.85	15.75	83.20	52.45	0.00
3	15 to 21 Jan.	0.70	1.24	1.14	30.30	16.30	90.55	44.95	0.98
4	22 to 28 Jan.	0.64	1.76	1.30	30.45	15.40	90.60	45.40	0.00
Mean±S.E.		**2.44±0.65**	**5.00±1.27**	**4.10±1.08**	**30.80±0.38**	**19.99±0.68**	**87.44±0.84**	**61.90±2.62**	**17.36±4.30**

Table 3. Correlation between weather parameters and incidence of thrips, *Thrips tabaci* Lindemann (Mean of two seasons kharif 2009-10 & 2010-11)

Weather parameter	Correlation coefficient (r)
Maximum temperature (^{O}C) (X_1)	0.721**
Minimum temperature (^{O}C) (X_2)	0.736**
Morning relative humidity (%) (X_3)	-0.605**
Evening relative humidity (%) (X_4)	0.295*
Rainfall (mm) (X_5)	0.277*
Regression equation	**R^2**
$= 4.433 + 0.347X_1 + 1.057X_2^* - 0.320X_3^* - 0.073X_4 + 0.006X_5$	0.697*

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

Table 4. Morpho-physical characterstics of cotton hybrids/variety and thrips incidence

Hybrid/Variety	Hair density on leaf lamina/mm diameter	Hair length on leaf lamina (µm)	Thrips/top 3 leaves/plant
RCH 2 BG II	3.1^{c}	161.0^{c}	0.22(0.85)^{a}
Mallika BG II	17.7^{b}	645.8^{a}	4.70(2.28)^{c}
L604 non-*Bt* variety	25.3^{a}	580.4^{b}	2.26(1.66)^{b}
F-test	SIG	SIG	SIG
SEm $\pm$	1.20	27.37	0.11
C.D. at 5 %	2.62	59.64	0.42

Values in parentheses are square root ("(X+0.5)) transformed values

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INFLUENCE OF WEATHER FACTORS ON THE OCCURRENCE OF SPOTTED POD BORER (*Maruca vitrata Geyer*) ON GREENGRAM IN SUMMER

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ABSTRACT

Field experiment was conducted to study the seasonal occurrence of spotted pod borer, *Maruca vitrata* on greengram at Agricultural Research Station, Madhira, during summer 2009-10 & 2010-11. The results revealed that the initial incidence of *M. vitrata* was observed during 3rd week of March *i.e.* at the bud initiation stage of the crop. Peak bud infestation (16%) was noticed in 13th standard week. The pest infestation was gradually declined and reached minimum by the last week of April (17th Standard week) with 0.5 larvae & webs per plant and has disappeared. The results also revealed that all the abiotic factors have been found to exert significant influence and they together contributed the per cent variation in number of larvae per plant by 53.48%, 76.83 % in bud infestation, 73.85 % in flower infestation, 84.61% in number of webs per plant and 55.05 % in pod damage by *M. vitrata*. Maximum temperature has been found to exert significant negative influence on larval incidence & bud infestation whereas minimum temperature found to exert significant positive influence on larval incidence, flower infestation and webbing. Evening relative humidity exert significant negative influence on larval incidence. All the weather variables have been found to exert positive influence on pod damage but non-significant in summer season.

Pulses are grown in the semi arid regions under a wide range of agro climatic conditions of India. Among the pulses, greengram (*Vigna radiata* L.) is the important pulse crop of India and it occupies an area of about 3 mha with a production of 0.25 mt and 425 kg ha^{-1} productivity. Andhra Pradesh is the 4th major state of India contributing to 15.5% of the national production of greengram with 351 kg ha^{-1} average productivity. Greengram is being cultivated throughout the year due to its short duration and suitability to crop rotation and crop mixtures. During summer, it is grown as a sole crop with adequate irrigation facilities.With the introduction of Bt cotton, most of the farmers are preferring greengram after completion of Bt cotton (Feb- April) by virtue of its short duration and drought tolerance in summer. It is also cultivated as relay crop in rice fallows. More than 200 insect pests are attacking greengram and inflicting heavy damages at different growth stages in different agro climatic conditions (Lal and Sachan, 1987) among which pod borers are important. Among the pod borers, *M. vitrata* is a serious concern to the greengram farmers, which cause damage mainly at reproductive phase of the crop. Borah (1995) reported that the main pests of summer greengram were *Amrasca bigittula bigittula, Bemisia tabaci* and *M. vitrata.* Because of its extensive host range and destructiveness, *Maruca* became a persistent pest in pulses particularly on greengram, as it is available throughout the year in different seasons / situations. Maruca is known to cause economic loss of 20 - 25 % and yield loss of 2 - 84% in greengram (Vishakanthaiah and Jagadish babu, 1980).

MATERIAL AND METHODS

A bulk plot of 180 m^2 sown on 10.02.2010 & 04.02.2011 with a greengram variety MGG-295 and crop was raised by adopting 30 X 10 cm spacing and maintained without insecticidal application to study the seasonal occurrence of *M. vitrata* during Summer, 2009-10 and 2010-11 in relation to abiotic factors. Observations were recorded on no. of *Maruca* infested buds, infested flowers, webs per plant from randomly selected 50 plants at five different locations (10 at each location) from bud initiation to pod maturity stage at 5 days interval. Percentage pod damage was recorded at the time of harvest from randomly selected 100 pods. The data on abiotic factors such as maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall were recorded daily from the meteorological observatory at Agricultural Research Station, Madhira and analysed statistically by subjecting the pest and weather data to multiple linear regression (MLR) analysis (Gomez and Gomez, 1994).

RESULTS AND DISCUSSION

During Summer, 2009-10 (Table 1) there was no larval incidence up to the 2nd week of March. The initial incidence of *M. vitrata* was observed during the 3rd week of March (21.03.2010) *i.e.* at the bud initiation stage of the crop with two larvae per plant and 12.0 per cent bud infestation in 12th Standard week. These observations are in accordance with the findings of Sunil Kumar Singh and Neeraj Kumar (2003). The prevailing average, maximum and minimum temperatures during the period were 36.7

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and 20.9^{0}C, respectively, while the average morning and evening relative humidity was 63.2 and 48.0 per cent respectively. The 21.5 mm rainfall received during 12th standard week helped for good vegetative growth of the crop.

The peak larval incidence was recorded during the last week of March (26.03.2010) *i.e.* at the bud initiation stage with 4 larvae per plant. During this period the average, maximum and minimum temperatures were 37.9^{0}C & 19.8^{0}C, while the average morning and evening relative humidity were 72.2 & 47.6 per cent respectively. The highest flower infestation was 10.0 per cent, 2 webs with 2.8 larvae per plant. There was 6.0 per cent pod damage recorded initially at 2nd week of April and reached a peak pod damage was 20.0 per cent by 3rd week of April (20.04.2010). The pest infestation was gradually declined and reached minimum by the last week of April with 0.5 larvae & webs per plant and by the end of April, the pest has disappeared. During this period, the average maximum, minimum temperatures were 39.9^{0}C and 24.3^{0}C, while the average morning and evening relative humidity was 70.6 and 49.0 per cent respectively. At pod maturity stage 25.2 mm rainfall was recorded.

During summer, 2010-11 the results (Table 2) on the occurrence of *M. vitrata* from greengram variety MGG 295, sown on 04.2.2011 revealed that there was no larval incidence up to the 2nd week of March. The initial incidence of *M. vitrata* was observed during the 3rd week of March (18.3.2011) i.e. at the bud initiation stage of the crop. Peak bud infestation (16.0%) was noticed during last week of March i.e. 13th Standard week. The flower infestation by Maruca was initially recorded as 5.0 per cent with 1.8 webs per plant at flowering stage. The peak larval incidence, floral infestation (14.0%) and pod damage (16.0%) was recorded during the 1st week of April (07.4.2011) i.e. at the pod formation stage with 2.4 larvae & 1.8 webs per plant. During this period the average maximum and minimum temperatures were 37.1^{0}C & 20.8^{0}C, while the average morning and evening relative humidity were 82.8 & 59.8 per cent respectively. At pod development stage (26.6 mm) and at pod maturity stage (29.0 mm) received rainfall helped the crop for the good seed set and yield. Sharma *et al*. (2000) reported that the peak population of *M. vitrata* was observed from the last week of February to the 2nd week of March on dolichos bean in summer season.

Influence of abiotic factors on the incidence of *M. Vitrata* during summer (pooled)

Influence of relevant weather variables viz., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall on Maruca infestation was determined subjecting the pooled mean data (2009-10 & 2010-11) recorded from 10th to 17th standard week.

Influence of abiotic factors on *maruca* larval incidence

The pooled data on *M. vitrata* larval incidence was subjected to MLR analysis and obtained the following equation (Table 3).

$$Y= 47.7797-1.0888^* X_1+0.4830^* X_2-0.0416 X_3-0.2225^* X_4-0.1241^* X_5$$

The results showed that all the weather variables contributed to the variation in larval incidence by 53.48 (R^2=0.5348) per cent. Of the five weather variables, all the weather variables except morning RH have been found to exert significant influence on larval incidence. When the other variables are at their mean level, one degree rise in minimum temperature would raise the no. of larvae by 0.48. Similarly, one degree increase in maximum temperature is expected to bring down larval population by 1.09 and one per cent increase in evening RH would bring down the no. of larvae by 0.22.

Influence of abiotic factors on bud infestation *maruca*

The data on bud infestation was subjected to MLR analysis and obtained the following equation (Table 4).The results revealed that all the weather variables in question together contributed the variation in bud infestation by 76.83 (R^2= 0.7683) per cent.

$$Y=169.5243 -4.5287^* X_1+1.2659 X_2-0.1878 X_3-0.1119 X_4-0.0440 X_5$$

Of the five variables, only maximum temperature alone has been found to exert significant influence on bud infestation. When the other variables are at their mean level, one degree rise in maximum temperature is expected to bring down the bud infestation by 4.5 per cent.

Influence of abiotic factors on flower infestation by *maruca*

The data on flower infestation was subjected to MLR analysis and obtained the following equation (Table 5)

$$Y=3.8735 - 0.2032 X_1+0.9566^* X_2-0.1404 X_3-0.0216 X_4-0.4498^* X_5$$

The results showed that all the abiotic factors together determine the variation in flower infestation by 76.83 (R^2= 0.7683) per cent. Of the five variables, minimum temperature and rainfall alone have been found to exert significant influence on flower

Table 1. Incidence of spotted pod boss (*M. vitrata*) in greengram during crop growth period in relation to weather factors (Summer, 2009-10)

Date of Sowing : 10.02.2010 Date of Harvesting : 30.04.2010

Observation Date	Standard Week	Temperature (^{0} C)		RH (%)		R.F. (mm)	Number per Plant			Crop Stage	Bud Infestation (%)*	Flower Infestation (%)*	Web/ Plant*	No. of larvae /	Pod Damage (%)*
		Maximum	Minimum	Morning	Evening		Buds	Flowers	Pods						
21.03.2010	12	36.7	20.9	63.2	48	21.5	8	0	0	B.I	5	0	0	2	0
26.03.2010	12	37.9	19.8	72.2	47.6	0	13	10	0	B.I	12	0	0	4	0
31.03.2010	13	38.4	23.4	78.6	53.6	0	15	18	0	50 % Flow.	5	5	1	3	0
05.04.2010	14	39.7	24.6	76	47	0	22	32	4	Flow	1	10	2	2.8	0
10.04.2010	14	40.6	22.9	70.4	44	0	6	20	18	Pod Form.	0	4	2	2.5	6
15.04.2010	15	41.02	24.7	72.4	45	0	2	11	20	Pod Dev.	0	2	1.5	2	18
20.04.2010	16	40.8	24.2	73.2	45	0	1	4	21	Pod Mat.	0	0	1	1	20
25.04.2010	17	39	22.9	66.6	48.2	25.2	0	3	25	Pod Mat.	0	0	0.5	0.5	12
30.04.2010	17	39.9	24.3	70.6	49	0	0	1	20	Pod Mat.	0	0	0.1	0	8

B.I = Bud initiation 50% Flow = 50% Flowering Flow = Flowering Pod form= Pod formation
Pod dev = Pod development Pod Mat. = Pod Maturity * = Pooled Data of 5 locations

Table 2. Incidence of *M. vitrata* in greengram during crop growth period in relation to weather factors (Summer, 2010-11)

Date of Sowing: 04.02.2011 Date of Harvesting: 24.04.2011

Observation Date	Standard Week	Temperature (^{0} C)		RH (%)		R.F. (mm)	Number per Plant			Crop Stage	Bud Infestation (%)*	Flower Infestation (%)*	Web/ Plant*	No. of larvae /	Pod Damage (%)*
		Maximum	Minimum	Morning	Evening		Buds	Flowers	Pods						
13.03.2011	10	36.2	17.8	83.8	57	0	5	0	0	B.I	5	0	0	0.5	0
18.03.2011	11	35.5	19.6	90	61.2	0	6	0	0	B.I	10	0	0.5	1	0
23.03.2011	12	35.1	18.4	83.6	59.4	0	10	18	0	50 % Flow.	13	5	1	1.5	0
28.03.2011	13	35.9	20.4	81.2	61.4	0	18	22	0	Flow	16	5	1.8	1.8	8
02.04.2011	13	37.6	20.8	79.8	58.8	0	21	24	3	Pod Form.	6	10	2	2	12
07.04.2011	14	37.1	20.8	82.8	59.8	26.6	10	15	20	Pod Dev.	4	14	1.8	2.4	16
12.04.2011	15	35.5	20.6	83.2	61.6	0	5	8	21	Pod Mat.	2	8	1.5	1	14
17.04.2011	15	37.7	21.6	84.6	52.6	0	3	3	22	Pod Mat.	0	4	1	0.5	10
22.04.2011	16	38.2	22.2	86.8	52	29	1	0	0	Pod Mat.	0	1	0	0	5

B.I = Bud initiation 50% Flow = 50% Flowering Flow = Flowering Pod form= Pod formation
Pod dev = Pod development Pod Mat. = Pod Maturity * = Pooled Data of 5 locations

Table 3. Multiple linear regression analysis of number of larvae of *M. vitrata* during summer (Pooled data)

Variable		Regression Co-efficient (b)	Standard Error (B)	t - value
X_1	Maximum temperature (^{0}C)	-1.0888*	0.3008	-3.6195
X_2	Minimum temperature (^{0}C)	0.4830*	0.1541	3.1337
X_3	Morning relative humidity (%)	-0.0416	0.0280	-1.4857
X_4	Evening relative humidity (%)	-0.2225*	0.0695	-3.2036
X_5	Rain fall (mm)	-0.1241*	0.0207	-5.9839

Intercept (a) = 47.7797 F cal value: 9.9666
Per cent of variation attributable to the Regression (R^2) = 0.5348

Table 4. Multiple linear regression analysis of bud infestation by *M. vitrata* during *summer* (Pooled data)

Variable		Regression Co-efficient (r)	Standard Error (B)	t - value
X_1	Maximum temperature (^{0}C)	-4.5287*	1.0170	-4.4529
X_2	Minimum temperature (^{0}C)	1.2659	0.5211	2.4293
X_3	Morning relative humidity (%)	-0.1878	0.0947	-1.9836
X_4	Evening relative humidity (%)	-0.1119	0.2348	-0.4764
X_5	Rain fall (mm)	-0.0440	0.0701	-0.6277

Intercept (a) = 169.5243 F cal value: 26.8704
Per cent of variation attributable to the Regression (R^2) = 0.7683

Table 5. Multiple linear regression analysis of Flower infestation by *M. vitrata* during summer (Pooled data)

Variable		Regression Co-efficient (r)	Standard Error (B)	t - value
X_1	Maximum temperature (^{0}C)	-0.2032	0.7055	-0.2880
X_2	Minimum temperature (^{0}C)	0.9566*	0.3615	2.6464
X_3	Morning relative humidity (%)	-0.1404	0.0657	-2.1388
X_4	Evening relative humidity (%)	-0.0216	0.1629	-0.1327
X_5	Rain fall (mm)	-0.4498*	0.0486	-9.2466

Intercept (a) = 3.8735 F cal value : 23.0319 *Significant at 5% level
Per cent of variation attributable to the Regression (R^2) = 0.7385

Table 6. Multiple linear regression analysis of Number of *M. vitrata* webs per plant during summer (Pooled data)

Variable		Regression Co-efficient (b)	Standard Error (B)	t - value
X_1	Maximum temperature (^{0}C)	-0.1326	0.1303	-1.0179
X_2	Minimum temperature (^{0}C)	0.3421*	0.0668	5.1248
X_3	Morning relative humidity (%)	-0.0005	0.0121	-0.0385
X_4	Evening relative humidity (%)	-0.0322	0.0301	-1.0714
X_5	Rain fall (mm)	-0.1033*	0.0090	-11.4938

Intercept (a) = 0.6962 F cal value: 43.8871
Per cent of variation attributable to the Regression (R^2) = 0.8461

Table 7. Multiple linear regression analysis of Pod damage by *M. vitrata* during summer (Pooled data)

Variable		Regression Co-efficient (r)	Standard Error (B)	t - value
X_1	Maximum temperature (^{0}C)	1.9852	1.7916	1.1081
X_2	Minimum temperature (^{0}C)	1.5808	0.9180	1.7220
X_3	Morning relative humidity (%)	0.1078	0.1667	0.6465
X_4	Evening relative humidity (%)	0.6934	0.4137	1.6763
X_5	Rain fall (mm)	0.2866	0.1235	2.3202

Intercept (a) = -149.5903 F cal value : 10.5539
Per cent of variation attributable to the Regression (R^2) = 0.5505

Table 8. Multiple linear regression analysis equations for *M. vitrata* infestation with abiotic factors during summer

Variable	Multiple linear regression analysis equation
No. of larvae/ Pl	
2009-10	$Y = 32.0848 – 0.7489 *X_1 – 0.3053*X_2 + 0.3211 *X_3 – 0.3493 *X_4 + 0.0063 X_5$
2010-11	$Y = -16.4413 + 0.3822 X_1 + 0.0822 X_2 - 0.0917* X_3 + 0. 2227* X_4 + 0.01221 X_5$
Pooled	$Y= 47.7797-1.0888* X_1+0.4830* X_2-0.0416 X_3-0.2225* X_4-0.1241* X_5$
Bud infestation	
2009-10	$Y = 65.8253 - 1.0180 *X_1 - 1.9396 *X_2 + 0.3264* X_3 - 0.0274 X_4 -0.0925 *X_5$
2010-11	$Y = 64.1824 -1.5448 X_1 -0.5712 X_2 - 0.2144 X_3 + 0.4840 X_4 -0.0195 X_5$
Pooled	$Y=169.5243-4.5287* X_1+1.2659 X_2-0.1878 X_3-0.1119 X_4-0.0440 X_5$
Flower infestation	
2009-10	$Y = 82.7314 - 3.3656* X_1 + 1.9555* X_2 + 0.8620 *X_3 - 1.1609 *X_4 -0.0753 X_5$
2010-11	$Y = -13.203 + 0.8462 X_1 + 0.7410 X_2 – 0.8897* X_3 + 0.7974* X_4 -0.1318 X_5$
Pooled	$Y=3.8735-0.2032 X_1 +0.9566* X_2-0.1404 X_3-0.0216 X_4-0.4498* X_5$
No. of web/ plant	
2009-10	$Y = -1.9995 - 0.1819 X_1 + 0.2161 X_2 + 0.1785 *X_3 - 0.2501*X_4 + 0.1359 X_5$
2010-11	$Y = -4.2593+- 0.0821 X_1 + 0.2776* X_2 - 0.1387* X_3 + 0.1444 *X_4 - 0.0080 X_5$
Pooled	$Y= 0.6962-0.1326 X_1 +0.3421* X_2-0.0005 X_3-0.0322 X_4-0.1033* X_5$
Pod damage	
2009-10	$Y = -261.9113 + 7.3043 *X_1-1.2170 X_2 - 0.2557 X_3 + 0.5538 X_4 + 0.3400 X_5$
2010-11	$Y = -55.0879+0.9806 X_1 + 2.9099* X_2-0.9392* X_3 + 0.7942* X_4 +0.0438 X_5$
Pooled	$Y= -149.59 + 1.9852X_1 + 1.5808X_2 + 0.1078X_3 + 0.6934X_4 + 0.2866X_5$

Table 9. Variation contributed by co-efficient of Determination in *M. vitrata* incidence during summer

Variable	By all weather factors (R^2)			
	2009-10 DOS : 10.02.2010	2010-11 DOS : 04.02.2011	Two years Average	Percentage
Number of larvae / plant	0.7809	0.7244	0.5348*	53.48
Bud infestation	0.9361	0.4158	0.7683	76.83
Flower infestation	0.6148	0.6920	0.7385	73.85
Number of web per plant	0.6710	0.8652	0.8461	84.61
Pod damage	0.6534	0.7312	0.5505	55.05

*Significant at 5% level

infestation. When the other variables are at their mean level, one degree rise in minimum temperature is expected to raise the flower infestation by 0.96 per cent.

Influence of abiotic factors on webbing by *maruca*

The data on webbing by *M. vitrata* was subjected to MLR analysis for following regression equation(Table 6)

$Y= 0.6962 -0.1326 X_1 + 0.3421^* X_2 - 0.0005 X_3 - 0.0322 X_4 - 0.1033^* X_5$

The results revealed that all the weather variables in question, together contributed to the variation in webbing by 84.61 (R^2= 0.8461) per cent. Of the five variables, minimum temperature and rainfall alone have been found to exert significant influence on webbing.When the other variables are at their mean level, one degree rise in minimum temperature is expected to raise in the no. of webs by 0.34.

Influence of abiotic factors on pod damage by *maruca*

The MLR analysis for pod damage by *M. vitrata* is given the following equation and all the weather variables in question, together contributed to the variation in pod damage by 55.05 (R^2 =0.5505) per cent. All the weather variables in question, showed non-significant influence on pod damage in summer.(Table 7)

$Y= -149.59 + 1.9852X_1 + 1.5808X_2 + 0.1078X_3 + 0.6934X_4 + 0.2866X_5$

The results of two summer seasons' (Table 8 & 9) revealed that all the abiotic factors have been found to exert significant influence and they together determined the variation in number of larvae per plant by 53.48%, 76.83 % in bud infestation, 73.85 % in flower infestation, 84.61% in number of webs per plant and 55.05 % in pod damage by *M. vitrata*.

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GENETIC VARIABILITY STUDIES FOR QUALITATIVE AND QUANTITATIVE TRAITS IN F_2 GENERATION OF AROMATIC RICE (*Oryza sativa L.*)

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ABSTRACT

F_2 generations of 28 crosses were evaluated for the genetic parameters in rice. The estimates of GCV were lower than the respective PCV, indicating the influence of environmental factors on the expression of the quantitative and qualitative traits studied. The phenotypic and genotypic coefficients of variation were high for no. of filled grains/panicle and grain yield per plant. High heritability along with medium to high genetic advance was noticed for the traits *viz.,* days to 50% flowering, 1000 grain weight and most of the kernel traits and these characters can be improved by direct selection and inter-mating superior genotypes in segregating population.

Aromatic rice (*Oryza sativa* L.) with an aroma and flavour similar to popcorn, constitutes a small group of rice that is regarded as best in quality (Singh *et al*., 2000). Although, aromatic rices popular in world market are long-grain types forming the bulk of export, majority of the Indian indigenous aromatic rices are small and medium-grain types, mostly cultivated for local consumption. Few of the small and medium-grained aromatic rices possess excellent aroma and other quality traits viz., kernel elongation after cooking, taste etc. which could be excellent sources for improving quality in high yielding varieties.

To achieve genetic improvement in yield traits, it is imperative to generate information on variability, its heritable proportion and also interrelationships existing in the breeding material handled. The F_2 generation is critical for success of the breeding programme, as there are remote chances of recovering superior recombinants in advanced generations, if proper selection is not exercised to spot useful segregants in F_2.

The present investigation was undertaken with 28 F_2 populations to study various genetic parameters so as to formulate effective selection criteria to isolate high yield potential pure lines of aromatic rice.

MATERIAL AND METHODS

The experimental material comprised of eight rice genotypes *viz*., BPT 5204, Akshyadhan, NLR 145, PUSA 1121, RNR 2354, Sumathi, improved Pusa Basmati and Basmati 370 which were crossed in a diallel fashion (8 x 8) without reciprocals during *Kharif* 2011 (June – November). The resultant F_1s were advanced to F_2 during Rabi 2011-12 (December – May) season.

Final experiment was laid out with F_2s of 28 crosses and their eight parents at Agricultural Research Station, Kampasagar, Nalgonda district during *Kharif,* 2012 in a Randomized Block Design with 3 replications. Recommended package of practices were followed as specified for transplanted rice. Each entry was grown in 12 rows of 3 m length adopting a spacing of 20 x 15 cm with single seedlings per hill. Observations were recorded on yield components and physical grain characteristics *viz.,* days to 50% flowering, plant height (cm), number of productive tillers per plant, panicle length (cm), panicle weight (g), number of filled grains per panicle, 1000 grain weight (g), grain yield per plant (g), kernel length (mm), kernel breadth (mm), kernel L/B ratio, kernel length after cooking (mm), kernel elongation ratio and head rice recovery (%) and the means were subjected to statistical analysis. Finally, the parameters genotypic and phenotypic coefficients of variation (Siva Subramanian and Madhavamenon, 1973), heritability in narrow sense, genetic advance and genetic advance as percentage of mean were estimated using Window Stat statistical package.

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RESULTS AND DISCUSSION

A wide range of variation was observed among 28 F_2 crosses for 14 characters which were evaluated (Table 1). The data revealed that variance due to treatments was highly significant for all the characters studied.

The estimates of genetic parameters including co-efficient of variation, heritability and genetic advance deserve attention in deciding the selection criteria for improvement in the concerned characters. The estimates of phenotypic coefficient of variation (PCV) were slightly higher than the respective genotypic coefficient of variation (GCV) for all the traits studied except panicle length and kernel elongation ratio (Table 2), indicating the influence of environmental factors on the expression of the traits studied which were in agreement with the findings of Chaubey and Singh (1994).

Among the yield characters, highest PCV and GCV values were recorded for no. of filled grains/ panicle followed by grain yield per plant and the lowest PCV and GCV values were recorded for days to 50% flowering. Among the grain quality characters highest PCV and GCV values were recorded for head rice recovery and lowest PCV and GCV was recorded for kernel breadth. Therefore, selection on the basis of phenotypic expression alone cannot be effective for the improvement of these traits. Similar opinion was expressed by Shivani and Reddy (2000), Iftekharudduala *et al.* (2001), Bidhan and Mandal (2001) and Bhadru *et al.* (2012).

Genetic co-efficient of variability along with heritability provides an idea of expected genetic gain from selection (Burton, 1952). Although PCV and GCV are indicative of the presence of degree of genetic variation, the amount of heritable portion of variation can only be determined with the help of the estimates of heritability and genetic advance.The estimates of heritability act as predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular character.

A perusal of data of heritability revealed that heritability estimates for fourteen characters under study ranged from 22 to 78 per cent. Among the yield and quality characters, highest heritability was registered for days to 50% flowering, kernel length and kernel L/B ratio, whereas kernel breadth recorded lowest heritability. Similar results were reported by Panwar *et al.* (1997), Sarawgi *et al.* (2000) and Sao (2002).

Genetic advance is an useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. Heritability in conjunction with genetic advance would give a more reliable index of selection value. Among the yield characters, genetic advance was highest for number of filled grains per panicle followed by plant height and lowest for panicle length. In case of grain quality characters, head rice recovery recorded highest genetic advance and the least was recorded by kernel breadth. Genetic advance as per cent of mean was highest in case of no. of filled grains/ panicle followed by grain yield per plant, while it was low in case of days to 50% flowering. Whereas, with respect to grain quality characters, head rice recovery registered the highest genetic advance as per cent mean and the lowest value was associated with kernel breadth. Regina *et al.,* (1994), Vanniarajan *et al.* (1996), Shivani and Reddy (2000), Iftekharuddaula *et al.,* (2001) and Sao (2002).

In general, the characters that recorded high heritability with high genetic advance are controlled by additive gene action and can be improved through simple or progeny selection methods. Selection for the traits having high heritability coupled with high genetic advance would accumulate more additive genes leading to further improvement of their performance. In the present study it is concluded that high heritability along with medium to high genetic advance was noticed for the traits, days to 50% flowering, 1000 grain weight and most of the kernel traits. These characters with high heritability, moderate genetic advance can be improved by direct selection and inter-mating superior genotypes in segregating population (F_2) developed from recombination breeding (Samadia, 2005).

Table 1. Analysis of variance (mean squares) for grain yield and kernel quality characteristics in rice

Source of variation	d.f.	Days to 50 % flowering	Plant height (cm)	No. of productive tillers/ plant	Panicle length (cm)	Panicle weight (g)	No. of filled grains/ panicle	1000 grain weight (g)
Replications	2	3.48	12.21	0.55	3.12	3.86	195.72	2.32 **
Treatments	65	230.17 **	492.78 **	13.79 **	25.37 **	134.23 **	8187.87 **	40.34 **
Error	130	3.4	12.11	0.85	4.65	3.99	212.27	0.4
Total	197	78.22	170.71	5.12	11.47	46.96	2843.65	13.6

Source of variation	d.f.	Grain yield/ plant (g)	Kernel length (mm)	Kernel breadth (mm)	Kernel l/b ratio	Kernel length after cooking (mm)	Kernel elongation ratio	Head rice recovery (%)
Replications	2	3.4	0.001	0.001	0.001	1.44 **	0.04 **	2.64
Treatments	65	125.62 **	1.25 **	0.02 **	0.42 **	5.75 **	0.14 **	204.48 **
Error	130	5.85	0.03	0.002	0.02	0.17	0.01	8.79
Total	197	45.35	0.43	0.01	0.15	2.02	0.05	73.3

* Significant at 5 % level, ** Significant at 1 % level

Table 2. Genetic parameters for yield and quality characters of rice in F_2 progenies

Parameter	Days to 50 % flowering	Plant height (cm)	No. of productive tillers/ plant	Panicle length (cm)	Panicle weight (g)	No. of filled grains/ panicle	1000 grain weight (g)	Grain yield/ plant (g)	Kernel length (mm)	Kernel breadth (mm)	Kernel l/b ratio	Kernel length after cooking (mm)	Kernel elongation ratio	Head rice recovery (%)
PCV (%)	5.59	12.01	18.52	13.49	19.49	34.79	18.38	26.92	9.73	6.54	10.00	12.09	10.40	20.47
GCV (%)	5.26	11.57	16.17	8.75	18.09	33.54	18.10	23.67	9.11	5.53	8.88	11.17	8.82	19.25
h^2 (narrow sense) (%)	62	50	32	22	29	37	47	70	78	25	78	42	33	26
GA (%)	14.25	35.09	4.45	3.82	12.26	84.00	9.89	11.05	1.34	0.21	0.75	2.66	0.33	23.48
GAM (%)	13.08	29.44	37.26	14.97	44.32	85.39	47.08	54.92	22.55	12.31	20.80	27.25	19.75	47.78

h^2 = heritability, GA = Genetic advance, GAM = Genetic advance as per cent of mean

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GENETIC VARIABILITY FOR GRAIN YIELD AND GRAIN QUALITY CHARACTERS IN MEDIUM AND LONG SLENDER VARIETIES OF RICE (*Oryza sativa* L.)

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ABSTRACT

Variability, variety x season interactions and genetic components were estimated in long and medium slender grain rice varieties. There was increase in duration, number of tillers and grain yield in rabi season while there was decrease in plant height compared to kharif. The variance due to varieties, seasons and variety x season interactions for grain yield and its components were significant except variety x season for grain yield in long slender varieties. Variance due to season was of higher magnitude. Among the grain quantity characters heritability estimates ranged from 79.2 for milling to 95.3 percent for grain yield in long slender varieties. Heritability ranged from 66.8 for milling to 95.8 for grain length in medium slender varieties. Genetic advance was higher for grain and kernel length in medium slender varieties which can be further improved by selection. Head rice recovery in both grain types had high heritability and genetic advance giving scope for further selection. Among long slender varieties RJ 78, RJ 93, RJ 99 and among medium slender varieties RJ 91, RJ 103, RJ 110 had higher yield and good grain quality attributes and appeared promising.

In the last decade India has became not only self sufficient in rice production but also exporting large quantities of non-scented rice. Success and survival in world rice trade depends on developing varieties that meet quality requirements apart from high yield. In the past many high yielding varieties and hybrids were released but quality considerations have limited their popularity. In North India mostly long slender grains are preferred while in south, medium slender grain varieties are more popular. By blending desirable quality characters RJ Biotech has developed many long and medium slender grain varieties by pedigree selection. These varieties need to be assessed for various grain quality characteristics apart from yield before recommending for multiplication, testing and large scale production.

MATERIAL AND METHODS

The material comprised of 18 medium slender grain varieties and 16 long slender grain varieties developed by RJ Biotech limited by pedigree selection. The parental lines used were samba mahsuri, white ponny, ambe mohar, JGL 384, RJ GP-6, RJ GP-11 as medium slender and IR-64, MTU 1010, Tella hamsa, as long slender grain varieties. Two set of experiments one with 18 medium slender varieties with samba mahsuri as check and other, 16 long slender grain varieties with MTU 1010 as check were sown during *kharif,* 2011 and *rabi* 2011-2012 at RJ Biotech R & D center, Aushapur. The design was randomised block replicated twice. The plot size was 10.8 m^2 and all package of practices were followed. The data was collected on days to flowering, plant height, number of productive tillers per hill and grain yield per plot during both the seasons. Data on physical grain quality characters *viz*. grain and kernel length, and width, L/B ratio, milling per cent and head rice recovery was collected from 2011-12 *rabi* trials. The data was analyzed for RBD, variety x season interactions and genetic components following standard procedures.

RESULTS AND DISCUSSION

In general higher mean values were observed for all characters in rabi season in both long slender and medium slender grain varieties compared to kharif except plant height (Table 1). There was reduction in plant height by 12.8 and 16 percent in long slender and medium slender varieties respectively.In rabi season both long and medium slender varieties flowering was delayed by 28 days than in kharif. Number of productive tillers is very important as it contributes to grain yield per unit area. There was average increase of 2.3 tillers in long slender grain varieties while it was marginal of 0.6 % tillers in medium slender varieties in rabi season. Average grain yield of long slender varieties in Rabi was 14.9 percent higher compared to Kharif while there was only four percent increase in Rabi in medium slender varieties. Considering both the seasons RJ 135, RJ 99, and RJ 93 among long slender varieties recorded higher grain yield of 12, 11.7, 11.5 t/ha respectively, while check variety MTU 1010 recorded 11.3 t/ha. Among medium slender grain varieties RJ 110, RJ 112, RJ 91 registered higher yield of 9.4, 8.3, 7.9 t/ha against Samba Mahsuri (7.7 t/ha). The range of grain yield in medium slender group was wider in rabi compared to kharif.

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Table1. Mean and range for yield and yield components in *kharif,* 2011 and *rabi,* 2012

Particulars	Plant height(cm)		Days to flowering		No. of productive tillers/hill		Grain yield t/ha	
	Kharif 2011	Rabi 2012	Kharif 2011	Rabi 2012	Kharif 2011	Rabi 2012	Kharif 2011	Rabi 2012
Long Slender								
Mean	95.7	83.4	97	125	13	16	9.53	10.95
Range	85-120	77-91	95-107	117-135	11-16	14-19	6.73-11.53	8.33-12.41
Check	85	77.5	96	117.5	11-16	14-19	6.73-11.53	8.33-12.41
SE± /	3.55	3.33	0.98	1.04	0.74	1.02	1.08	1.30
CD (5%)	7.17	6.72	1.98	2.10	1.49	2.02	2.18	2.62
Medium slender								
Mean	89.9	75.5	99.9	128.5	16	17	8.11	8.43
Range	80.107	67-87	92.5-107	116.5-137.5	14-19	15-24	6.5-9.5	7.13-13.13
Check	82	67.5	106.5	133	14.0	18	8.01	9.58
SE± /	2.56	3.76	1.29	1.23	1.0	1.0	0.52	0.23
CD (5%)	5.17	7.59	2.6	2.48	2.0	2.0	1.05	0.46

ANOVA revealed significant difference due to varieties, seasons and their interactions (Table 2) for yield components in long and medium slender varieties.V x S interaction was not significant for grain yield in long slender varieties indicating linear performance of varieties in kharif and rabi seasons.

This is also evident from variance component which has higher estimates for varieties and seasons except flowering in medium slender varieties. In medium slender group v x s interaction component for grain yield was almost equal to variance of variety. Environmental effect on grain yield and yield components was also reported by Franky (2004) as these are mostly governed by polygenes. Hereditability estimates varied from 32.7 for productive tillers to 85.3 percent for grain yield in long slender varieties while it was 44.0 for grain yield to 79.8 percent for flowering in medium slender varieties. Thus, selection can be exercised for these characters in further improvement except productive tillers in long slender varieties. Satish *et al.* (2003) also observed higher heritability for grain yield and scope of selection.

Grain shape and visual appearance of rice is important to determine acceptance and commercial success. The shape depends on grain and kernel length and breadth. Grain length of long slender varieties averaged 9.14 mm and breadth 2.48 mm (Table 3). Among the varieties RJ 93, RJ 99, RJ 102, and RJ 78 were akin to MTU 1010. Among these RJ 78 has an edge of higher milling (75.4%) and head rice recovery (54%) apart from higher yield, hence it is commercialized under the name 'Janaki'. Medium slender varieties averaged 7.9 mm grain length with a range of 6.6 to 9.6 mm and average grain breadth was 2.35 with range of 2.16 to 2.63 mm. The cultures RJ 91, RJ 103, RJ 110 were akin to Samba Mahsuri. They have advantage of being one week early with higher yield .In respect of kernel length long slender varieties averaged 6.38mm, lowest being 5.57 and highest 6.93mm. In medium slender varieties kernel length was 5.46 mm with a range of 4.12 to 6.66 mm.

Ramaiah committee classified fine grain rice varieties into long slender, medium slender and short slender while coarse grain into long bold, medium bold, and short bold. This index is widely used for fixing prices of rice varieties in grain market. Franky *et al.* (2004) reported that these grain dimensions are least affected by g x e interactions. In this study also environmental effect was less as GCV & PCV estimates were close with higher heritability ranging from 78.9 to 95.8 percent, in both long slender and medium slender varieties. However, genetic advance was higher for grain length and kernel length in medium slender varieties. Thus, further improvement is possible by selection.

Table 2. Variety x season interaction and variance components for grain yield and yield components

Source	Degrees of freedom	Plant height	Days to flowering	No. of productive tillers	Grain yield
Long slender grains					
Varieties	16	189.69**	66.32**	2.85**	7.37**
Season	1	2557.19**	12719.12**	101.31**	34.48**
Replication/location	1	47.44	0.06	0.14	2.72
Varieties x season	16	98.06**	25.18**	5.80**	1.68
Error	32	18.15	1.03	0.517	1.43
σ^2V		91.63	10.28	0.92	1.42
σ^2S		72.33	373.35	2.78	0.97
σ^2V x S		39.95	12.08	2.98	0.97
σ^2e		18.08	0.51	0.28	0.72
h^2		78.9	62.0	37.2	85.3
s^2V/ s^2V x S		2.29	0.85	0.30	10.92
Medium slender grains					
Varieties	18	168.62**	103.68**	19.34**	3.10**
Season	1	3951.36**	15461.25**	4.21**	1.31**
Replication/location	1	34.36**	3.40	13.52**	1.72**
V x S	18	25.95**	34.29**	5.21**	1.14**
Error	36	1.14	1.60	1.03	0.16
σ^2V		33.56	17.35	3.53	0.491
σ^2S		103.07	405.97	-0.03	0.005
σ^2V x S		16.61	16.20	2.08	0.48
σ^2e		0.57	0.80	0.52	0.08
h^2		79.8	67.6	64.4	44.6
σ^2V/ σ^2 V x S		2.02	1.07	1.70	1.02

** Significant at 1%

Vivekanandan and Giridharan (1998) observed high genetic advance for L/B ratio and indicated additive gene action. In this study for L/B ratio also, heritability was more than 78 percent with higher genetic advance indicating role of selection for further improvement.

Milling and head rice recovery are most important grain quantity characters. Milling recovery ranged from 65.6 to 77.5 percent with average of 72.9 in long slender varieties. Medium slender varieties also possess almost similar estimates. However, heritability is high in long slender varieties, therefore selection for milling percent would be effective. Mean head rice recovery of medium slender varieties was higher (50.1 percent) than long slender varieties (41.6%). Nirmala devi *et al.* (2000) also observed higher head rice recovery in short slender varieties compared to long slender varieties. In medium slender group RJ 90, RJ 5, RJ 87 and RJ 110 had higher head rice recovery than Samba Mahsuri. Among these RJ 110 has 22.2 percent higher yield over Samba Mahsuri. Highest head rice recovery in long slender varieties was observed only in RJ 78 with 54 % and others had more brokens.

Considering grain yield and grain quality characters RJ 78, RJ 93, RJ 99 with long slender grains and RJ 110, RJ 91, RJ 103 with medium slender grain were most promising (Table 4) for advancing to minikit.

Table 3. Mean, range and genetic components for physical grain quality characters in long and medium slender grain varieties

Long slender	Grain length (mm)	Grain	Kernel breadth (mm)	Kernel length (mm)	L/B ratio breadth (mm)	Milling (%)	Head rice recovery (%)
Mean	9.14	2.48	6.38	2.11	3.03	73	41.6
Range	8.03-9.66	2.04-2.85	5.57-6.93	1.82-2.29	2.5-3.57	66.8-79.4	32.6-54.0
Check	9.4	2.65	6.86	2.18	3.15	5.45	51.3
SE ±	0.12	0.18	0.26	0.01	0.08	1.01	1.49
PCV	5.76	9.21	5.99	9.88	17.81	5.45	16.24
GCV	5.59	8.89	5.84	6.99	9.03	4.85	15.05
h^2	94.2	93.1	95.1	88.9	90.6	79.2	95.3
G.A (%)	11.18	17.63	11.74	13.58	17.72	8.89	31.18
Medium Slender							
Mean	7.88	2.35	5.46	2.02	2.7	73.1	46.9
Range	6.03-9.58	2.16-2.63	4.12-6.30	1.85-2.23	2.44-3.14	65.6-76.8	34.1-57.0
Check	8.00	2.31	5.44	1.98	2.75	76.0	50.1
SE ±	0.18	0.06	0.33	0.16	0.12	2.03	2.61
PCV	11.63	6.56	13.24	7.45	17.80	5.20	18.46
GCV	11.39	5.93	11.77	7.42	9.06	4.25	17.61
h^2	95.80	81.5	78.9	89.0	78.9	66.8	91.1

Table 4. Means of desirable varieties for grain yield (mean of *kharif* and *rabi* 2011-12) and grain quality characters

Medium slender varieties	Grain yield t/ht	Grain length (mm)	Grain breadth (mm)	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Milling (%)	Hulling (%)
RJ-103	7.20	7.74	2.30	5.28	1.96	2.69	66.4	52.4
RJ-110	9.41	6.60	2.26	5.15	2.01	2.56	73.7	51.0
RJ-91	7.81	7.50	2.22	5.17	1.90	2.72	72.7	45.1
Samba Mahsuri	7.70	8.00	2.31	5.44	1.98	2.75	75.0	50.1
Long slender varieties								
RJ-78	11.50	9.31	2.62	6.56	2.21	2.96	75.4	54.0
RJ-99	11.68	9.53	2.61	6.49	2.26	2.87	70.0	44.4
RJ-93	11.40	9.66	2.71	6.44	2.16	2.98	77.8	49.1
RJ-101	11.30	9.56	2.52	6.35	2.35	2.70	66.8	36.4
MTU 1010	11.00	9.44	2.65	6.86	2.18	3.15	76.3	51.3

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ESTIMATION OF GENETIC DIVERSITY IN FARMERS' VARIETIES OF RICE (*Oryza sativa* L.) THROUGH DUS DESCRIPTORS

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ABSTRACT

The genetic divergence in 57 Farmers' Varieties from the eastern region of the country was estimated using Mahalnobis's D^2 – statistics. Cluster analysis was done based on morphological characteristics. The genotypes were grouped into 12 clusters, of which cluster I, III, II were the major clusters. A total of 33 genotypes were grouped in cluster I, followed by cluster III and II with 8 and 5 genotypes respectively. Cluster III showed maximum intra cluster divergence while inter cluster divergence was maximum between clusters IX and X. Traits viz., Gelatinization temperature, Grain Aroma, Endosperm content of Amylose, Presence of amylose and Decorticated grain colour were the major contributors to genetic divergence. The study helped to understand the extent of genetic diversity among the Farmers' varieties which are a potential source that can be exploited.

Rice is the world's most important food crop and a primary food source for more than one third of world's population (Singh and Singh, 2008). India has a rich and wide range of genetic wealth of Rice. Farmers' varieties are traditionally cultivated, evolved over generations with proven special features over wild relatives. Traditional varieties serve as a reservoir of useful genes and provide the genetic building blocks for plant breeding. These varieties may not possess high yielding potential but certainly possess resistance to biotic and abiotic stresses and medicinal properties. Farmers prefer to grow these varieties owing to their special or unique features although most of them are poor yielders. These are generally non homogenous but stable with some distinct characters. Improvement in such varieties has been brought through selection for high yield stability, low dependence on external inputs and good storage/ cooking quality and specific preferences for taste. Systemic study and characterization of such genotypes is important for utilizing the appropriate attribute based donors and also essential in the present era for protecting the uniqueness of rice.

Characterization of variety is useful to identify and avoid duplication. Qualitative traits being more stable over generations (Raut, 2003) are reliable for characterization of varieties. Characterization should eventually lead to a system of recording and storing useful data that can be readily retrieved and made available to others and help in planning breeding programmes (Debas *et al*., 1994). PPV& FR authority was established in 2005 under the aegis of PPV & FR Act, 2001 for providing protection to plant varieties based on distinctiveness, uniformity, stability [DUS]. The concept of DUS is fundamental to the characterization of a variety as unique and provides official description of a variety as it is globally accepted for varietal identification.

The present investigation was undertaken with the objective of identifying the variability available in the collection using DUS descriptors.

MATERIAL AND METHODS

The experimental material consisted of 57 Farmers' varieties which were evaluated in replicated trial for two seasons during *kharif* 2011 and 2012 at DRR Farm, ICRISAT campus, situated at 17.53°N latitude, 78.27°E longitude and altitude of 545m above mean sea level. Each entry was sown in three rows of 6m length at spacing of 30 cm between rows and 20 cm between plants. Observations for all the 62 DUS descriptors were recorded on ten randomly chosen plants at different stages of growth with appropriate procedures as per the DUS test guidelines of PPV & FR Act, 2001.The traits studied were Coleoptile: Colour; Basal leaf: Sheath colour; Leaf: Intensity of green colour; Leaf: Anthocyanin colouration; Leaf: Distribution of anthocyanin colouration; Leaf sheath: Anthocyanin colouration; Leaf sheath: intensity of anthocyanin colouration;

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Leaf: Pubescence of blade surface; Leaf: Auricles; Leaf: Anthocyanin colouration of auricles; Leaf: Collar; Leaf: Anthocyanin colouration of collar; Leaf: Ligule; Leaf: Shape of ligule; Leaf: Colour of ligule; Leaf: Length of blade; Leaf: Width of blade; Culm: Attitude; Time of heading; Flag leaf: Attitude of blade ; Spikelet: Density of pubescence of lemma; Male sterility; Lemma: Anthocyanin colouration of keel; Lemma: Anthocyanin colouration of area below apex; Lemma: Anthocyanin colouration of apex; Spikelet: Colour of stigma; Stem: Thickness; Stem: Length [excluding panicle; excluding floating rice]; Stem: Anthocyanin colouration of nodes; Stem: Intensity of anthocyanin coloration of nodes; stem: Anthocyanin colouration of internodes; Panicle: Length of main axis; Flag leaf: Attitude of blade; Panicle: Curvature of main axis; Panicle: Number per plant; Spikelet: Colour of tip of lemma; Lemma and Palea: Colour; Panicle: Awns; Panicle: Colour of awns; Panicle: Length of longest awn; Panicle: Distribution of awns; Panicle: Distribution of awns; Panicle: Presence of secondary branching; Panicle: Attitude of branches; Panicle: Exertion; Time of maturity; Leaf senescence; Sterile lemma: Colour; Grain: Weight of 1000 fully developed grains; Grain: Length; Grain: Width; Grain: Phenol reaction of lemma; Decorticated grain: Length; Decorticated grain: Width; Decorticated grain: Shape; Decorticated grain: Colour; Endosperm: Presence of amylose; Endosperm: content of amylose; Varieties with endosperm of amylose absent only; Polished grain: Expression of white core; Gelatinization temperature through alkali spreading value; Decorticated grain: Aroma. The variability for these descriptors were categorised into different classes and the frequencies of these traits were determined.

RESULTS AND DISCUSSION

The Analysis of variance revealed significant differences among the 57 genotypes for sixty-two characters studied. The results indicated high variances for most of the characters, which may favour the selection and its further utilization in breeding programmes. The quantum of genetic divergence was assessed by cluster analysis using Mahalnobis's Euclidean squared distances and average distance between the clusters was estimated. The Euclidean squared distance grouped the material into 12 clusters. Among the clusters, cluster 3 was largest comprising of 33 genotypes followed by Cluster 3 and cluster 2 with 8 and 5 genotypes respectively. The clustering pattern reflects the closeness between the clusters and the geographical adaptation of the genotypes (Ram and Panwar, 1970).

The intra and inter cluster distance values are presented in Table 1. Cluster III (107.83) showed maximum intra cluster divergence while inter cluster divergence was maximum between clusters IX and X (641.47). It is reported that genotypes within the cluster with high degree of divergence would produce more desirable breeding materials for achieving maximum genetic advance. Highly divergent genotypes would produce a broad spectrum of variability in the subsequent generation enabling further selection and improvement, which would facilitate successful breeding of rice. Thus hybrids developed from the distant cross may produce high magnitude of heterosis or desirable transgressive segregants, which would facilitate successful breeding of rice. The selection of parents for hybridization should be from two clusters having wider inter cluster distance to get maximum variability in the segregating generations (Rahman *et al*. 1997). The number of times that each yield component appeared in first rank and its respective percent contribution towards genetic divergence is presented in Table 3.The results showed that the contribution of Gelatinization temperature towards genetic divergence was highest (70.05%), followed by Decorticated grain: Aroma (24.44%), Polished grain: expression of white core (2.38%), Endosperm: Content of Amylose (1.32%), Endosperm: Presence of Amylose (0.88%), Decorticated Grain Colour (0.56%), Grain: Phenol reaction of lemma (0.13%) and Sterile lemma: Colour (0.13).

Mean values for Gelatinization temperature were observed to be high in cluster 4,6 and 8. High mean values for decorticated grain aroma was

observed in cluster 4 and 5 and in cluster 12 for polished grain: expression of white core was observed. Endosperm content of amylose and its presence was found to be high in cluster 2. Decorticatede grain colour was found to be higher in cluster 10.Hybridization between genotypes of different clusters is necessary for the development of desirable genotypes (Singh *et al.*, 1996 and Sinha *et al.*, 1991).

CONCLUSION

In the present investigation, characterization of genetic material showed considerable variability for most of the morphological characters indicating their utility in rice variety improvement programme and also usefulness for breeders, researchers and farmers to identify and choose the restoration and conservation of beneficial genes for crop improvement and also to seek protection under Protection of Plant Varieties and Farmer's Rights Act. The traits contributing to the maximum genetic divergence viz. gelatinization temperature, decorticated grain: aroma, polished grain: expression of white core, endosperm: content of amylose may be utilized in selecting genetically diverse parent.

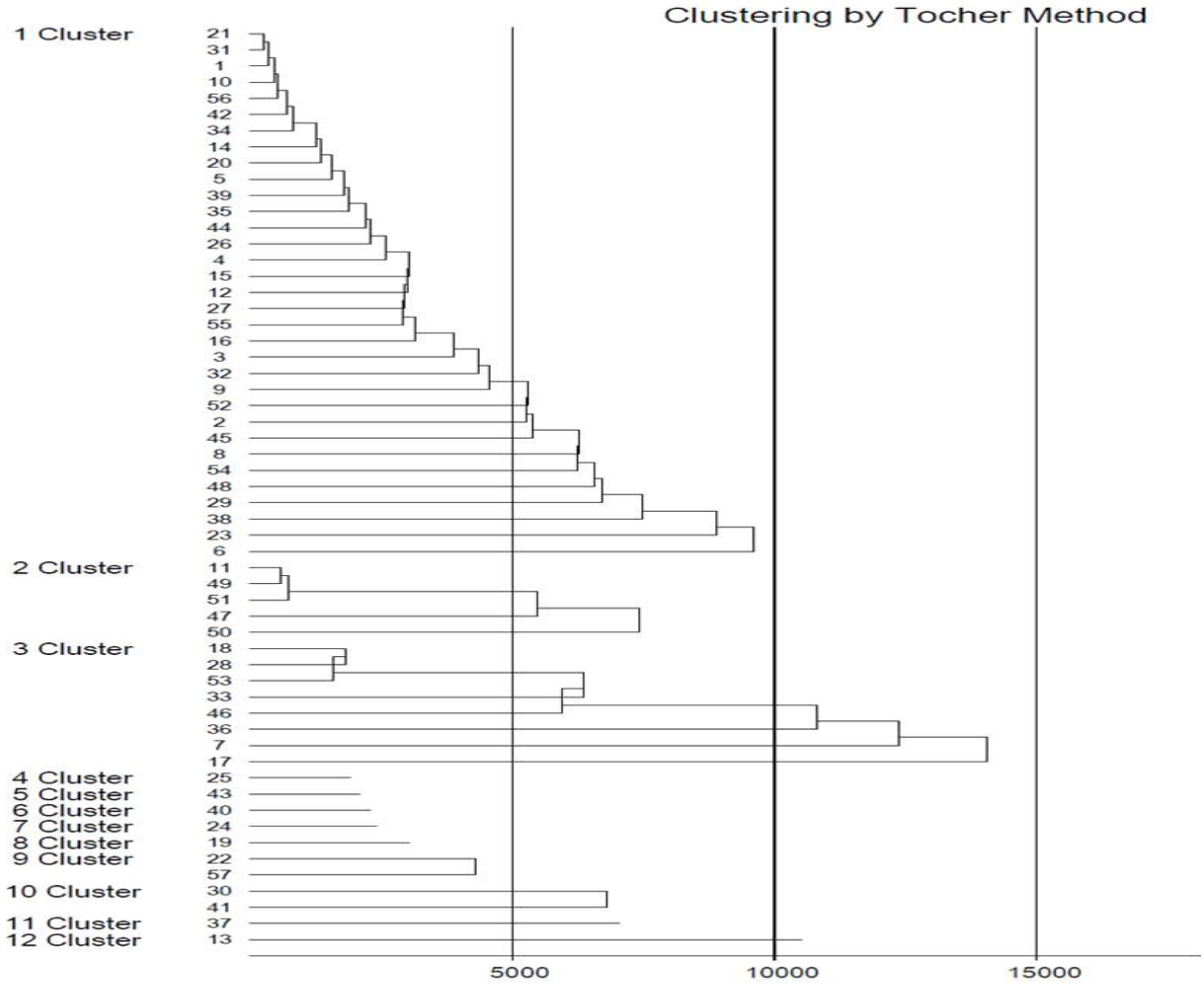

Fig 1. Clustering of 57 traditional rice genotypes based on morphological data

(Number : Farmers' variety)

1 : Harishankara, 2 : kadalikenda, 3 : kathia, 4 : Basta Bhog, 5 : Nagra, 6 : Dhabula Bhuta, 7 : kalia, 8 : Gelei, 9 : Ladari, 10 : Sunapani, 11 : Macha Kanta, 12 : Nini Budhi , 13 : Badi, 14 : Denger Chudi, 15 : Sekta, 16 : Govind Bhog, 17 : Karpur Bhog, 18 : Magura, 19 : Lalubodi Koberi, 20 : Shiuli, 21 : Samudra Bali, 22 : Chinger, 23 : Nini, 24 : Kelas, 25 : Likitimachi, 26 : Chamarmani, 27 : Ratanchudi, 28 : Kalabhutia, 29 : Ghoes, 30 : Karani, 31 : Jaksaru, 32 : Pankapota, 33 : Ranikajal, 34 : Sapori, 35 : Kolina, 36 : Rama chandra Boita, 37 : Kanakchur, 38 : Geelavathi, 39 : Pora Senkara, 40 : Sarsonful, 41 : Kusuma, 42 : Haladi chudi, 43 : Kalajira, 44 : Denga buri, 45 : Samulei, 46 : Banaphul, 47 : Suna Mukhi, 48 : Medi, 49 : Puagli, 50 : Senkara, 51 : Asit Kalma, 52 : Bidan Sapru, 53 : Jugal, 54 : Malapatri, 55 : Danisaria, 56 : Kerala Sundari, 57 : kanta Dumer

Table 1. Intra and Inter cluster distances

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12
Group 1	71.77	136.98	232.52	107.48	110.17	133.23	149.70	128.36	246.47	442.27	115.60	355.55
Group 2		78.60	334.78	162.24	212.61	242.30	254.48	235.60	154.42	515.45	132.26	449.30
Group 3			107.83	255.23	148.63	134.14	145.11	134.67	454.78	354.04	269.29	181.42
Group 4				0.00	123.75	147.30	135.30	163.34	231.60	152.76	182.90	402.58
Group 5					0.00	50.85	70.20	70.49	324.60	405.19	163.04	283.97
Group 6						0.00	61.63	55.13	353.73	390.93	188.52	268.87
Group 7							0.00	86.59	353.61	431.41	218.05	289.10
Group 8								0.00	353.88	376.30	179.62	253.84
Group 9									65.59	641.47	249.06	583.28
Group 10										82.43	397.69	267.97
Group 11											0.00	364.70
Group 12												0.00

Table 2. Relative contribution of different traits to genetic diversity in rice

Source	Times Ranked 1st	Percentage of contribution
1) Gelatinization Temperature	1118	70.05
2) Decorticated grain: Aroma	390	24.44
3) Polished grain : expression of white core	38	2.38
4) Endosperm : Content of Amylose	21	1.32
5) Endosperm : Presence of Amylose	14	0.88
6) Decorticated Grain Colour	9	0.56
7) Grain : Phenol reaction of lemma	2	0.13
8) Sterile lemma : Colour	2	0.13
9) Grain : Length	1	0.06
10) Grain : Width	1	0.06

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PHYSICOCHEMICAL AND MICROBIAL ANALYSIS OF MINIMALLY PROCESSED FRUITS AND VEGETABLES

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ABSTRACT

Minimal processing foods gives additional value to fresh cuts in terms of convenience and time saving, although several hurdles are encountered due to the difficulty in preserving their freshness for prolonged periods. These products in fact are characterized by their shorter life than their whole counter parts because of microbial spoilage, increased respiration rate, etc. Hence, the present study was carried out to know the physico-chemical parameters (PH, moisture, acidity)and microbial analysis (TPC and yeasts and moulds) of minimally processed fruits and vegetables at different storage periods i.e. at 0, 3rd, 5th day respectively. Consumer Survey was carried out to know the maximum consumption and the most frequently consumed fruits and vegetables in local areas of Hyderabad and it was observed that the consumption of sprouted seeds and individually processed cabbage and cauliflowers was high.Among the physicochemical parameters, the moisture content of minimally processed pineapple and cabbage decreased during different storage periods. pH and acidity decreased during different storage periods. The microbial parameters i.e., TPC and yeasts / moulds content increased both for pineapple and cabbage during different storage periods.

Fresh fruit and vegetables are essential components of the human diet and there is considerable evidence of the health and nutritional benefits associated with the composition of fresh fruit and vegetables (Alzamora *et al.,* 2000). Minimal processing technology involves cleaning, washing, trimming, coring, slicing and shredding of fruits and vegetables. Fresh cut pineapple has a marked additional advantage of weight reduction for transport, since bulky inedible crown and peel tissues are removed (Budu and Joyce, 2003). However, minimal processing of fruits and vegetables may increase their perishability and therefore, stabilization is usually required with minimally processed food. Hence, food processing techniques are widely used to stabilize the products and extend the storage and shelf life of fruits and vegetables.

Minimal processing results in convenience of a product, but it reduces the shelf life. As a result, maintenance of the quality is a challenge to the rapidly expanding minimal processing sector. The increasing popularity of minimally processed fruits and vegetables has resulted in greater health benefits.

However, with fresh-cut fruit, very low APC, TPC and especially yeast and mold counts correlate with increased shelf-life. The predominant microorganisms associated with spoilage of fresh-cut vegetables are bacteria (eg : Pseudomonads spp), whereas the predominant microorganisms associated with the spoilage of fresh-cut fruit products are yeasts and molds.

Hence, the present study has been carried out in the year 2012 to analyze the physico -chemical and microbial parameters of minimally processed fruits and vegetables available in local markets of Hyderabad. Market survey and consumer survey was carried out to known the maximum availability and consumption of minimally processed fruits and vegetables in local areas of Hyderabad.

MATERIAL AND METHODS

All chemicals were purchased from Qualigens Fine Chemicals (Mumbai, India) or Molychem India Pvt. Ltd. (Mumbai, India).Microbiology media were obtained from Hi-Media Laboratories(Mumbai, India).Unless otherwise mentioned, all chemicals used were of analytical grade.In the present study, minimally processed fruits and vegetable i.e., pineapple and cabbage, were collected aseptically from local super markets and analyzed for physicochemical and microbial parameters.

Physico-chemical characteristics

P^H of minimally processed fruits and vegetables was measured with the help of p^H meter, and the moisture content was determined using approved AOAC methods (AOAC, 2002). Acidity was calculated by titrating against 0.1 N NaOH and expressed as percentage of citric acid.

Microbial analysis

Ten gram analytical unit of each food sample [minimally processed fruits and vegetables i.e.

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pineapple and cabbage was homogenized with 90 ml of sterile Ringer's solution for 2 min and then 10 fold serial dilutions were prepared in sterile Ringer's solution. Briefly, individual serial decimal dilutions, starting with the prepared sample and each of the subsequent dilutions were prepared in 9 ml volume of sterile Ringer's solution up to 1×10-6 dilution, of the original food sample.

Triplicate 1 ml inoculums of appropriate dilutions were pouring plated, on the following media; for enumeration of total plate counts (TPC) on plate count agar and for enumeration of yeast and moulds on potato dextrose agar. The inoculated petri plates were incubated at 37°C for 48 h for TPC and at 25°C for 48 h for yeast and moulds, respectively. Colonies were counted and expressed as colony forming units (cfu) per gram. Standard enumeration procedures were followed (Speck,1975).

RESULTS AND DISCUSSION

Physicochemical parameters of minimally processed fruits and vegetables

Various physicochemical parameters viz., moisture, pH, acidity were analyzed for minimally processed fruits and vegetables i.e. pineapple and cabbage. The results obtained for various physicochemical parameters of minimally processed fruits and vegetables are enlisted below.

The data in Table 1 shows that the mean values of moisture content of minimally processed pineapple and cabbage during different storage periods. The moisture content of minimally processed pineapple at 0, 3rd, 5th days were 85.87±0.06, 85.36±0.40, 84.57±0.28 respectively. The mean values of moisture content of minimally processed cabbage at 0, 3rd, 5th day were 91.12±0.06, 90.32±0.06, 89.36±0.19 respectively. The F values are 15.675 for pineapple and 145.103 for cabbage. A significant difference was observed in the moisture content of pineapple and cabbage during storage.The results showed that the moisture content of minimally processed pine apple and cabbage was decreased during storage periods. It might be due to loss of water content or due to collapse of injured cells at the cut surface, loss of water content during preparation of fresh cut fruits.

Beuchat (2002) carried out a study on "shelf life of fresh cut vegetables". The result of the study shows that the moisture content of fresh cut vegetables was decreased during storage period. It was due to the reason that wounds inflicted during the preparation of fresh cut vegetables promote many physical and physiological changes that hasten loss of product quality, Foremost among these, are the removal of protective epidermal layers and/or exposure of internal cells.These changes facilitate loss of moisture content at the cut surfaces. These results coincide with the present study.

The data in the Table 2 shows that the mean values of pH of minimally processed pineapple and cabbage during different storage periods. The mean values of pH of minimally processed pineapple at 0, 3rd, 5th days were 3.48±0.03, 3.20±0.00, 3.00±0.00 respectively. The mean values of p^H of minimally processed cabbage at 0,3rd, 5th day were 6.73±0.21, 6.00±0.00 and 5.70±0.00 respectively. The F values

Table 1. Moisture content of minimally processed pine apple and cabbage during different storage periods

Minimally processed fruits and vegetable	Mean ± SD			F Value	Sig
	0 Day	3rd Day	5th Day		
Pineapple	85.87±0.06	85.36±0.40	84.57±0.28	15.675	0.004*
Cabbage	91.12±0.06	90.32±0.06	89.36±0.19	145.103	0.000*

P value < 0.05 significant at 0.05% level * Significant at 0.05% level

Table 2. P^H of minimally processed pine apple and cabbage during different storage periods

Minimally processed fruits and vegetable	Mean ± SD			F Value	Significant
	0 Day	3rd Day	5th Day		
Pineapple	3.48±0.03	3.20±0.00	3.00±0.00	637	0.000*
Cabbage	6.73±0.21	6.00±0.00	5.70±0.00	58.692	0.000*

P value < 0.05 significant at 0.05% level, * Significant at 0.05% level.

are 637 for pineapple and 58.692 for cabbage. A significant difference was observed in the p^H of pineapple and cabbage during storage.

The results showed that the p^H value of minimally processed pineapple and cabbage was decreased during storage periods.It might be due to storage temperatures, method of packaging of minimally processed food (i.e., modified atmospheric packaging, vacuum packaging),amount of acid content in fruits and vegetables.The result coincides with the present study.

The acidity of minimally processed pineapple and cabbage during storage period is presented in Table 3.

The data in the Table 3 shows that the mean values of acidity of minimally processed pineapple and cabbage during different storage periods.The mean values of acidity of minimally processed pineapple at 0, 3rd, 5th days were 0.13±0.01, 0.10±0.00, 0.08±0.00 respectively.The mean value of acidity of minimally processed cabbage at 0, 3rd, 5th day was 1.10±0.01, 1.02±0.01, 0.99±0.01 respectively. The F value is 196.000 for pineapple and 145.500 for cabbage.A significant difference was observed in the p^H of pineapple and cabbage during storage. The results showed that the acidity of minimally processed pineapple and cabbage was decreased druing storage periods. Abeywickrama *et al*. (2004) carried out a study on effects of controlled atmospheres on microbial spoilage, electrolyte leakage and sugar content on fresh, ready to use grated carrots. The results showed that malic acid has decreased in grated carrots packed under modified atmosphere (10% O_2 and 40% CO_2) for 10 days at 10^0C.

Microbial quality of minimally processed fruits and vegetables

The consumption of fresh fruits and vegetables continues to increase owing to consumers preferences for fresher, nutritious foods that also happen to meet the needs of busy lifestyles, globalization of foods supply introduces hazards from one region in to other areas.The presence of numerous genera of spoilage bacteria, yeast and molds, and an occasional pathogen on fresh produce has been recognized for many years. Several out breaks of human gastroenteritis have been linked to the consumption of contaminated fresh fruits and vegetables. In the present study, the microbiological quality of minimally processed fruits and vegetables i.e. cabbage and pineapple was analyzed and the TPC and yeasts / molds content present in the samples was analyzed and observed during storage periods.

The data in the Table 4 shows that the mean values of total plate count of minimally processed pineapple and cabbage during different storage periods. The mean values of TPC of minimally processed pineapple at 0, 3rd, 5th days were $5.6 \times 10^3 \pm 5\%$, $2.0 \times 10^5 \pm 5\%$,$5.8 \times 10^6 \pm 5\%$ respectively. The mean values of TPC of minimally processed cabbage at 0, 3rd, 5th day were $3.1\times 10^3 \pm 5\%$, $1.9\times 10^5 \pm 5\%$, $5.3\times 10^6 \pm 5\%$ respectively. The F values are 9.2×10^3 for pineapple and 1.1×10^3 for cabbage. A significant difference was observed in the TPC of minimally processed pineapple and cabbage during

Table 3. Acidity of minimally processed pine apple and cabbage during different storage periods

Minimally processed fruits and vegetable	Mean ± SD			F Value	Sig
	0 Day	3rd Day	5th Day		
Pineapple	0.13±0.01	0.10±0.00	0.08±0.00	196	0.000*
Cabbage	1.10±0.01	1.02±0.01	0.99±0.01	145.50	0.000*

P value < 0.05 significant at 0.05% level, *Significant at 0.05% level

Table 4. Total plate count (cfu/gm) of minimally processed pineapple and cabbage

Minimally processed fruits and vegetables	Mean ± SD			F-Value	Sig
	0 Day	3rd Day	5th Day		
Pineapple	$5.6 \times 10^3 \pm 5\%$	$2.0 \times 10^5 \pm 5\%$	$5.8 \times 10^6 \pm 5\%$	9.2×10^3	0.000*
Cabbage	$3.1\times 10^3 \pm 5\%$	$1.9\times 10^5 \pm 5\%$	$5.3\times 10^6 \pm 5\%$	1.1×10^3	0.000*

P value < 0.05 significant at 0.05% level, * Significant at 0.05% level

storage. The results in the Table show that Total Plate count of minimally processed pine apple was increased during storage periods.

The reasons for increase in Total Plate Count Content might be due to inadequate employee hygiene during processing operations, higher susceptibility to microbial spoilage, increased respiration rate and ethylene production, which is stimulated by wounding of the tissues in fact, the processes operations (i.e., cutting, splicing etc) form lesions in the tissues that determine enzymatic browning, texture decay, rapid microbial growth, thus reducing the shelf life and coarse and abrasion peelings increase the microbial content over that of hand peeling. Mossel *et al.* (2000) studied the "Microbial Quality of minimally processed perola pineapple grown under good agriculture systems".The result of the study shows that the total plate count of pineapple was low when it is processed under GAS systems, but when the processing was not carried under GAS system there was a significant increase in microbial load.It might be due to pineapple skin may be the potential contamination with microorganisms from animals housed near the production faculty, contaminated water and inadequate employee hygiene. employee hygiene during processing operations, higher susceptibility to microbial spoilage, increased respiration rate and ethylene production, which is stimulated by wounding of the tissues in fact, the processes operations (i.e., cutting, splicing etc.) form lesions in the tissues that determine enzymatic browning, texture decay, rapid microbial growth, thus reducing the shelf life.. The results showed that yeasts/molds count of minimally processed cabbage and pineapple was increased during storage periods.

Aida *et al*. (2007) carried out study on microbiological aspects of fresh cut fruits and around national capital region (NCR), the results showed that the yeasts and molds which ranged from 40×10^1 cfu/g. It was observed that highest coliform load was found in okhla mandi sample.Due to the increasing demand for convenience foods from consumers, the market share of pre-packaged fresh cut fruits and vegetables and sprouts on supermarket shelves was increased dramatically in the last several years. Plant products such as fresh cut vegetables, generally have an image as healthy foods and form an important part of a healthy nutritious diet. The results obtained have demonstrated that the microbiological quality of fresh cut fruits, vegetables sold in Hyderabad is poor. Hence, to ensure the safety of these products

Table 5. Yeast / Molds (cfu/gm) of minimally processed pineapple and cabbage

Minimally processed fruits and vegetables	Mean ± SD			F Value	Sig
	0 Day	3rd Day	5th Day		
Pineapple	$7.9\times10^2 \pm 5\%$	$8.4\times10^3 \pm 5\%$	$8.4\times10^4 \pm 5\%$	1.9×10^4	0.000*
Cabbage	$7\times10^2 \pm 5\%$	$7.5\times10^3 \pm 5\%$	$5.7\times10^4 \pm 5\%$	8.3×10^3	0.000*

P value < 0.05 significant at 0.05% level *Significant at 0.05% level

The data in the Table 5 shows that the mean values of yeasts /molds of minimally processed pineapple and cabbage during different storage periods. The mean values of yeasts /molds of minimally processed pineapple at 0, 3rd, 5th days were $7.9\times10^2 \pm 5\%$, $8.4\times10^3 \pm 5\%$, $8.4\times10^4 \pm 5\%$ respectively. The mean values of yeasts /molds of minimally processed cabbage at 0, 3rd, 5th day was $7\times10^2 \pm 5\%$, $7.5\times10^3 \pm 5\%$, respectively. The F values are 1.9×10^4 for pineapple and 8.3×10^3 for cabbage.A significant difference was observed in the Yeast/ molds of pineapple and cabbage during storage. The results in the Table 5 show that yeasts/molds count of minimally processed pine apple was increased during storage periods. The reasons for increase of yeasts/molds content might be due to inadequate in to the future, it is critical that food safety control measures are effectively implemented.

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IMPACT OF FARM VIDEO PROGRAMMES ON THE KNOWLEDGE GAIN ON CASTOR CULTIVATION OF RURAL WOMEN

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ABSTRACT

Video is one such tool which has not yet been fully exploited in the Indian educational system. Its ability to overcome limitation of a single subject has been widely recognized in the modern self learning systems of education. Thus, video can easily be used to transmit knowledge to farm women, even information can be updated as per requirement any number of times. A large majority of the respondents (71.25%) had low level of knowledge with regard to castor cultivation before exposure to video programme and were in the category of medium level of knowledge (73.75%) on castor cultivation after exposure to video programme in experimental group. A majority of the respondents (60.00%) were in the category of low level knowledge with regard to castor cultivation before exposure and after exposure (not exposed) to video programme in control group. The study revealed that there was a significant difference of mean scores of knowledge gain between before exposure and after exposure to video programme in castor cultivation.

Video is an effective communication tool to increase awareness about specific development problems and stimulate local discussion of possible solutions. It has become relatively cheap and easy to use. Video enables the audience to see objects that are too small to be visible to the entire gathering. It provides an opportunity to record performance, procedures and behavior that can be evaluated or shown to others often. The message reaches the mind of the audience both, through eyes and ears simultaneously, in the same form to large number of people. It helps to motivate the people and also bring changes in their attitude (Pandian *et al.,* 2002).

Professor Jayashankar Telangana State Agricultural University (PJTSAU) along with the research stations and extension centres located at regional and district levels have accomplished great feats in research on farmer friendly and farmer beneficial technologies. Almost all of them have been proved to be successful in field conditions. However, the farmers do not practice all of them in their fields. The major reason is the lack of awareness among the farmers, leaving behind the existing socio-economic factors. None can deny the endeavours' of the research and extension centres disseminating the technologies in rural India. The need of the hour is the rapid communication of new ideas through modern communication media. The university has developed video programmes on rice, groundnut, castor, chillies, maize and oyster mushroom etc. In this study, castor cultivation was selected with an objective to study the impact on rural women in terms of knowledge gain.

MATERIAL AND METHODS

The study was conducted in the year 2012 by adopting an experimental design (before exposure and after exposure) method and was primarily used to study the impact of selected video programme developed by PJTSAU i.e., on castor cultivation. The locale of the study was in Mahabubnagar district of Telangana. Out of 64 mandals in the district, five mandals were selected purposively. One village from each mandal was selected by simple random sampling method. Thus, a total of five villages were selected randomly. Out of these five villages, four villages were treated as experimental villages and one village was selected as control village. Fourty respondents from each village were selected by simple random sampling method in experimental villages thus a total of 160 rural women. Similarly, respondents were selected for the control group. Thus, a total of 200 rural women (160 experimental group and 40 control group) formed the respondents for the study.

In this study, the knowledge of rural women was tested before exposure and after exposure of the farm video programmes. Data on knowledge items was collected from 160 (Experimental group) and 40 (Control group) respondents before and after viewing the video programme separately. Knowledge scores of respondents was calculated for castor cultivation and the difference of scores was also worked out, the possible range of gain in knowledge was between 0 and 24 in castor cultivation. Knowledge gap among the rural women on castor cultivation was tested for

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its significance with the help of paired't' test and values were computed with table values at 0.01 and 0.05 level of probability at before- exposure stage and immediately after exposure stage in each of the farm video programme

RESULTS AND DISCUSSION

It could be clearly observed from the Table 1 that pre exposure to video programme on castor cultivation to experimental group respondents, belonged to low knowledge (71.25%) category followed by medium (19.38%) and high (9.37%) categories. Further, it could be observed from Table 1 that majority of the experimental group respondents exposed to castor cultivation video programme, 73.75 percent belonged to medium knowledge category, while 13.12 per cent belonged to high and low knowledge category. The findings revealed that before exposure to the farm video programme on castor cultivation the knowledge of respondents in experimental group was low 71.25 per cent followed by medium and high respectively. Further the data evidently indicates that after exposure to farm video programme on castor cultivation, the knowledge level of respondents was 73.75 per cent i.e., medium category followed by high and low knowledge. Agriculture being the main occupation of the respondents they are always trying to update themselves with new and improved agricultural technologies.

Further, the findings inferred that the video exposed on castor cultivation acted as an intervening variable in changing and increasing the cognitive domain of respondents. The video programmes exposed on castor cultivation was satisfied with the overall visual quality and overall sound quality, interactive links provided to each topic, classification of content into different parts, appropriate sequencing of the programme and clarity of the picture. This could be the reason for a high per cent of respondents having medium to high level of knowledge. A meager per cent are having low level of knowledge which is a natural phenomenon in a society where some laggards always exist. By this it could be concluded that the recommended package of practices of the commercial crop of the area i.e. castor could register an encouraging gain in knowledge on the part of the respondents to the related farm video programme. The respondents of an average gain in knowledge should be kept in view and efforts to provide them scope for gaining a full knowledge which can be put forth by the extension functionaries to suitably encourage them for viewing video programme with keen mind and sharp eyes and ears without any dilution of concentration to grasp while seeing. The result was in conformity with Selvaraj (1997), Vikram (2000) and Reddy (2002) pointed out that video presentation had produced remarkable impact on gain in knowledge of the technology disseminated.

It could be clearly observed from the Table 2 that pre exposure to video programme on castor cultivation, mean knowledge scores of experimental group was 10.65 the mean knowledge scores immediately after exposure was 19.36.The gain in knowledge score was 8.71.

E.H. : There will be significant difference between before exposure and after exposure with regard to mean knowledge levels of rural women on castor cultivation video programme

Table 1. Distribution of respondents of Experimental group according to the level of knowledge before exposure and after exposure to video programme on castor cultivation

N=160

S. No.	Category	Before exposure		After exposure	
		Frequency	Percentage	Frequency	Percentage
1.	Low (0-8 scores)	114	71.25	21	13.13
2.	Medium (9-16 scores)	31	19.38	118	73.75
3.	High (17-24 scores)	15	9.37	21	13.12

Table 2. Gain in knowledge after exposure to video programme on Castor Cultivation

S. No.	Category	Mean Knowledge Score		Difference	Paired't' Value
		Before exposure	After exposure		
1.	Experimental group (N= 160)	10.65	19.36	8.71	32.57**

** : Significant at 1% level

N.H. : There will be no significant difference between before exposure and after exposure with regard to mean knowledge levels of rural women on castor cultivation video programme

As seen from the Table 2 that the computed 't' value was found to be positive and significant at 0.01 level of probability for castor cultivation video programme in respect of gain in knowledge. Hence the Null hypothesis was rejected and the empirical hypothesis was accepted. Hence, it could be concluded that there was a positive and significant difference between before exposure level and after exposure knowledge levels of respondents exposed to castor cultivation video programme

It could be inferred that there was a significant difference of mean scores of knowledge gain between before exposure and after exposure respectively. From the findings it could be understood that 8.71 mean score knowledge gain was noticed when exposed to video programme on castor cultivation (Table 2). This implied that the knowledge gained by the respondents with regard to castor cultivation was substantial because of the exposure to the developed video programme. It has also been supported by the 't' value of 32.57 which was found to be statistically significant ($p<0.01$). Thus, it could be concluded that the video method presentation is an audio-visual medium which involves more number of senses of the subjects reducing the monotony and thereby increasing the understanding of the difficult steps involved in the crop production technology. From the results of the study it is evident that there is ample scope for communication of farm technologies capsule in the form of video lessons. It is imperative for the extension personnel to make effective use of video for changing the knowledge of rural women.

CONCLUSION

The study concluded that there was a significant difference between before exposure and after exposure to a agriculture(castor cultivation) video and understood that majority of the respondents gained in good knowledge when exposed to video programme on castor cultivation.

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INFORMATION SOURCE UTILIZATION PATTERN FOR HOMESTEAD TECHNOLOGIES OF RAJENDRA AGRICULTURAL UNIVERSITY BY RURAL WOMEN OF BIHAR

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ABSTRACT

The data on information source utilization pattern was collected from 225 rural women from nine selected villages from three districts viz. Vaishali, Samastipur and Muzaffarpur of Bihar in the year 2013 with respect to the nine selected homestead technologies of Rajendra Agricultural University, Samastipur, Bihar. Analysis of the data revealed that majority (78.67 %) of the respondents utilized information source to a medium extent for gaining knowledge on the selected homestead technologies, the percentage of respondents who gained information on the selected homestead technologies from University Krishi Vigyan Kendra ranged from 21.33 per cent to 59.11 percent, while from Directorate of Extension ranged from 8.00 per cent to 48.89 per cent. Training – cum- demonstration method stood out to be the first and most utilized method of information dissemination for the homestead technologies-mushroom cultivation (58.67%), vermicompost (55.11%), value addition to cereals & pulses (50.67%) and stitching & embroidery (44.44%).

Women's knowledge of the latest technologies could be made possible with the use of various information sources/ channels. India have a wide range of information sources, mass media ranging from satellite broadcasting to the print media and from personal localite to cosmopolite. These media include newspaper, magazines, books, radio, television, extension personnel, informal channels etc. More than 70.0 per cent farmers of Maharashtra and Western Maharashtra gained information through mass media including newspapers, radio and television. The agro services centres served as information source for 77.42 per cent of farmers in Vidarbha region followed by agricultural department, agricultural university, extension activities, media and progressive farmers (Navadkar *et al*, 2004). Among the various sources of information, professional sources representing private firms and assistant agricultural officers (31.66%), non-professional sources i.e. contact farmers and local leaders (25.66%) and other sources (20.94%) were utilized by rice farmers in adoption of organic farming practices (Kavaskar and Santha, 2008).

Women have a key position in the family. Hence, transfer of appropriate home and farm technologies to rural women is of immense importance. Although, there are a number of information sources which are being used by the developmental agencies and other institutions to transfer the generated homestead technologies, we still do not know to what extent rural women utilize these sources. Thus, the present study is an effort/ attempt to assess the information source utilization pattern of farm women with the following specific objectives- to assess the information source utilization pattern of the respondents and to find out the source of awareness of the selected homestead technologies under study.

MATERIAL AND METHODS

A list of rural women who were exposed to the nine homestead technologies viz., fruit & vegetable preservation, stitching & embroidery, value addition to garments, arts & craft making, value added products from cereals & pulses, mushroom production, value added mushroom products, vermicompost technology and apiculture under study, were identified from the nine selected villages. Twenty five rural women were randomly selected from the who constituted the sample for the research study. Hence, a total of 225 (two hundred and twenty five) rural women who were exposed to the selected Homestead technologies constituted the sample for the study.

The information sources were studied from two aspects i.e. source of information and method of dissemination. The different sources of information identified were University (Krishi Vigyan Kendra, Directorate of Extension and Scientists), NGO (Krishi Vigyan Kendra and Voluntary Organisations), Department of Agriculture (Agriculture Technology Management Agency), informal sources (relatives, friends and neighbours) and others (input dealers). The different methods of information dissemination identified were training-cum-demonstration, publications, mass media, visits and exhibition/ kisan mela. The developed schedule included these two

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aspects of information source utilized by the respondents and also the source of awareness with respect to the nine selected homestead technologies.

The respondent was given one score for utilising each method of dissemination through various sources. Total score of the respondent was calculated by summing up the scores obtained on different disseminations methods utilized through various sources. Mean and standard deviation was calculated and the respondents were placed into low, medium and high categories.

RESULTS AND DISCUSSION

The data on total scores obtained by the respondents on different sources of information and the methods of dissemination utilized by them was shown in Table 1. From the data of this Table, it was found that majority (78.67 %) of the respondents utilized information source to a medium extent for gaining knowledge on the selected homestead technologies under study. This was followed by respondents who utilized information sources to a higher extent (20.0 %) and lower extent (1.33 %).

The data in Table 2 presents the relative importance of the different sources of information from where the respondents had gained knowledge about the selected homestead technologies. It was observed that the respondents gained information from one or more sources of information for gaining knowledge on these selected homestead technologies. From the findings of this table it was revealed that the percentage of respondents who gained information on the selected homestead technologies from University KVK ranged from 21.33 per cent to 59.11 percent, while from Directorate of Extension ranged from 8.00 percent to 48.89 percent. Percentage of respondents who gained information from University Scientists ranged from 10.22 per cent to 56.89 per cent and from informal sources (relatives, neighbours and friends) ranged from 16.89 per cent to 32.89 per cent. The percentage of respondents who gained information from ATMA office ranged from 0.44 per cent to 24.89 per cent while only 6.67 per cent and less per cent of the respondents had gained information from Voluntary organisations.

The data in Fig 1. depicted the sources of awareness through which the respondents became aware of the homestead technologies. It was seen from the data of this figure that for majority of the respondents, the major source of awareness for six out of nine homestead technologies was found to be KVK. The technologies were mushroom Production (59.11%), vermicompost technology (55.11%), value addition to garments (44.44%), art & craft making (42.67%), stitching & embroidery (39.56%) and fruit & vegetable preservation (33.33%). Rajendra Agricultural University Scientists played an active role in generating awareness on technologies of Value added mushroom products as expressed by 52.89 per cent and Value added Products from Cereals & Pulses as expressed by 46.22 per cent of the respondents. 35.56 per cent of the respondents indicated that Directorate of Extension was the source of awareness for them on Apiculture.

The data presented in Fig 2. highlighted the relative importance of the different information dissemination methods used by the research scientists and extension scientists for dissemination of Homestead technologies. It was found that the respondents were utilizing more than one information source for gaining knowledge about the selected homestead technologies.

From the data of this figure it was found that training – cum- demonstration method stood out to be the first and most utilized method of information dissemination for the following Homestead technologies- mushroom production (58.67%), vermicompost technology (55.11%), value addition to cereals & pulses (50.67%) and stitching & embroidery (44.44%). Exhibition/ Kisan Melas was the second most utilized method of information dissemination for the following Homestead technologies- value addition to garments (49.78%), value added mushroom products (49.33%), art & craft making (41.33%), apiculture (40.0%) and fruit & vegetable preservation (39.11%). Visits (institutions, KVK, neighbours, friends & relatives), publications and mass media were the third, fourth and fifth most utilized information dissemination method respectively.

Table 1. Distribution of respondents based on information source utilization (N=225)

Sl. No.	Category	Frequency (f)	Percentage (%)
1	Low	3	1.33
2	Medium	177	78.67
3	High	45	20.00
	Total	225	100.00

Mean = 39.32 Standard Deviation = 18.37

Table 2. Distribution of respondents based on the sources of information utilized by the respondents

Sl. No.	Homestead technology	Sources of information utilized													
		University						NGOs				DOA		Informal	
		KVK		DOE		Scientist		KVK		VOs		ATMA		Relatives, Friends and Neighbours	
		f	%	f	%	f	%	f	%	f	%	f	%	f	%
1.	Fruit & Vegetable preservation	75	33.33	70	31.11	43	19.11	0	0	1	0.44	10	4.44	48	21.33
2.	Stitching & embroidery	89	39.56	18	8.00	23	10.22	0	0	15	6.67	1	0.44	59	26.22
3.	Value addition to garments	100	44.44	77	34.22	56	24.89	0	0	0	0.00	2	0.89	38	16.89
4.	Art & craft making	96	42.67	58	25.78	56	24.89	0	0	0	0.00	4	1.78	57	25.33
5.	Value addition to cereals & pulses	94	41.78	72	32.00	104	46.22	0	0	0	0.00	21	9.33	74	32.89
6.	Mushroom production	133	59.11	110	48.89	128	56.89	0	0	0	0.00	56	24.89	66	29.33
7.	Value added mushroom products	48	21.33	94	41.78	119	52.89	0	0	0	0.00	28	12.44	67	29.78
8.	Vermicompost technology	124	55.11	103	45.78	85	37.78	0	0	10	4.44	44	19.56	74	32.89
9.	Apiculture	78	34.67	80	35.56	60	26.67	0	0	0	0.00	23	10.22	54	24.00
	Average		41.33		33.68		33.28		0.0		1.28		9.33		26.52
	Rank order		I		II		III		VII		VI		V		IV

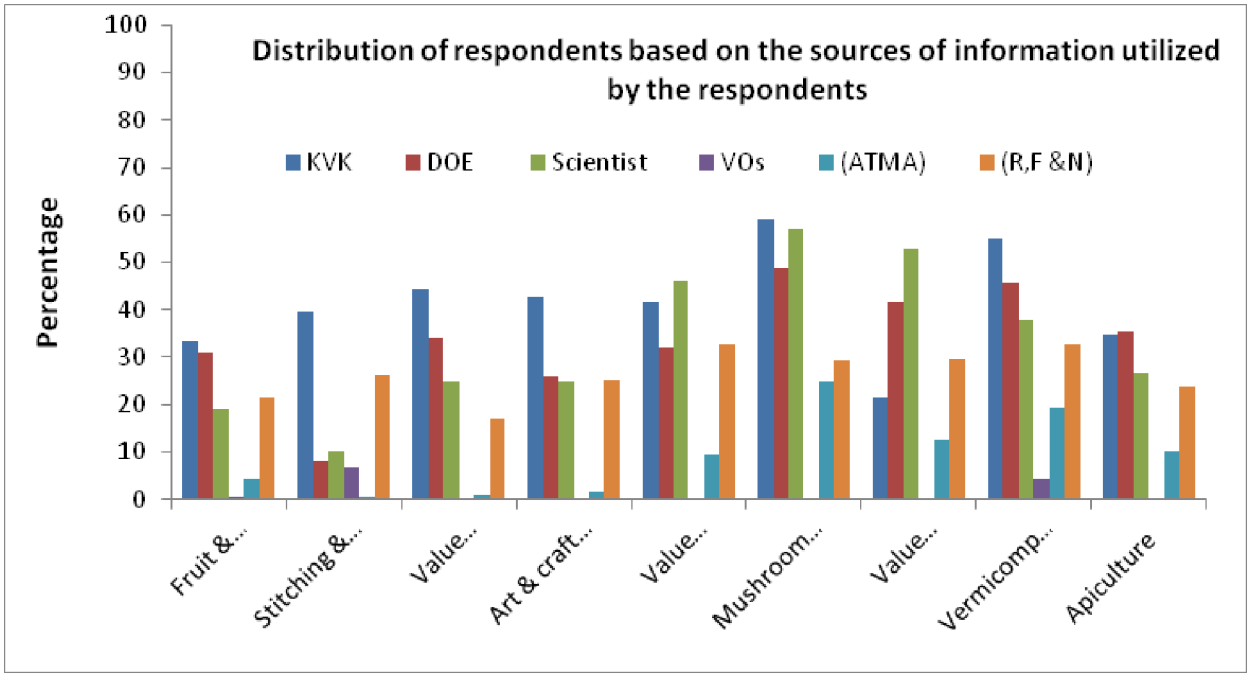

Fig 1. Distribution of respondents based on the source of information utilized

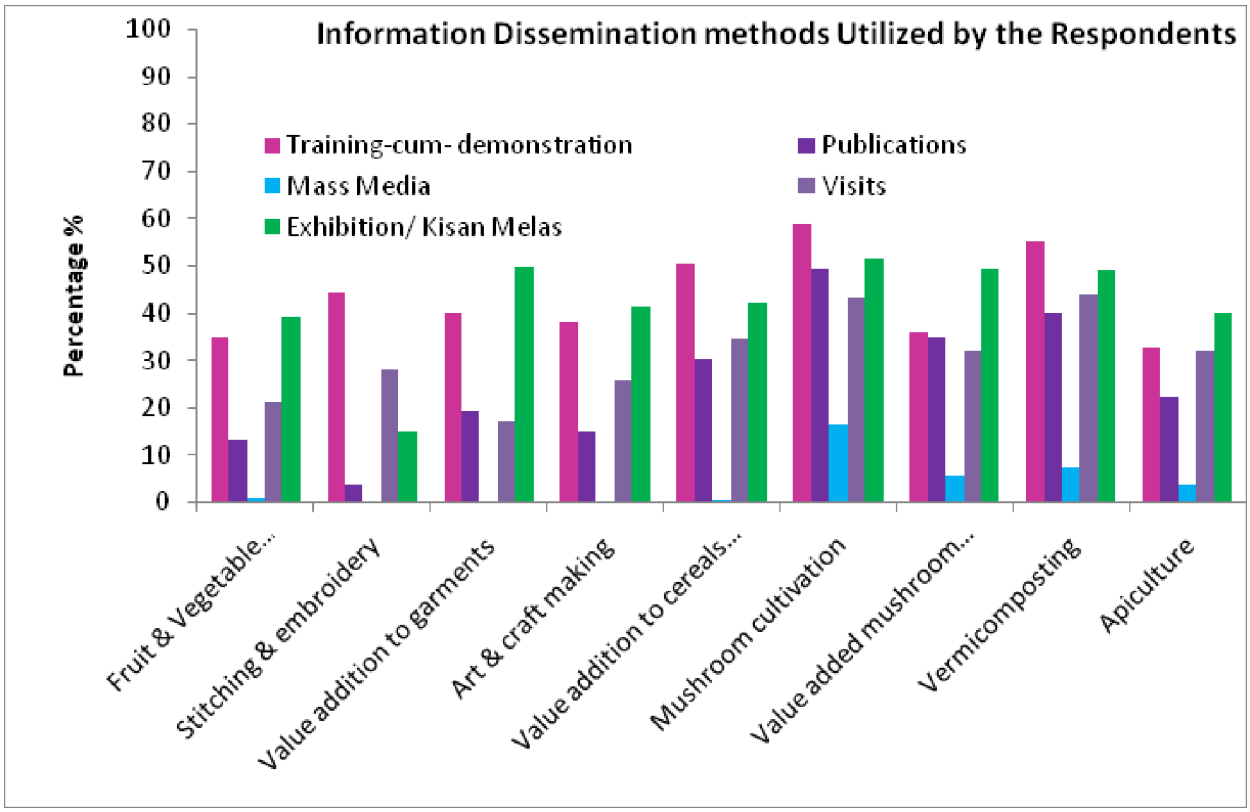

Fig 2. Distribution of respondents based on the information dissemination methods utilized

It suggests that KVK is playing a very important role in disseminating technologies to rural women and bringing positive change in their life in collaboration with the University and other VOs operating in those areas. Also, it ascertains that the traditional methods are still an effective means of information dissemination in comparision to mass media and other written methods like publications.

Veerendranath (2000) reported that among formal sources, demonstrations were the most credible sources and therefore ranked first followed by ANGRAU/ KVK Scientists, group meetings, field trips/ tours, Voluntary organisations, training program, AEOs/ BDOs, AOs, agriculture consultants and ADAs.

CONCLUSION

More efforts has to be made to improve accessibility of various information sources utilized by rural women in gaining knowledge and becoming aware about homestead technologies. Other sources and channels of information dissemination viz., community radio services, farming related programs in local television channels etc. also needs to be made use of by the researchers, extensionists and various development agencies so that women become accessible to these technologies.

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STORAGE CHARACTERISTICS OF FEW RICE VARIETIES OF CHHATTISGARH IN RAW AND PARBOILED CONDITIONS

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ABSTRACT

Rice is one of the most important food crops in the world and the staple diet for nearly half the world's population. Few rice varieties *(Mahamaya and Swarna*) were taken up to explore the effects of storage on milling and cooking qualities of raw and parboiled rice. The stored samples were tested for milling and cooking qualities at 0, 20 and 40 days of storage. During milling quality evaluation, head yield of raw and parboiled samples was decreased which is also reflected by higher broken percentage with increase in storage period. Leaching loss and water uptake ratio of raw as well as parboiled grains depicted, in general, decreasing trend with increasing storage period in both varieties. The bran oil content of raw and parboiled grain was also found to decrease throughout the storage period for both varieties of rice in raw and parboiled conditions.

In India, rice (*Oryza sativa* L.) is grown under wide agro-climatic conditions. Over 3000 varieties are under cultivation in different parts of the country with variations in their duration, grains quality and other characters (Rangaswami, 1993). It has been reported that the production of rice in the Chhattisgarh is about 11.7 million tonnes in the year 2012-13 (2014). In this state rice mills are usually engaged in production of both forms of rice i.e. raw and parboiled. Parboiling as a well-developed pre-milling treatment given to the rice is practiced throughout the world. Rice soaked, steamed, dried and milled is known as parboiled rice.The purpose of parboiling is to produce physical and chemical modification in the rice with economic and nutritional advantages (Pandey, 1998).Realizing that storage is an inevitable step, the present investigation was carried out to assess the degree of parboiling and storability of few rice varieties popularly grown in Chhattisgarh state.

MATERIAL AND METHODS

Two varieties of rice, *Mahamaya* and *Swarna* were procured from research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur. Rice cleaning was done manually to remove foreign matter, stones, immature, damaged and discoloured grains.The experiments were conducted in order to achieve the objectives of the present investigation. Parboiling experiment involved preliminary soaking, main soaking (temperature 60°C for 4 hrs), steaming (15 min) and shade drying (24 hrs).The degree of parboiling of rice grains on the basis of equilibrium moisture content at saturation, water uptake, spreading value and sedimentation value before storage. Storage experiments consisting of storing raw and parboiling rice for 0, 20 and 40 days were conducted. Effect of (i) storage on milling quality of parboiled rice, (ii) storage on cooking quality (leaching loss and water uptake at 97°C) and (iii) oil content in bran obtained from milling of raw and parboiled rice stored for different durations were also determined (Bosario and Gariboldi, 1965).

A. Degree of parboiling determination

(i) Equilibrium moisture content at saturation

For EMC-S determination, 2 g of raw and parboiled rice sample were soaked in 10 ml of distilled water for 24 hrs at room temperature. Then moisture content of grain was determined by using hot air oven (Parnsakhorn and Noomhorm, 2008).

Table 1. Spreading value on seven point scale

Spreading Phenomena	Spreading value
Kernel not affected	1
Kernel swollen	2
Kernel swollen, periphery narrow	3
Kernel swollen, periphery complete and wide	4
Kernel split	5
Kernel dispersed merging	6
Kernel completely dispersed and intermingled	7

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(ii) Alkali dispersion test

For alkali spreading value, 6 grains of raw and parboiled rice samples were soaked in 10 ml of KOH solution (1.7% conc.) and after 24 hrs grains were rated for spreading according to the seven point scale (Mariotti *et al*., 2010).

(iii) Sedimentation test

For this test, 2 g of ground sample was taken in seperate test tubes and volume was made up to 15 ml by adding 0.05 N HCl. After 4 hrs, the volumes of sediments in the test tubes were noted (Parnsakhorn and Noomhorm, 2008).

(iv) Water uptake ratio (W_{62}/W_{97})

For water uptake ratio, 2 g of raw and parboiled rice samples were cooked in 15 ml of distilled water at 62°C for 45 min and 97°C for 30 min. Then ratio of water uptake (W_{62}/W_{97}) was calculated (Parnsakhorn and Noomhorm, 2008).

A. Storage experiment

The storage of rice was done at room temperature. The independent variable involved in the storage experiment is storage duration (zero, 20 and 40 days).The dependent variables involved are milling quality, cooking quality and rice bran oil content.

Raw and parboiled rice samples 150 g were kept in polyethylene bags and mouth of bags were tied with rubber bands. Subsequently, the polythene bags containing raw and parboiled rice were kept in stainless steel containers, which were covered with lids. After that containers were placed in a separate shelf. Stirring of sample was done at an interval of 10 days to obtain the same storage effect throughout all individual samples. After desired storage duration (zero, 20 and 40 days) samples were taken out and subjected to quality evaluation tests.

B. Milling quality evaluation

The operations of cleaning, shelling, separation, polishing and grading were adopted for all the samples and the estimation of various milling properties for each sample was done. The milling efficiency, head yield and broken yield were calculated as suggested by Mandhyan and Sharma (1992).

$$\eta_{me(\%)} = \frac{W_{tr}}{W_{tp}} x100 \qquad (1)$$

Where milling efficiency (%), weight of total rice (g) and total weight of rice (g) is indicated by η_{me}, W_{tr} and W_{tp} respectively.

$$Y_h(\%) = \frac{W_{hr}}{W_{hr}} x100 \qquad (2)$$

where head yield (%), weight of head rice (g) and weight of milled rice (g) is represented by Y_h, W_{hr} and W_{mr} respectively.

$$Y_b(\%) = \frac{W_{bpr}}{W_{tpr}} x100 \qquad (3)$$

where brokens (%), weight of broken polished rice (g) and weight of total polished rice (g) is designated by Y_b, W_{bpr} and W_{tpr} respectively.

C. Cooking quality evaluation

(i) Water uptake at 97°C

Water uptake was determined by cooking 2 g of rice samples in 15 ml distilled water for 30 min at 97°C and the moisture content of cooked grains was determined by hot air oven method (Islam *et al.,* 2003).

(ii) Leaching loss of solids in gruel during cooking

For determining leaching loss of solids, 2 g of rice sample was cooked in boiling water for 30 min, gruel with one or two rinses of water was dried in hot air oven and loss of solids was calculated on percentage basis (Islam *et al.,* 2003).

D. Oil Content in bran

For determining the oil content in bran, samples were grounded and then 2-3 g sample was weighed accurately into a thimble and plugged with cotton. The thimble was then placed in an apparatus and extracted with petroleum ether/hexane for 6 hrs. The extract was filtered into a weighed conical flask. The extract was washed 4-5 times as small quantity of ether was also transferred. The ether was then removed by evaporation and the flask with the residue is dried in an oven at 60-70°C, cooled in a desiccator and weighed. The percentage of oil in raw and parboiled bran was calculated (Proctor and Bowen, 1996).

$$oil\% = \frac{W_o}{W_d} x100 \qquad (4)$$

where weight of oil (g) and weight of dry matter (g) is denoted by W_o and W_d respectively.

RESULTS AND DISCUSSION

In parboiling experiment, temperature and time of soaking and steaming were kept constant. After shade drying for 24 hrs, the parboiled (as well as raw) samples were subjected to storage by placing them in polyethylene bags. The two varieties of rice in raw and parboiled conditions are called as MT-1

and MT-2 (for *Mahamaya*) and ST-1 and ST-2 (for *Swarna*) respectively.

A. Degree of parboiling attained by rice grains

Degree of parboiling was evaluated on the basis of equilibrium moisture content at saturation, water uptake ratio, alkali spreading and sedimentation values for raw and parboiled grains of *Mahamaya* and *Swarna* varieties.

(i) Equilibrium moisture content at saturation

The EMC-S value of parboiled samples were found to be higher (67.07%, 62.28%:: *Mahamaya*, *Swarna*) and that of raw samples lower (37.73%, 30.76%:: *Mahamaya*, *Swarna*). The possible reason for lower value of EMC-S value of raw rice samples may be that as no gelatinization of starch took place in them and therefore absorbed lower moisture even after exposing them for 24 hrs.

(ii) Alkali spreading value

It can be observed that raw samples of rice were almost unaffected and obtained lower values (1.60, 1.65:: *Mahamaya*, *Swarna*). Parboiled rice sample showed higher spreading values (2.85, 3.10:: *Mahamaya*, *Swarna*). This higher value of spreading is due to higher gelatinization of starch, which reacted by alkali solution.

(iii) Sedimentation test

It can be observed that the increase in sedimentation volume were lower (1.86 ml, 1.92 ml:: *Mahamaya*, *Swarna*) for raw rice grains and higher (2.33 ml, 2.35 ml :: *Mahamaya*, *Swarna*) for parboiled rice samples. Increase in volume for raw grain was less owing to ungelatinized starch which resulted in less absorption of HCl. Gelatinized starch of parboiled grains absorbed more HCl and therefore attained higher sedimentation value.

(iv) Water uptake ratio (W_{62}/W_{97})

Raw rice sample attained lower value ($2.03x10^{-2}$, $2.36x10^{-2}$) while parboiled rice showed higher value ($2.36x10^{-2}$, $2.40x10^{-2}$) thus water uptake ratio of raw sample of rice was low in comparision to parboiled rice sample in both varieties. This is because raw sample at 62°C absorbed less moisture in 45 min and absorbed more moisture at 97°C in 30 min., owing to its un-gelatinized starch. Das *et al.* (1989) also reported that water uptake ratio of parboiled rice is higher with severity of parboiling.

B. Effect of storage on moisture content of rice

Raw sample as well as parboiled gave a fluctuating trend for their moisture content throughout the storage period (Fig.1).In *Mahamaya* and *Swarna* varieties, the moisture content of raw as well as parboiled sample declined because samples were stored in shade and during 40 days atmospheric temperature was high (above 45°C). Hence, moisture evaporated from all samples and showed a declining trend in moisture content. Similarly, in case of *Swarna* variety, the moisture content of raw as well as parboiled samples declined throughout the storage period because samples were stored at room temperature and atmospheric temperature was high. At the end of storage, moisture content of raw sample was 11.07 per cent while that of parboiled sample is 10.11 per cent.

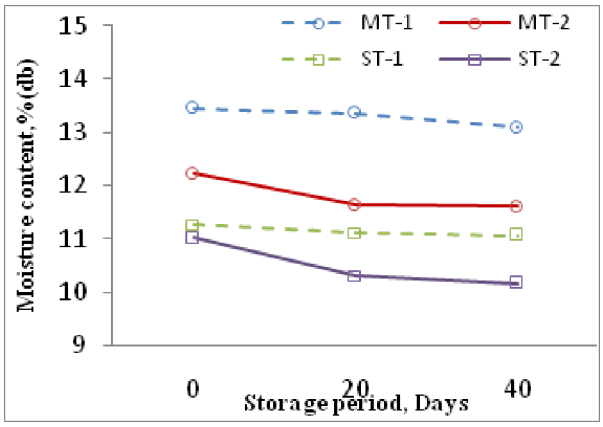

Fig 1. Effect of storage on moisture content of raw and parboiled rice

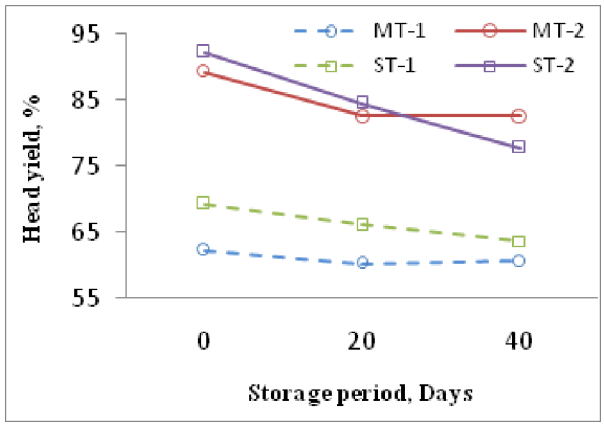

Fig 2. Effect of storage on head yield

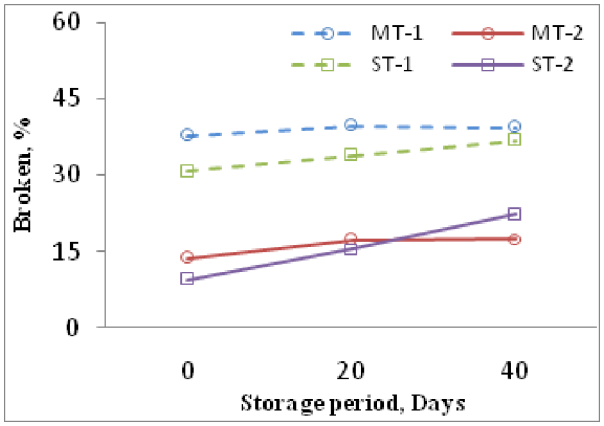

Fig 3. Effect of storage on broken yield

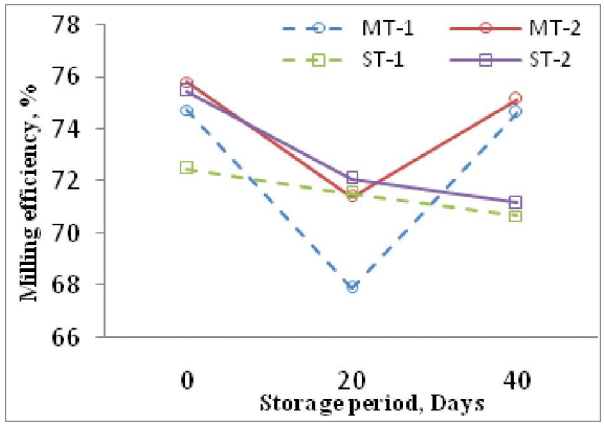

Fig 4. Effect of storage on milling efficiency

C. Effect of storage on milling quality

Effect of storage on milling quality of rice have been represented graphically in Fig. 2 , 3 and 4. It is clear that for raw rice sample as the storage time increased, head yield and milling efficiency decreased up to 20 days storage period and then again decreased upto 40 days storage in *Mahamaya* variety. However, in case of *Swarna* variety, raw as well as parboiled sample showed a declining trend throughout the storage period. Broken percentage increased into raw and parboiled sample throughout the storage period.

D. Effect of storage on cooking quality

(i) Water uptake at 97°C

Effect of storage on water uptake of raw as well as parboiled sample of rice have been represented graphically in Fig. 3 (i). The results revealed that water uptake of raw and parboiled rice sample decreased up to 20 days and afterwards the water uptake increased for *Mahamaya* variety. However, in case of *Swarna* variety, the results revealed that water of raw and parboiled rice samples decreased throughout the storage period.

(ii) Leaching of solids during cooking

The results of leaching of solids during cooking of rice in boiling water are represented in Fig 5. The results show that loss of solids declined throughout the storage period for raw and all parboiled rice samples. Leaching loss was higher at the beginning of storage period for all samples whether raw or parboiled. However, at every stage of storage leaching loss of solids (for raw sample owing to its un-gelatinized starch) was found to be higher than all parboiled rice samples. Among all the samples, higher leaching loss was found with rice samples (26.39%, 20.23%::*Mahamaya*, *Swarna*) at the beginning of storage.

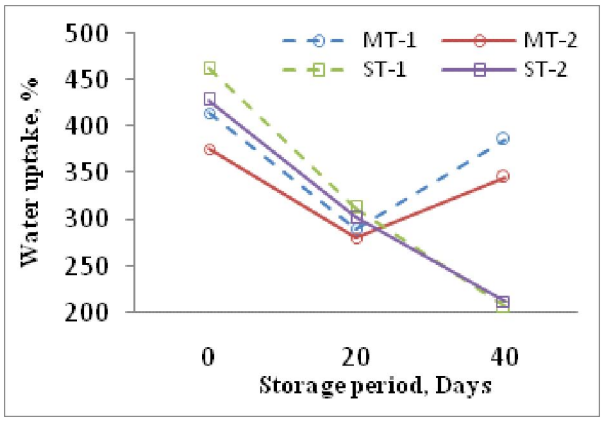

Fig 5. Effect of storage on water uptake at 97°C

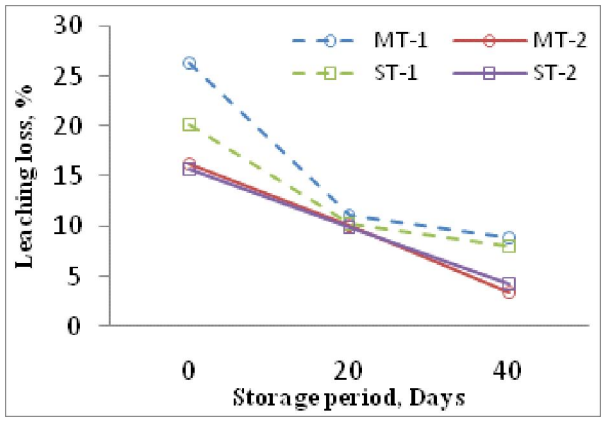

Fig 6. Effect of storage on leaching loss of solids with gruel

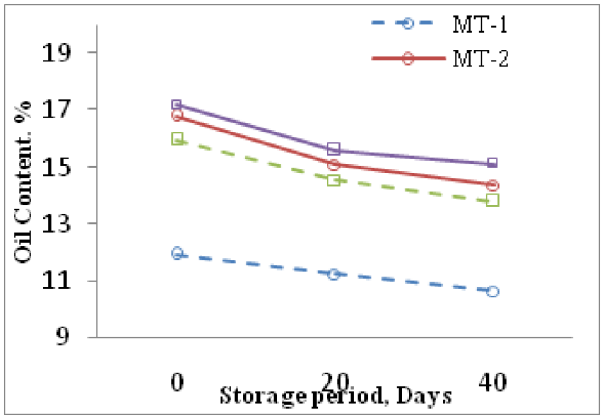

Fig 7. Effect of storage on oil content in bran

A. Oil content in bran

Effect of storage on oil content in bran of raw as well as parboiled rice is represented in Fig 7. The oil content of raw bran was lower than that of parboiled bran. The results revealed that the oil content of raw and parboiled bran sample had declined throughout the storage period for both *Mahamaya* and *Swarna* variety.

CONCLUSION

For all storage durations raw rice had higher moisture content than parboiled rice sample in both *Mahamaya* and *Swarna* varieties. The oil content in bran of parboiled rice samples was found to be higher than that of raw rice sample for both varieties. The oil content decreased appreciably with increase in storage periods of both varieties for both raw and parboiled conditions.

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PERFORMANCE OF CHRYSANTHEMUM (*Dendranthema grandiflora*) HYBRIDS

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ABSTRACT

An experiment on the evaluation of certain chrysanthemum genotypes was conducted for three consecutive years from 2010 to 2013 at Floricultural Research Station, Hyderabad with an objective of the identification of a suitable variety for the cultivation in Telangana. Fourteen genotypes of chrysanthemum along with check Silper were evaluated and maximum average plant height (58.8 cm), no. of branches/plant (13.2), spray length (32.0 cm) and no. of flowers / spray (32.3) were recorded in PAU-B-43 over check Silper. Highest plant spread (69.5 cm) and diameter of flower (7.9 cm) were recorded in Garden Beauty over control. Minimum no. of days taken to 1st flower bud appearance (36), no. of days taken to 50% flowering (55) were recorded in Yellow Delight over Silper. Average flower weight (3.2 g) was recorded in Raichur over check. Highest no. of flowers/plant (yield) was recorded in winter queen (211) over silper and no. of suckers/plant was recorded maximum in PAU-D-1 (42.7) over control.

Chrysanthemum (*Dendranthema grandiflora*) is becoming a commercially viable ornamental crop. Chrysanthemum ranks 2nd among the top cut flowers around the globe. In India, it is very popular as loose flower, cut flower as well as pot plant (Kher, 1988). Environment/season is the most important limiting factor for growth and flowering (Raman *et al.,*1969)

In Telangana state much information is not available on the performance of Chrysanthemum genotypes. Hence, present experiment has been conducted with an objective to test the promising cultivars evolved at different centres for their flower production and market acceptability.

MATERIAL AND METHODS

The present investigation of performance of chrysanthemum hybrids was done on different genotypes of Chrysanthemum i.e. UHFS-Chr-77, Pusa Anmol, PAU-D-1, PAU-A-43, PAU-A-64, PAU-B-107, PAU-B-43, Winter Queen, Royal Purple, Yellow Delight, Garden Beauty, Autumn Joy, Raichur along with check variety Silper locally very popular variety in Andhra Pradesh was carried out for three consecutive years from 2010-2013 at Floricultural Research Station, Hyderabad. The experiment was laid out in Randomised Block Design (RBD) with three replications. The cuttings were sown with spacing of 30 x 30 cm. Regularly standard cultural operations were carried out throughout the experiment as per our recommendations.

The observations pertaining to 11 different parameters of plant height, plant spread, no. of branches/plant, days taken to 1st flower bud appearance, days to 50% flowering, spray length, no. of flowers / spray, average flower weight, diameter of flower, no. of flowers/ plant, no. of suckers/plant were recorded from five randomly selected plants from net plot area at regular intervals.

RESULTS AND DISCUSSION

Fourteen in different genotypes of Chrysanthemum were studied for their vegetative and floral characters along with check Silper. Among growth characters it was observed that, PAU-B-43 was recorded maximum Plant height (58.8 cm) followed by PAU-B-107 (53.4cm) over check Silper (35.3 cm). Plant Spread was recorded maximum in Garden Beauty (69.5 cm) followed by PAU-B-43 (54.8 cm) over check Silper (33.7 cm). The earlier findings of Gaikwad and Patil (2001) regarding evaluation of chrysanthemum varieties under open and polyhouse conditions are in accordance with our present study. More no. of branches / plant was recorded in PAU-B-43 (13.2) followed by Winter Queen (12.4) over Silper (7.2). Similar variation among the varieties for number of branches was also observed by Mukesh Kumar and Chattopadhyay (2002). No. of days taken to 1st flower bud appearance is recorded minimum in Yellow Delight (36) followed by Autumn Joy (48) over check (82). Minimum No. of days taken to 50% flowering was recorded in Yellow Delight (55) followed by Autumn Joy (79) over Silper (101). Maximum Spray length was recorded in PAU-B-43 (32.0 cm) followed by PAU-B-107 (29.8 cm) over check (17.7 cm).

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Table 1. Phenotypic performance of Chrysanthemum hybrids

S.No.	Varieties	Plant height (cm)				Plant spread (cm)				No. of branches / Plant				No. of days taken to 1st flower bud appreance				No. of days taken to 50% flowering				Spray Length (cm)			
		2010-11	2011-12	2012-13	AVG	2010-11	2011-12	2012-13	AVG	2010-11	2011-12	2012-13	AVG	2010-11	2011-12	2012-13	AVG	2010-11	2011-12	201 2-13	AVG	2010-11	2011-12	2012-13	AVG
1	UHFS-Chr-77	30.3	34.5	29.0	31.2	16.2	19.4	19.1	18.2	8.3	4.7	10.1	7.7	98	95	107	100	120	103	114	113	21.3	11.4	18.8	17.2
2	PusaAnmol	31.5	28.9	38.4	33.0	28.3	25.7	29.2	27.7	5.3	7.5	8.5	7.1	54	87	91	77	105	99	111	105	13.3	17.6	10.9	13.9
3	PAU-D-1	19.3	47.8	45.4	37.5	35.2	33.2	41.0	36.5	3.9	8.4	9.0	7.1	63	88	63	71	106	100	117	108	1.2	19.2	15.8	12.1
4	PAU-A-43	34.6	43.8	45.8	41.4	27.1	31.4	30.9	29.8	11.0	8.0	8.3	9.1	53	96	113	87	120	106	139	122	19.5	23.7	13.3	18.8
5	PAU-A-64	25.1	23.7	24.1	24.3	32.1	28.9	25.2	28.7	8.2	7.0	7.3	7.5	40	61	71	57	83	79	106	89	18.6	14.8	13.4	15.6
6	PAU-B-107	49.9	56.7	53.8	53.4	30.1	36.0	45.0	37.0	15.9	9.2	11.7	12.3	62	74	102	80	102	91	124	106	41.5	26.6	21.4	29.8
7	PAU-B-43	54.3	49.0	73.0	58.8	53.2	46.5	64.6	54.8	13.5	10.1	15.9	13.2	93	86	90	90	107	100	116	108	35.4	21.4	39.1	32.0
8	Winter Queen	46.7	37.5	42.3	42.2	39.3	37.6	45.7	40.9	12.3	8.9	16.0	12.4	63	81	91	78	121	89	142	117	31.6	17.6	19.0	22.7
9	Royal Purple	25.8	28.1	25.8	26.5	25.6	19.8	23.8	23.0	9.2	4.6	8.9	7.5	43	84	92	73	107	97	113	106	20.5	11.2	10.9	14.2
10	Yellow delight	22.6	23.6	29.9	25.4	25.3	27.5	18.4	23.7	4.2	5.1	6.9	5.4	32	34	42	36	57	43	65	55	19.1	17.1	17.6	17.9
11	Garden beauty	47.1	44.9	41.2	44.4	62.1	88.8	57.8	69.5	15.8	7.0	8.8	10.5	60	84	94	79	113	93	126	111	38.7	17.4	13.6	23.2
12	Autumn Joy	32.4	28.3	36.4	32.4	35.2	27.6	39.2	34.0	6.5	8.6	10.2	8.4	43	47	54	48	78	57	103	79	26.8	23.9	20.1	23.6
13	Raichur	34.6	38.3	32.1	35.0	18.2	20.0	19.0	19.1	5.0	3.2	2.8	3.7	75	63	72	70	111	84	92	96	23.8	24.6	19.8	22.7
14	Silper (Check)	34.2	39.5	32.3	35.3	38.2	22.2	40.8	33.7	6.8	4.5	10.3	7.2	79	81	87	82	97	86	121	101	17.7	16.6	18.8	17.7
	SEm ±	1.250	1.330	3.135		1.450	2.190	3.245	2.295	0.630	0.540	1.450		3.080	1.950	9.028		3.280	1.920	4.640	3.280	0.780	1.390	3.099	
	CD at 5 %	3.65	3.38	9.5		7.32	6.41	9.47	7.73	1.85	1.56	4.25		8.99	5.68	26.34		28.7	5.6	30.5	21.6	2.28	3.81	9.05	

Table 2. Phenotypic performance of Chrysanthemum hybrids

S.No.	Varieties	No. of flowers / spray				Average flower weight (g)				Diameter of flower (cm)				No. of flowers / Plant (yield)				No. of suckers / Plant			
		2010-11	2011-12	2012-13	AVG	2010-11	2011-12	2012-13	AVG	2010-11	2011-12	2012-13	AVG	2010-11	2011-12	2012-13	AVG	2010-11	2011-12	2012-13	AVG
1	UHFS-Chr-77	6.2	5.8	6.7	6.2	2.3	2.0	0.8	1.7	3.9	4.6	4.3	4.3	38	42	28	36	6.5	5.9	7.8	6.8
2	PusaAnmol	16.0	13.4	9.6	13.0	1.3	0.7	0.8	0.9	4.4	2.7	3.5	3.5	137	95	81	104	24.5	32.5	13.9	23.6
3	PAU-D-1	7.4	10.2	11.5	9.7	1.4	0.7	2.1	1.4	5.3	5.2	5.8	5.4	30	99	91	74	58.2	55.4	14.5	42.7
4	PAU-A-43	10.7	12.2	10.7	11.2	1.8	1.8	1.6	1.7	4.5	5.8	5.7	5.3	29	113	87	76	30.2	18.4	8.7	19.1
5	PAU-A-64	29.9	16.7	15.4	20.7	0.8	0.8	0.8	0.8	3.9	4.3	4.3	4.2	199	157	86	147	16.4	17.2	30.5	21.4
6	PAU-B-107	20.9	9.5	34.9	21.8	2.8	2.0	2.0	2.3	5.5	5.5	5.8	5.6	230	122	199	184	53.5	31.6	17.3	34.1
7	PAU-B-43	35.3	21.7	40.0	32.3	2.3	2.3	1.4	2.0	4.3	5.6	5.7	5.2	193	227	178	200	48.2	53.5	22.0	41.2
8	Winter Queen	14.3	14.9	19.1	16.1	2.5	2.2	1.3	2.0	6.6	7.0	7.5	7.0	241	206	186	211	37.3	33.7	36.3	35.8
9	Royal Purple	19.3	14.5	12.7	15.5	1.3	1.4	1.3	1.3	4.6	5.8	5.3	5.2	120	139	91	117	8.1	11.3	5.7	8.4
10	Yellow delight	10.3	8.9	6.8	8.7	1.1	1.1	1.3	1.1	3.3	5.3	3.8	4.1	29	35	49	37	17.5	17.5	19.1	18.0
11	Garden beauty	9.4	12.7	10.9	11.0	2.2	1.5	1.2	1.6	7.4	8.1	8.2	7.9	202	190	76	156	17.1	17.6	18.0	17.6
12	Autumn Joy	23.7	18.3	11.7	17.9	1.6	1.3	1.2	1.4	6.3	6.2	7.0	6.5	197	145	147	163	38.2	36.4	22.9	32.5
13	Raichur	10.7	8.3	7.6	8.9	1.2	3.5	4.8	3.2	4.7	5.7	2.3	4.2	29	27	32	29	3.9	2.8	4.3	3.7
14	Silper (Check)	15.2	4.3	19.0	12.8	3.1	1.6	3.8	2.8	5.8	5.3	6.9	6.0	73	35	92	66	11.3	12.4	7.1	10.3
	SEm ±	1.78	1.16	1.897		0.09	0.37	0.047		0.21	0.440	0.054		3.41	9.73	11.40		1.03	1.03	1.049	
	CD at 5 %	5.21	3.38	5.54		0.26	1.07	0.14		0.61	1.28	0.16		9.95	28.39	33.27		3.01	3.01	3.06	

Maximum No. of flower/spray was recorded in PAU-B-43 (32.3) followed by PAU-B-107 (21.8) over Silper (12.8). More average flower weight was recorded highest in Raichur (3.2 g) followed by Check (2.8 g). Highest diameter of flower was recorded in Garden Beauty (7.9 cm) followed by Winter Queen (7.0 cm) over Check (6.0 cm), No. of flowers/plant (yield) was recorded maximum in Winter Queen (211) followed by PAU-B-43 (200) over check Silper (66). Dilta *et al.*(2005) also observed a wide range of diversity in flower number, size and flower duration in different chrysanthemum cultivars. Maximum no. of suckers/ plant was recorded in PAU-D-1 (42.7) followed by PAU-B-43 (41.2) over check (10.3)

CONCLUSION

Highest plant spread (69.5 cm) and diameter of flower (7.9 cm) were recorded in Garden Beauty over control. Minimum no. of days taken to 1st flower bud appearance (36), no. of days taken to 50% flowering (55) were recorded in Yellow Delight over Silper. Average flower weight (3.2 g) was recorded in Raichur over check. Highest no. of flowers/plant (yield) was recorded in Winter Queen (211) over silper and No. of suckers/plant was recorded maximum in PAU-D-1 (42.7) over control.

The economical characters viz., the no. of flowers/spray, no. of flowers/plant, no. of branches / plant are very important in Chrysanthemum. Hence, the genotypes Viz., PAU-B-107, PAU-B-43, Yellow Delight can be recommended to the farmers.

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CORRELATION AND PATH ANALYSIS IN ORIENTAL PICKLING MELON (*Cucumis melo* L. *var. conomon*) GENOTYPES

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ABSTRACT

Correlation and path analysis was carried out for yield and yield attributing traits in 46 oriental pickling melon genotypes. Yield per vine was correlated positively and significantly with node number of first female flower, days to first female flower, fruit weight, fruit length, fruit girth, flesh thickness, placenta weight per fruit, days to first fruit harvest, seed cavity width, seed cavity length, TSS, number of fruits per vine, number of primary branches per vine and 100 seed weight. Path coefficient analysis revealed that traits like 100 seed weight, placenta weight per fruit and fruit weight exhibited high positive direct effect on fruit yield per vine and these traits recorded significant positive correlation with fruit yield per vine signifying the importance of these traits in selection programme for crop improvement.

In Andhra Pradesh, oriental pickling melon (*Cucumis melo* L.var *conomon*) the vegetable is popularly known as cooking melon (or) Dosa kaya (Telugu). It is commonly cooked as curry, added in sambar or soup, daal and also in making *dosa-aavakaaya* (Indian pickle)and chutney. For a successful crop improvement programme, it is extremely important to study the inter-relationships among various characters. Therefore, it is important to know the association between yield and its components as it would provide valuable information about the correlated response to selection. The knowledge of correlation alone does not present the complete picture, since the understanding of direct and indirect effects of important yield contributing traits is necessary for selecting high yielding genotypes. Path analysis separates the correlation coefficients into components of direct and indirect effects.

MATERIAL AND METHODS

The experimental material consisted of 46 oriental pickling melon genotypes obtained from NBPGR, Hyderabad. The experiment was laid out in randomized block design with 46 treatments and two replications during *kharif,* 2012 at Vegetable Research Station, Agriculture Research Institute, Rajendranagar, Hyderabad. The seeds were sown at a spacing of 3m from row to row and 0.5 m from plant to plant with in a row. The recommended package of practices was followed. Observations on node number of first male flower, node number of first female flower, days to first male flower, days to first female flower, number of primary branches per vine, vine length (cm), days to first fruit harvest, number of fruits per vine, fruit length (cm), fruit girth (cm), flesh thickness(cm), average fruit weight (g), placenta weight per fruit (g), seed cavity length (cm), seed cavity width (cm), 100 Seed weight (g), total soluble solids (^{0}Brix) and yield per vine (Kg) for each genotype were recorded from five randomly selected plants per replication.

RESULTS AND DISCUSSION

The phenotypic and genotypic correlation coefficients between different characters studied are presented in Table 1.From the perusal of Table 1 in general the magnitudes of genotypic correlation coefficients were higher than phenotypic correlation coefficients indicating strong association among various characters studied.

In the present study, fruit yield per vine had significant positive correlation with node number of first female flower, days to first female flower, fruit weight, fruit length, fruit girth, flesh thickness, placenta weight per fruit, days to first fruit harvest, seed cavity width, seed cavity length, total soluble solids and 100 seed weight at both phenotypic and genotypic levels and number of primary branches per vine at phenotypic level. Hence, these traits can be considered as the main fruit yield influencing components and high fruit yield could be obtained by operating selection pressure over any of these traits. Similar positive association of fruit yield with days

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to first female flower, fruit weight and fruit length was reported by Ramana (2000) in oriental pickling melon, Positive association of fruit yield with seed cavity width, total soluble solids, 100 seed weight and number of primary branches per vine were reported by Reddy *et al*. (2007) in snap melon, Mehta *et al.* (2010) in musk melon and Hossain *et al*. (2010) in cucumber. Fruit yield per vine had significant negative correlation with number of fruits per vine at both phenotypic and genotypic levels. Similar negative association of fruit yield with number of fruits per vine was also observed by Ramana (2000) in oriental pickling melon and Reddy *et al*. (2007) in snap melon.

Node number of first male flower had significant positive correlation with number of days to first male flower at both phenotypic and genotypic levels, while days to first male flower had significant positive correlation with fruit weight, fruit length, placenta weight per fruit and total soluble solids at genotypic level only. First female flowering node and days to first female flower are the indicators of earliness in pickling melon. Early female flowering gives early pickings and better returns. Node number of first female flower and days to first female flower had significant positive correlation with each other and also with fruit weight, fruit length, fruit girth, flesh thickness, placenta weight per fruit, days to first fruit harvest, seed cavity width, seed cavity length, total soluble solids and 100 seed weight. These findings are in agreement with the earlier findings of Prasad *et al*. (1992) in musk melon and Reddy *et al*. (2007) in snap melon. Node number of first female flower and days to first female had significant negative correlation with number of fruits per vine at both phenotypic and genotypic levels.

Fruit traits viz., fruit weight, length and girth, flesh thickness, placenta weight per fruit, seed cavity width and length and 100 seed weight and quality traits viz., total soluble solids and earliness trait such as days to fruit harvest had significant positive association among themselves and also with node number of first female flower and days to first female flower. All these traits had significant negative association with number of fruits per vine which in turn had significant positive association with vine length. Positive association among fruit weight, length and girth, flesh thickness, placenta weight per fruit, seed cavity width and length and 100 seed weight were reported by Ramana (2000) in oriental pickling melon, Yadav and Ram (2002), Tomar *et al*. (2008).

Vine length and number of primary branches largely determine the fruit bearing surface thus are considered as growth attributes. Vine length had significant positive association with days to first female flower and fruit girth at genotypic level, number of fruits per vine at phenotypic level and with number of primary branches per vine at both phenotypic and genotypic levels. While number of primary branches had significant positive association with fruit girth at genotypic level. These findings are in conformity with the earlier findings of Reddy *et al*. (2007) in snap melon. These results support the findings of Kumar *et al*. (2007) in bottle gourd.

The estimation of direct and indirect effects of different characters on fruit yield per vine is presented in Table 2. The path coefficient analysis showed that 100 seed weight at both genotypic and phenotypic levels, placenta weight per fruit at genotypic level and fruit weight at phenotypic level exhibited high positive direct effect on yield per vine and these traits recorded significant, positive correlation with fruit yield per vine. It clearly indicates that direct selection based on these characters would be effective for an increase in yield. Similar results were also reported. Prasad *et al*. (1992) in cucumber; Singh and Lal (2005) in musk melon and Kumar *et al*. (2007) in bottle gourd.

Number of fruits per vine with high positive direct effect on yield at both genotypic and phenotypic levels had significant negative correlation at genotypic and phenotypic levels suggesting restricted selection model to make use of the direct effect. Similar results were also reported by Hossain *et al*. (2010) in cucumber and Tomar *et al*. (2008) in musk melon.

Selection of genotypes with heavier seeds and large fruits with higher placenta weight is desirable for improved yield in oriental pickling melon. In this study, the residual effect at genotypic level was low (0.0943) indicating that 90.57% of the variability in yield has been explained by the yield attributes included in the experiment.

CONCLUSION

Correlation and path analysis revealed that the traits viz., fruit weight, placenta weight per fruit and 100 seed weight were the primary yield contributing components which can be effectively utilized through selection in oriental pickling melon varietal improvement programme.

Table 1. Association among eighteen yield components and fruit yield attributes in 46 genotypes of oriental pickling melon

Characters		Node number of first male flower	Days to first male flower	Node number of first female flower	Days to first female flower	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Flesh thickness (cm)	Placenta weight per fruit (g)	Days to first fruit harvest	Seed cavity width (cm)	Seed cavity length (cm)	TSS (°Brix)	Number of fruits per vine	Vine length (cm)	Number of primary branches per vine	100 Seed weight (g/fruit)	Fruit yield per vine (kg)
Node number of first male flower	P	1.000	0.766**	0.010	-0.007	0.106	0.062	-0.007	-0.0259	0.114	0.073	-0.084	0.014	0.088	-0.069	-0.130	0.004	0.022	0.122
	G	1.000	0.887**	0.039	-0.047	0.117	0.067	-0.005	-0.029	0.127	-0.097	-0.095	0.043	0.096	0.080	-0.072	-0.004	0.039	0.126
Days to first male flower	P		1.000	0.066	-0.088	0.117	0.121	0.009	0.015	0.138	-0.149	0.081	0.136	0.127	-0.072	-0.062	-0.048	0.091	0.130
	G		1.000	0.144	-0.169	0.201*	0.214*	0.078	0.049	0.233*	-0.194	0.124	0.196	0.220*	-0.178	-0.051	-0.078	0.146	0.160
Node number of first female flower	P			1.000	0.939**	0.635**	0.563**	0.478**	0.536**	0.629**	0.952**	0.352**	0.553**	0.479**	-0.520**	0.105	0.059	0.697**	0.564**
	G			1.000	1.068**	0.681**	0.621**	0.558**	0.572**	0.663**	0.977**	0.376**	0.601**	0.522**	-0.630**	0.186	0.087	0.662**	0.608**
Days to first female flower	P				1.000	0.517**	0.440**	0.385**	0.416**	0.516**	0.928**	0.243*	0.433**	0.386**	-0.437**	0.100	0.049	0.503**	0.470**
	G				1.000	0.712**	0.631**	0.568**	0.581**	0.698**	1.0008	0.332**	0.603**	0.545**	-0.706**	0.268**	0.118	0.688**	0.691**
Fruit weight (g)	P					1.000	0.932**	0.799**	0.881**	0.949**	0.552**	0.750**	0.914**	0.834**	-0.736**	-0.055	0.025	0.977**	0.856**
	G					1.000	0.935**	0.813**	0.882**	0.954**	0.618*	0.740**	0.918**	0.836**	-0.746**	0.080	0.099	0.984**	0.940**
Fruit length (cm)	P						1.000	0.836**	0.887**	0.885**	0.517**	0.753**	0.977**	0.815**	-0.617**	-0.147	-0.059	0.902**	0.809**
	G						1.000	0.826**	0.893**	0.896**	0.602**	0.740**	0.988**	0.809**	-0.563**	0.005	0.028	0.917**	0.935**
Fruit girth (cm)	P							1.000	0.830**	0.755**	0.410**	0.615**	0.796**	0.798**	-0.529**	0.029	0.119	0.783**	0.691**
	G							1.000	0.862**	0.763**	0.505**	0.597**	0.808**	0.805**	-0.412**	0.355**	0.295*	0.826**	0.882**
Flesh thickness (cm)	P								1.000	0.841**	0.465**	0.651**	0.829**	0.789**	-0.551**	-0.069	-0.004	0.855**	0.804**
	G								1.000	0.842**	0.525**	0.640**	0.834**	0.795**	-0.533**	0.040	0.061	0.856**	0.885**
Placenta weight per fruit (g)	P									1.000	0.551**	0.695**	0.855**	0.743**	-0.682**	-0.023	0.008	0.904**	0.827**
	G									1.000	0.607**	0.690**	0.864**	0.740**	-0.710	0.075	0.059	0.906**	0.896**
Days to first fruit harvest	P										1.000	0.304**	0.512**	0.418**	-0.437**	0.055	0.016	0.533**	0.503**
	G										1.000	0.341**	0.581**	0.482**	-0.564**	0.117	0.041	0.590**	0.553**
Seed cavity width (cm)	P											1.000	0.750**	0.692**	-0.596**	-0.112	0.035	0.742**	0.561**
	G											1.000	0.729**	0.684**	-0.583**	-0.007	0.106	0.742**	0.633**
Seed cavity length (cm)	P												1.000	0.788**	-0.615**	-0.133	-0.045	0.890**	0.793**
	G												1.000	0.791**	-0.597**	-0.019	0.020	0.902**	0.890**
TSS (°Brix)	P													1.000	-0.614**	-0.037	0.067	0.891**	0.724**
	G													1.000	-0.586**	0.149	0.172	0.832**	0.837**
Number of fruits per vine	P														1.000	0.712**	0.146	-0.713**	-0.345**
	G														1.000	-0.063	0.020	-0.751**	-0.502**
Vine length (cm)	P															1.000	0.877*	-0.043	0.137
	G															1.000	0.924*	0.038	0.113
Number of primary branches per vine	P																1.000	0.037	0.203*
	G																1.000	0.084	0.180
100 Seed weight (g/fruit)	P																	1.000	0.855**
	G																	1.000	0.919**

* Significant at 5 per cent level; ** Significant at 1 per cent level

Table 2. Direct and indirect effects of component characters on fruit yield in 46 genotypes of oriental pickling melon

Characters		Node number of first male flower	Days to first male flower	Node number of first female flower	Days to first female flower	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Flesh thickness (cm)	Placenta weightper fruit (g)	Days to first fruit harvest	Seed cavity width (cm)	Seed cavity length (cm)	TSS (°Brix)	No. of fruits per vine	Vine length (cm)	Number of primary branches per vine	100 seed weight(g)	Fruit yield per vine (kg)
Node number of first male flower	P	-0.0273	0.0029	0.0033	0.0000	0.0029	0.0017	-0.0002	-0.0007	0.0033	0.0020	-0.0001	0.0015	0.0024	-0.0019	-0.0035	0.0023	0.0023	0.1320
	G	-0.1249	0.0168	0.0089	0.0106	0.0264	0.0151	-0.0012	-0.0067	0.0286	0.0219	-0.0034	0.0098	0.0216	-0.0180	-0.0162	0.0112	0.0101	0.2711
Days to first male flower	P	0.0182	-0.0287	0.0065	0.0021	0.0028	0.0029	0.0002	0.0004	0.0033	-0.0036	0.0019	0.0032	0.0030	-0.0017	-0.0015	0.0011	0.0022	0.1301
	G	0.2121	-0.2423	0.0349	0.0087	-0.0489	-0.0519	-0.0190	-0.0121	-0.0565	0.0470	-0.0301	-0.0477	-0.0543	0.0433	0.0124	0.0190	-0.0155	0.1608
Node number of first female flower	P	0.0017	0.0106	-0.1631	-0.1532	-0.1037	-0.0919	-0.0780	-0.0875	-0.1026	-0.1554	-0.0574	-0.0902	-0.0783	0.0849	-0.0172	-0.0097	-0.1123	0.5643
	G	0.0075	0.0272	-0.1890	-0.2019	-0.1287	-0.1173	-0.1055	-0.1082	-0.1255	-0.1847	-0.0711	-0.1136	-0.0987	0.1191	-0.0353	-0.0165	-0.1251	0.6087
Days to first female flower	P	0.0000	-0.0060	0.0643	0.0685	0.0355	0.0302	0.0264	0.0285	0.0354	0.0636	0.0167	0.0297	0.0265	-0.0299	0.0069	0.0034	0.0345	0.4706
	G	-0.0024	-0.0082	0.0548	0.0513	0.0365	0.0324	0.0292	0.0298	0.0358	0.0514	0.0171	0.0310	0.0280	-0.0363	0.0138	0.0061	0.0353	0.6192
Fruit weight (g)	P	0.0756	0.0830	0.4501	0.3665	0.7082	0.6603	0.5660	0.6242	0.6725	0.3910	0.5314	0.6479	0.5908	-0.5212	-0.0391	0.0183	0.6923	0.8563
	G	0.0005	0.0009	0.0030	0.0032	0.0045	0.0042	0.0036	0.0039	0.0043	0.0028	0.0033	0.0041	0.0037	-0.0033	0.0004	0.0004	0.0044	0.9403
Fruit length (cm)	P	-0.0135	-0.0262	-0.1211	-0.0947	-0.2005	-0.2150	-0.1797	-0.1909	-0.1903	-0.1112	-0.1620	-0.2101	-0.1754	0.1326	0.0316	0.0128	-0.1940	0.8099
	G	0.0083	0.0263	0.0762	0.0776	0.1148	0.1227	0.1014	0.1096	0.1100	0.0740	0.0909	0.1213	0.0993	-0.0691	0.0006	0.0035	0.1126	0.9350
Fruit girth (cm)	P	0.0010	-0.0012	-0.0584	-0.0470	-0.0976	-0.1021	-0.1221	-0.1014	-0.0896	-0.0501	-0.0752	-0.0972	-0.0975	0.0647	-0.0036	-0.0146	-0.0956	-0.6911
	G	0.0010	-0.0146	-0.1039	-0.1058	-0.1514	-0.1538	-0.1861	-0.1606	-0.1422	-0.0941	-0.1112	-0.1505	-0.1500	0.0767	-0.0662	-0.0550	-0.1538	0.8821
Flesh thickness (cm)	P	-0.0028	0.0017	0.0576	0.0447	0.0947	0.0953	0.0892	0.1074	0.0904	0.0500	0.0699	0.0891	0.0848	-0.0592	-0.0075	-0.0005	0.0918	0.8043
	G	-0.0018	0.0030	0.0339	0.0344	0.0522	0.0529	0.0510	0.0592	0.0498	0.0311	0.0379	0.0494	0.0471	-0.0316	0.0024	0.0036	0.0507	0.8854
Placenta weightper fruit (g)	P	0.0183	0.0222	0.1007	0.0826	0.1519	0.1415	0.1174	0.1346	0.1599	0.0881	0.1112	0.1368	0.1175	-0.1091	-0.0037	0.0014	0.1446	0.8275
	G	0.0562	0.1031	0.2934	0.3087	0.4219	0.3960	0.3376	0.3723	0.4420	0.2685	0.3052	0.3822	0.3273	-0.3140	0.0332	0.0262	0.4006	0.8967
Days to first fruit harvest	P	-0.0100	-0.0204	0.1294	0.1261	0.0750	0.0703	0.0557	0.0633	0.0749	0.1359	0.0413	0.0696	0.0569	-0.0594	0.0076	0.0022	0.0725	0.5036
	G	-0.0058	-0.0116	0.0585	0.0599	0.0371	0.0361	0.0303	0.0315	0.0364	0.0599	0.0204	0.0348	0.0289	-0.0338	0.0070	0.0025	0.0354	0.5531
Seed cavity width (cm)	P	0.0005	-0.0090	-0.0388	-0.0268	-0.0827	-0.0830	-0.0678	-0.0717	-0.0766	-0.0335	-0.1101	-0.0827	-0.0762	-0.0657	0.0124	-0.0039	-0.0818	0.5613
	G	0.0021	-0.0173	-0.0524	-0.0463	-0.1032	-0.1031	-0.0832	-0.0892	-0.0962	-0.0475	-0.1393	-0.1016	-0.0953	0.0813	0.0011	-0.0148	-0.1035	0.6336
Seed cavity length (cm)	P	0.0078	0.0194	0.0786	0.0615	0.1299	0.1388	0.1131	0.1178	0.1215	0.0728	0.1066	0.1420	0.1119	-0.0875	-0.0189	-0.0065	0.1264	0.7931
	G	0.0054	0.0245	0.0747	0.0750	0.1143	0.1228	0.1004	0.1037	0.1075	0.0722	0.0907	0.1243	0.0983	-0.0743	-0.0025	0.0025	0.1121	0.8907
TSS (°Brix)	P	0.0112	0.0161	0.0606	0.0488	0.1053	0.1029	0.1008	0.0997	0.0927	0.0528	0.0873	0.0994	0.1262	-0.0775	-0.0048	0.0085	0.1034	0.7249
	G	0.0248	0.0568	0.1347	0.1407	0.2157	0.2087	0.2078	0.2053	0.1910	0.1244	0.1764	0.2041	0.2579	-0.1513	0.0384	0.0444	0.2146	0.8379
No. of fruits per vine	P	-0.0395	-0.0412	-0.2972	-0.2493	-0.4199	-0.3520	-0.3023	-0.3144	-0.3892	-0.2496	-0.3404	-0.3514	-0.3505	0.5705	0.0984	0.0834	-0.4072	-0.3458
	G	-0.0326	-0.0727	-0.2562	-0.2874	-0.3036	-0.2291	-0.1675	-0.2168	-0.2889	-0.2295	-0.2373	-0.2431	-0.2385	0.4067	-0.0257	0.0084	-0.3058	-0.5025
Vine length (cm)	P	-0.0099	-0.0048	0.0080	0.0077	-0.0042	-0.0112	0.0023	-0.0053	-0.0017	0.0042	-0.0086	-0.0101	-0.0029	0.0131	0.0759	0.0666	-0.0033	0.1379
	G	-0.0086	-0.0061	0.0224	0.0322	0.0096	0.0006	0.0426	0.0048	0.0090	0.0140	-0.0009	-0.0024	0.0178	-0.0076	0.1197	0.1106	0.0046	0.1133
Number of primary branches per vine	P	-0.0031	-0.0014	0.0017	0.0014	0.0007	-0.0017	0.0035	-0.0001	0.0003	0.0005	0.0010	-0.0013	0.0019	0.0042	0.0254	0.0289	0.0011	0.2037
	G	-0.0005	-0.0004	0.0005	0.0006	0.0005	0.0002	0.0016	0.0003	0.0003	0.0002	0.0006	0.0001	0.0009	0.0001	0.0051	0.0055	0.0005	0.1803
100 seed weight(g)	P	0.0393	0.0426	0.2937	0.2359	0.4579	0.4227	0.3669	0.4005	0.4235	0.2499	0.3478	0.4169	0.3836	-0.3342	-0.0206	-0.0174	0.4684	0.8552
	G	0.0582	0.0955	0.4320	0.4490	0.6425	0.5986	0.5390	0.5585	0.5913	0.3853	0.4845	0.5884	0.5428	-0.4905	0.0253	0.0550	0.6523	0.9195

Phenotypic Residual effect = 0.2376; Genotypic Residual effect=0.0943; Diagonal (under lined) values indicate direct effects G : Genotypic P : Phenotypic

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PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF RAJASRI BIRDS REARED UNDER DIFFERENT SYSTEMS OF MANAGEMENT

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ABSTRACT

A study was conducted during the year 2010- 11 to evaluate the productive and reproductive performance of Rajasri, a backyard poultry variety At seven weeks of age 500 birds were randomly distributed into five treatment groups with four replicates having 20 Female and 5 Males in each group and reared under different systems of management. The mean hen day production was significantly (P<0.05) better with control group (54.07%) and least with 20% and 40% *ad lib.* (20.93 and 27.13%) groups. Scavenging at farmer's backyard resulted in 35.83% and at farm it was less (32.47%). The egg weights ranged between 50.41 and 53.87 grams.There were no significant differences among treatment groups for egg quality parameters except yolk colour. The control group recorded the least (88.42%) fertility, while SI-20%, SI-40%, SC-F and SC recorded 94.86, 94.71, 93.62 and 93.43 percent fertility respectively. The hatchability on TES was significantly (P<0.05) least with control group (80.86%), while better in SI-20% (88.92%) followed by SC (88.38%), SI-40% (87.73%) and SC-F (84.99%) groups respectively than control.

Modern poultry production is rapidly progressing towards vertical integration. The scale of operations of poultry farms has gone up. The number of small and marginal poultry farms both in urban and rural areas is reducing and availability of country chicken is gradually coming down. Further, after commercialization of poultry production, the trend and availability of eggs and chicken meat was completely reversed. As a result about 75 percent of total poultry produce is available for 25 percent of country's population residing in urban / semi urban areas (Prasad, 2004). These two vital aspects have provided an excellent base for production of backyard poultry suitable for backyard rearing. Accordingly, certain varieties were developed but they are crosses of one /two/three breeds.However, employing RIR, WLH, DR and Non-descript native breeds, a four breed backcross with 25% native inheritance (Rajasri) was developed for backyard rearing. Present study was under taken to evaluate the productive and reproductive performance of Rajasri birds reared under different systems of management.

MATERIAL AND METHODS

Five hundred one day old chicks were reared up to 6 weeks of age in the intensive system, at seven weeks of age birds were randomly distributed into five treatment groups with four replicates having 20 Female and five Males in each group. The control group was reared under intensive system offering *ad lib.* feed, while second and third groups were maintained under semi intensive system providing 20 (SI-20%) and 40 percent (SI-40%) of *ad lib.* feed respectively. The remaining two treatment groups were reared under scavenging, one group at farm (SC-F) and the other at farmer's backyard (SC).

Egg production was recorded up to 52 weeks, divided in to 10 laying periods of 28 days each. Percent Hen day (HD) egg production was calculated for each treatment (Table 1). The egg weight was recorded to nearest one gram accuracy in each of the replicate, the average weight of all the eggs during the last two consecutive days of each laying period was taken as average egg weight of each treatment group. Haugh Unit Score of all the eggs was calculated according to the formula given by Haugh (1937). The shell weight was recorded after drying in hot air oven at 105 ^{0}F for 6 hours. The shell membranes were peeled out from the shell, the observations were recorded nearest to 0.1g accuracy and expressed as percent shell. From the dried shell the thickness was measured using Mitutoyo dial gauge meter, to an accuracy of 0.01mm. The values were measured at three places viz., middle, narrow and broad ends and expressed in millimetres. The fertility and hatchability was recorded during 44, 48 and 52 weeks of age.

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RESULTS AND DISCUSSION

The best mean percent hen day production (Table 1) was recorded with *ad lib.* group (54.07) compared to other groups because the birds were fed *ad lib*. with layer mash. The data of Shawkat Ali *et al*. (2002) have shown that egg production was significantly higher in *ad lib.* fed birds than 30 and 60g supplementation with scavenging and scavenging alone.

The mean egg weights were significantly (P<0.05) influenced by treatment groups, the highest mean egg weight (53.87g) was recorded with control group (Table 2), while significantly least mean egg weight (50.41 g) was recorded on backyard farming (scavenging) which was statistically comparable to scavenging on farm (51.38g) and 20% *ad lib*. group (51.49g). The results of this study also followed similar trend as reported by Shawkat Ali *et al.,* (2002) who observed significantly least egg weight (45.3g) on scavenging birds when compare to *ad lib*. (47.5 g), 60g (46.0) and 30g (46.0) with semi scavenging condition.Similar results were also reported by Wani *et al.* (2007).Significantly highest Haugh unit score (88), was seen with scavenging at back yard followed by 20% supplement and scavenging at farm and lowest scores are recorded in control group and 40% supplemental group. Similarly, Shawkat Ali *et al*. (2002) observed Haugh Unit Score to be 88 in *ad lib*. while fully scavenging and 60 and 30 g supplementation 84.4 and 88.6, whereas in this study at 20 and 40 % supplemental groups the scores were 87 and 84, respectively. In contrary, Wani *et al*. (2007) reported that the Haugh Unit Score of backyard birds as 77.40, while for intensive 83.38, which is quite reverse. The highest Albumin index value (0.091) was recorded on scavenging at farmer's backyard, while significantly least value was seen with control (0.084).There were no significant difference between 20 and 40% feed supplemental groups (0.085 and 0.086) and 40% supplement and scavenging at farm groups (0.086 and 0.087). These values are comparable to the findings of Wani *et al*., (2007).

Table 1. Hen day egg production (%)of Rajasri from 20 to 60 weeks of age

Trts	Laying periods (28 days each)										Treatment mean
	1	2	3	4	5	6	7	8	9	10	
Control	35.60 ^{a}	68.14 ^{a}	58.76 ^{a}	50.95 ^{a}	58.04 ^{a}	58.75 ^{a}	64.11 ^{a}	50.48 ^{b}	44.35 ^{a}	51.49 ^{a}	**54.07 ^{a}**
SI-20%	0.00	2.79 ^{c}	27.90 ^{c}	32.88 ^{c}	21.13 ^{b}	28.44 ^{d}	32.08 ^{d}	22.89 ^{e}	22.26 ^{c}	18.92 ^{e}	**20.93 ^{e}**
SI-40%	0.00	3.46 ^{c}	36.05 ^{b}	37.85 ^{b}	35.34 ^{c}	36.26 ^{c}	41.69 ^{bc}	29.03 ^{d}	27.52 ^{c}	24.11 ^{d}	**27.13 ^{d}**
SC-F	0.00	22.54 ^{b}	32.76 ^{b}	29.39 ^{dc}	37.18 ^{c}	37.45 ^{c}	38.95 ^{c}	47.80 ^{c}	37.68 ^{b}	40.94 ^{c}	**32.47 ^{c}**
SC	0.25 ^{b}	27.45 ^{b}	37.00 ^{b}	28.49 ^{d}	40.45 ^{d}	40.66 ^{b}	43.43 ^{b}	54.09 ^{a}	41.20 ^{ab}	45.22 ^{b}	**35.83 ^{b}**
SEM	3.263	5.563	2.516	1.960	2.740	2.339	2.525	2.872	2.070	2.911	**2.603**
P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**

Means in a column not sharing a common superscript differ significantly (P<0.005)

Table 2. The Mean Egg weight (g), Haugh unit score, Albumin Index, Percent shell, Shell thickness, Yolk Index and Yolk color of Rajasri during 40–60 weeks of age

Trts	Egg production	Egg weight (g)	Haugh unit score	Albumin Index	Percent shell	Shell thickness	Yolk Index	Yolk color
CON	54.07^{a}	53.87 ^{a}	84^{c}	0.084^{d}	9.70	0.348	0.355	3.69^{e}
SI-20%	20.93^{e}	51.49^{bc}	87^{b}	0.085^{cd}	9.49	0.360	0.353	6.00^{d}
SI-40%	27.13^{d}	52.41^{b}	84^{c}	0.086^{bc}	9.51	0.355	0.344	7.38^{c}
SC-F	32.47^{c}	51.38^{bc}	87^{b}	0.087^{b}	9.58	0.358	0.358	8.00^{b}
SC	35.83^{b}	50.41^{c}	88^{a}	0.091^{a}	9.70	0.353	0.367	9.06^{a}
SEM	2.603	0.31	0.35	0.001	0.070	0.003	0.001	0.43
P	0.000	0.000	0.000	0.000	0.907	0.001	0.079	0.00

Means in a column not sharing a common superscript differ significantly (P<0.005)

Yolk Index was not significantly (P<0.05) influenced by the treatment groups, while yolk colour was significantly (P<0.05) different for all the treatment groups and the best value (9.06) was recorded with scavenging at farmers backyard followed by scavenging at farm (8.00). In 40 and 20 % *ad lib*. groups the yolk colour was 7.38 and 6.00, respectively. However, the least yolk colour (3.69) was observed with control diet at intensive system of rearing. Similar results have also been reported by Shawkat Ali *et al*., (2002) and Mahbubur Rashid *et al.,* (2004).

The mean percent shell values were not significantly (P<0.05) influenced by different treatments (Table 2).However, the mean shell thickness was significantly (P<0.05) influenced by the treatments being significantly least (0.348) for control group which was also comparable (0.353) to scavenging group. Rest of the treatment groups gave similar shell percent values 0.360, 0.355 and 0.358 for SI-20%, SI-40% and SC-F, respectively. The data of Shawkat Ali *et al*.,(2002) indicate significantly least (0.314 mm) with scavenging than *ad lib*. (0.339 mm) and partly fed groups (0.315 and 0.310 mm), respectively.

The control group recorded significantly low (88.42%) mean fertility, compared to other groups (Table 3).Among different age groups there were no significant differences in percent fertility.The mean hatchability TES was significantly (P<0.05) least with control group (80.86), which is statistically comparable with scavenging (84.99%) group (Table 4). Significantly better mean hatchability (Total Eggs Set -TES) was observed with 20% of *ad lib* (88.92%), scavenging at backyard (88.38%) and 40% of *ad lib* (87.73%) than control, respectively. Treatment groups could not exert any significant (P<0.05) effect on the mean hatchability on fertile eggs set (FES).Similarly, Singh (2005) recorded better percent fertility and hatchability with CARI Nirbheek, CARI Shyama, Upcari and Hitcari cross bred chicken reared under farm conditions. However, among the age groups there were significant difference at 40 weeks of age only for percent hatchability on TES and FES, where significantly (P<0.05) lower values were recorded on control groups. Almost similar trend was noticed with rest of the age groups with minor variations where the values ranged from 90.89 to 94.56.

It could be concluded that egg weights recorded in this study were in ideal range, eggs produced from the scavenging group had significant differences in their quality with marginal variations with other treatment groups. However, increased yolk colour score definitely improved the form appeal to the consumers. Fertility was better in scavenging groups, indicated instinct for mating under natural environmental conditions than under captive system i.e., intensive.The percent hatchability both in TES and FES with Rajasri is fairly high, comparable to or better than other backyard birds.

Table 3. Percent fertility at 44, 48 and 52 weeks of age for different treatment groups of four breed backcross with 25% of native inheritance

Trts	44 weeks	48 weeks	52 weeks	Treatment mean
CON	88.14	88.87	88.26	**88.42^{b}**
SI-20%	93.52	99.12	91.93	**94.86^{a}**
SI-40%	92.11	96.50	95.53	**94.71^{a}**
SC-F	90.98	95.02	94.86	**93.62^{a}**
SC	90.53	96.52	93.23	**93.43^{a}**
SEM	0.655	0.121	0.897	**0.736**
P	0.095	0.064	0.059	**0.014**

Means in a columns not sharing a common superscript differ significantly (P<0.005)

Table 4. Percent hatchability at 44, 48 and 52 weeks of age for different treatment groups of four breed backcross with 25% of native inheritance

Treat.	Hatchability (TES)			Treat.	Hatchability (FES)			Treat.
	44 wks	48 wks	52 wks	mean	44 wks	48 wks	52 wks	mean
CON	74.13[b]	85.58	82.87	**80.86[b]**	84.10[c]	96.38	93.89	**91.46**
SI-20%	87.96[a]	92.81	85.97	**88.92[a]**	94.04[a]	93.66	93.57	**93.76**
SI-40%	83.29[a]	90.87	89.01	**87.73[a]**	90.26[b]	94.19	93.11	**92.57**
SC-F	82.95[a]	88.65	85.94	**84.99[ab]**	91.18[ab]	93.85	90.66	**90.89**
SC	83.77[a]	89.57	91.80	**88.38[a]**	92.55[ab]	92.73	98.39	**94.56**
SEm	1.217	1.068	1.491	**1.124**	0.900	0.844	1.345	**0.656**
P	**0.000**	**0.135**	**0.413**	**0.037**	**0.000**	**0.346**	**0.522**	**0.384**

Means in a columns not sharing a common superscript differ significantly (P<0.005)

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Research Note
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RESPONSE OF *RABI* PIGEONPEA (*Cajanus cajan* (L) Millsp) TO DIFFERENT DRIP NUTRIGATION LEVELS

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Raising pigeonpea during winter (*rabi*) season with assured irrigation can provide more stability in production and higher productivity. As water and fertilizers are limiting and costly inputs, its judicious use and application method needs special attention for maximizing pigeonpea yield per unit quantity of applied water and fertilizers.

The field experiment was carried out at Water Technology Centre, College Farm, Rajendranagar, Hyderabad during *rabi*, 2012 to study the effect of different nutrigation levels on growth and yield of pigeonpea under surface drip irrigation. The experiment was laid out in randomized block design with 3 replications and 8 treatments viz., T_1 (drip nutrigation of 100 % N + 50 % P_2O_5 ha^{-1}), T_2 (drip nutrigation of 80 % N + 50 % P_2O_5 ha^{-1}), T_3 (drip nutrigation of 60 % N + 50 % P_2O_5 ha^{-1}), T_4 (drip nutrigation of 100 % N + 100 % P_2O_5 ha^{-1}), T_5 (drip nutrigation of 80 % N + 100 % P_2O_5 ha^{-1}), T_6 (drip nutrigation of 60 % N + 100 % P_2O_5 ha^{-1}), T_7 (drip irrigation with 100 % RDF in conventional method) and T_8 (furrow irrigation at 0.8 IW /CPE with 100 % RDF in conventional method). The irrigation to T_1 to T_7 treatments was scheduled at 0.8 E_{pan}. The recommended dose of fertilizer (RDF) was 40, 50 and 20 kg N, P_2O_5 and K_2O ha^{-1}, respectively. The ½ N, total P_2O_5 and K_2O of RDF was applied as basal and remaining ½ N was applied 20 days after sowing (DAS) for T_7 and T_8 treatments through urea, di-ammonium phosphate and muriate of potash fertilizers.For treatments T_1 to T_6, total K_2O was applied as basal and N & P_2O_5 was applied as nutrigation in 12 splits (one split during establishment at 14 DAS, 7 splits during vegetative stage from 27 DAS to 71 DAS, 3 splits during flowering from 78 to 95 DAS, one at pod development at 112 DAS) through urea and mono ammonium phosphate. The soil was sandy clay, moderately alkaline in reaction, non saline, medium in available nitrogen and potassium and high in available phosphorous. The irrigation water was moderately alkaline (pH-8.51), Class II (C_4S_1) without any residual alkalinity problem. Pigeonpea variety – PRG - 158 was sown on 5th October 2012 by adopting a spacing of 0.6 m between the rows and 0.1 m between the plants within a row to maintain a desired plant population of 1,66, 666 plants ha^{-1}. Irrigations were scheduled based on the USWB Class A pan evaporation rates (0.8 replenishment factor) for treatments under drip irrigation and the calculated irrigation water was delivered in surface irrigation treatment plot directly using a water meter and a flexible pipe. Total precipitation received during the cropping period was only 109.8 mm.

There was no significant difference in plant height, branches $plant^{-1}$, test weight and seeds pod^{-1} of *rabi* pigeonpea due to different levels of N & P_2O_5 nutrigation, drip irrigation and furrow irrigation treatments. Similar results of non significant difference in branches $plant^{-1}$ due to increase in fertilizer dose was reported by Meena (2010) and Rajneesh Pandey and Kushwaha (2009).Similar results of non significant differences in seeds pod^{-1} were reported by Singh (2007) and Ansari and Rana (2012).Leaf area index (LAI) was significantly influenced by different treatments of drip nutrigation and application of 100 % RDF (T_8) in conventional method under furrow irrigation recorded significantly higher over all other treatments. Significantly lower LAI was recorded with application of 60% N with 50% P_2O_5 (T_3) at harvest over rest of the treatments (Table 1). Significantly higher LAI over under furrow irrigation may be due to more availability of water during early stages to the plant which produced more leaves, there by recorded higher leaf area index. Significantly higher LAI due to drip nutrigation of 100% N with 50 or 100% P_2O_5 compared to other drip

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Table 1. Growth, yield attributing characters and yield of *rabi* pigeonpea under different levels of drip nutrigation

Treatment details	Plant height (cm)	LAI	Branches plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	100 seed weight (g)	Yield (kg ha^{-1})	Total dry matter (kg ha^{-1})	Harvest index (%)
T_1 - 100 % N + 50 % P_2O_5 by drip nutrigation	82.5	2.53	8.6	76.5	3.8	13.0	756	4965	15.36
T_2 - 80 % N + 50 % P_2O_5 by drip nutrigation	80.3	2.44	7.7	73.1	3.8	12.0	681	4080	16.73
T_3 - 60 % N + 50 % P_2O_5 by drip nutrigation	79.3	2.29	7.6	70.8	3.8	11.0	645	3334	19.38
T_4 - 100 % N + 100 % P_2O_5 by drip nutrigation	81.4	2.72	9.5	77.9	3.8	14.0	772	5389	14.72
T_5 - 80 % N + 100 % P_2O_5 by drip nutrigation	80.6	2.61	8.8	75.2	3.8	13.0	735	4214	17.45
T_6 - 60 % N + 100 % P_2O_5 by drip nutrigation	78.2	2.50	7.9	70.7	3.8	12.3	663	3636	18.25
T_7 - 100 % RDF - conventional method with	80.5	2.56	7.6	70.2	3.6	13.7	590	3921	15.10
drip irrigation									
T_8 – 100 % RDF - conventional method with	83.9	2.93	7.3	61.8	3.9	11.7	515	2523	20.54
furrow irrigation									
SEm±	2.2	0.10	0.5	2.2	0.1	0.6	20	247	1.07
CD at 5 %	NS	0.20	NS	6.7	NS	NS	61	752	3.25
CV (%)	4.9	3.7	11.1	5.3	4.1	8.7	5	11	10.80

nutrigation treatments may be due to better N and P_2O_5 nutrients availability and absorption by the plants due to none accurate and uniform supply of specified nutrient with these drip nutrigation treatments during crop growth period which produced more leaves resulting in higher LAI in these treatments. Similar findings were reported by Singh and Singh (2012).

Significantly more number of pods plant^{-1} (77.9) were recorded with drip nutrigation of 100 % N + 100 % P_2O_5 (T_4) over 60 % N with 50 % (T_3) or 100 % P_2O_5 (T_6) and application of 100 % RDF in conventional method under drip irrigation (T_7) and was on par with drip nutrigation of 100 % N (T_1) or 80% N (T_2) with 50 % P_2O_5 and 80 % N + 100 % P_2O_5 (T_5).The higher number of pods with drip nutrigation at higher dose of nutrients may be due to availability of sufficient nitrogen and phosphorus nutrients to meet the crop requirement resulted in enhanced photosynthetic activity due to higher leaf area index and better translocation of assimilates from source to sink (floral parts). Furrow irrigation with 100 % RDF (T_8) recorded significantly lower number of pods plant^{-1} (61.8) than all other treatments may be due to leaching of nutrients and moisture variations between two successive irrigations (Parmodh Sharma *et al.*, 2012) with lower uptake of nutrients. Similar results were reported by Goud and Kale (2010) and Ansari and Rana (2012).

Significantly higher seed yield (772 kg ha^{-1}) and total dry matter (5389 kg ha^{-1}) of *rabi* pigeonpea was recorded with drip nutrigation of 100 % (40 kg ha^{-1}) N + 100 % P_2O_5 (50 kg ha^{-1}) and was on par with 100 % N + 50 % P_2O_5 (T_1) and 80 % N + 100 % P_2O_5 (T_5). These treatments were significantly higher over 80 % or 60 % N with 50 % P_2O_5, 60 % N + 100 % P_2O_5, application of 100 % RDF (40:50:20 kg N, P_2O_5 & K_2O ha^{-1}) in conventional method either under drip or furrow irrigation. Significantly lower seed yield (515 kg ha^{-1}) and total dry matter (2523 kg ha^{-1}) was recorded with 100 % RDF in conventional method with furrow irrigation (T_8) (Table 1).The increased yield under drip irrigation may be due to uniform availability of water during crop growth as the soil moisture is being maintained at field capacity, which resulted in better growth and yield attributes, contributed to higher yields. While in furrow irrigation the soil moisture variation between two successive irrigations made the plant to extract water difficult with every passing day since progressive decrease in soil water content increases soil moisture tension and this decrease in soil water potential and wide fluctuations in soil moisture owing to longer irrigation interval in furrow irrigation (8-10 days) compared to drip (2-3 days) affected the crop growth, development and yield attributing characters resulting in reduced crop yield (Mahalakshmi *et al.,* 2011). Balanced fertilization under drip nutrigation treatments improved the nutrient availability resulting in greater uptake which might have increased the photosynthesis and translocated photosynthates to different parts and uniform availability of moisture under drip nutrigation treatments than furrow irrigation treatment (T_8) aided the crop plants to put forth more canopy growth and resulted in higher plant height and LAI and in turn improved performance over other treatments in terms of more number of pods plant^{-1}, seeds pod^{-1} and pod weight plant^{-1} (Goud and Kale, 2010).This improved performance of plants resulted in higher yield and dry matter. Yield under furrow irrigation was statistically inferior to drip nutrigation and drip irrigation treatments (T_1 to T_7). The similar increase in yield with increase in fertilizer dose was also reported by Singh (2007) and Rajneesh Pandey and Kushwaha (2009).

Harvest index (HI) of *rabi* pigeonpea (20.54%) recorded with 100 % RDF in conventional method under furrow irrigation (T_8) was on par with drip nutrigation of 60 % N with 50 % P_2O_5 (T_3), or 100 % P_2O_5 (T_6) and 80% N with 100% P_2O_5 (T_5) and was significantly higher over other drip nutrigation and RDF applied in convention method under drip irrigation treatments (Table 1).Significantly lower HI was recorded by drip fertigation with 100% N + 100% P_2O_5 (T_4) and was on par with other drip nutrigation treatments except nutrigation of 60% N with 50 or 100% P_2O_5 (T_3 and T_5). However, Devendra Mahatele and Kushwaha (2011) and Deshbhratar *et al.* (2010) reported significant increase in HI with increase in fertilizer dose.

The results of present study indicated that higher yields of *rabi* pigeonpea can be achieved by drip nutrigation of 80 or 100 % N and 100% P_2O_5 @ 40:50 kg ha^{-1} respectively, followed by 100 % N and 50% P_2O_5 with 20 kg ha^{-1} K_2O as basal in soils with high available phosphorus.

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Research Note
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ASSESSMENT OF VARIABILITY FOR GRAIN YIELD AND QUALITY CHARACTERS IN RICE (*Oryza sativa* L.)

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India has the largest area under rice in the world and ranks second in production. Therefore, intensive efforts are needed to improve grain yield and quality in rice. In this context, critical assessment of the nature and magnitude of genetic variability present for grain quality characters in addition to yield is one of the pre-requisites in formulation of effective breeding strategies aimed at improvement of yield and quality. Hence, in the present investigation, attempts have been made to estimate genetic variability for various grain quality characters besides grain yield.

A field experiment was conducted during *Kharif,* 2013 at College Farm, Mahanandi, Acharya N G Ranga Agricultural University with 25 rice varieties in a randomized block design with three replications. All recommended practices were adopted to raise a healthy crop. Observations were recorded on grain yield per plant and the quality parameters, namely, hulling percent, milling percent, head rice recovery, kernel length, kernel breadth, kernel L/B ratio, kernel elongation ratio, kernel length after cooking, water uptake, volume expansion ratio, alkali spreading value, gel consistency, amylose content as per the standard procedure. Genotypic and phenotypic co-efficients of variation were calculated as per the formulae proposed by Burton (1952) and estimates of heritability in broad sense [$h^2_{(b)}$] and genetic advance were calculated by the formulae given by Lush (1940).

The analysis of variance (ANOVA) revealed highly significant differences among all the twenty-five rice varieties for all the characters indicating the existence of sufficient variation in the materials. A detailed analysis of the results on *per se* performance of yield and quality characters of the rice varieties studied in the present investigation revealed NLR 34449 to be high yielding (23.59 g) with high head rice recovery (69.00), in addition to intermediate amylose content (20.78) and desirable alkali spreading value (4.97), gel consistency (36.00) and volume expansion ratio (4.69) along with kernel length after cooking (8.80) and water uptake (118.50) on par with BPT 5204 (Table 1). Further, RNR 15048 had also recorded high grain yield (21.96), head rice recovery (62.00), kernel length after cooking (9.60) and water uptake (161.67), compared to BPT 5204 in addition to desirable kernel elongation ratio (2.14), volume expansion ratio (4.27), alkali spreading value (4.00), gel consistency (30.33) and amylose content (20.62) quality parameters.JGL 19621 was also noticed to be high yielding (21.85) with high head rice recovery (61.33), compared to BPT 5204, in addition to intermediate amylose content (20.60) along with desirable gel consistency (41.33). Further, water uptake (128.33), volume expansion ratio (4.25), kernel elongation ratio (1.78) and kernel length after cooking (9.13) values for the variety were noticed to be on par with BPT 5204. Similarly, JGL 11470 was noticed to possess high yield (20.13), head rice recovery (67.00) and water uptake (140.00), compared to BPT 5204, in addition to intermediate amylose content (20.01), kernel length after cooking (9.00) and volume expansion ratio (4.97) on par with BPT 5204. The alkali spreading value (4.80) and gel consistency (38.33) values were also noticed to be in the desirable range of Indian consumer preference. In addition, JGL 11727 had also recorded high grain yield (20.27), head rice recovery (63.67), kernel length after cooking (10.80), volume expansion ratio (6.26) and water uptake (141.67) along with intermediate amylose content (20.21), desirable gel consistency (40.50) and kernel elongation ratio (1.89) values. The above varieties (NLR 34449, RNR 15048, JGL 19621, JGL 11470 and JGL 11727) are therefore identified as promising varieties with high yield potential and good quality in the scarce rainfall zone of Andhra Pradesh.

A perusal of these results revealed wide range of variability for water uptake followed by gel consistency and head rice recovery (Table 2). Further, high (>20%) estimates of genotypic and phenotypic co-efficient of variation were also recorded for water

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Table 1. Mean performance of rice varieties for yield and quality characters

Variety	Grain yield per plant (g)	Hulling per cent (%)	Milling Per cent (%)	Head rice recovery (%)	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Kernel length after cooking (mm)	Kernel elongation ratio	Volume expansion ratio	Water uptake (ml)	Alkali spreading value	Gel consistency (mm)	Amylose content (%)
BPT 2295	19.96	78.33	71.00	66.67	5.23	1.90	2.75	9.53	1.82	5.27	153.33	5.07	33.00	22.18
BPT 3291	18.75	78.33	69.67	64.33	5.64	2.04	2.76	9.00	1.60	4.41	111.83	2.87	44.67	20.59
BPT 5204	18.14	75.10	65.80	58.40	4.75	1.77	2.68	8.78	1.85	4.99	125.50	3.57	22.33	23.58
JGL 384	18.56	77.60	70.63	56.92	5.37	1.68	3.19	8.75	1.63	4.44	215.70	4.33	43.70	20.53
JGL 1798	17.63	76.60	71.50	60.89	5.05	1.90	2.66	8.65	1.71	3.92	176.97	4.17	53.67	19.79
JGL 3855	18.58	80.67	71.67	66.33	5.24	1.80	2.91	8.73	1.67	4.16	143.33	5.00	23.50	19.18
JGL 11118	18.67	77.67	70.00	65.67	5.63	1.83	3.08	10.07	1.79	4.42	208.33	7.00	34.33	17.81
JGL 11470	20.13	80.33	73.00	67.00	5.36	1.86	2.88	9.00	1.68	4.97	140.00	4.80	38.33	20.01
JGL 11727	20.27	78.67	69.67	63.67	5.71	1.82	3.14	10.80	1.89	6.26	141.67	2.20	40.50	20.21
JGL 19621	21.85	79.00	71.67	61.33	5.14	1.85	2.78	9.13	1.78	4.25	128.33	3.53	41.33	20.60
NDLR 7	18.63	78.67	71.33	65.00	5.33	1.84	2.89	9.07	1.70	4.86	145.00	4.20	26.67	18.85
NDLR 8	19.82	79.33	71.33	64.00	5.28	1.78	2.96	9.07	1.72	4.98	158.33	4.13	44.17	21.58
NLR 145	18.93	78.33	71.00	61.67	6.39	2.22	2.88	9.47	1.48	4.87	115.17	3.37	43.17	21.62
NLR 3042	19.65	78.00	70.33	61.33	5.08	2.22	2.29	9.53	1.88	5.05	130.17	3.00	41.17	22.85
NLR 3083	20.51	77.67	72.67	68.67	5.46	2.28	2.40	8.60	1.58	3.07	255.00	7.00	30.17	22.18
NLR 34449	23.59	79.67	72.33	69.00	5.29	1.84	2.87	8.80	1.66	4.69	118.50	4.97	36.00	20.78
NLR 40024	21.87	77.67	70.33	66.33	5.75	2.36	2.44	9.80	1.70	3.13	106.67	2.87	34.17	22.53
RDR 992	18.32	77.33	68.33	64.00	5.73	1.81	3.17	9.67	1.69	5.65	96.67	5.80	34.33	23.23
RGL 2332	18.82	77.67	68.67	64.33	5.63	2.25	2.50	11.00	1.95	3.48	123.33	4.13	44.00	25.34
RGL 11414	19.54	77.33	68.33	55.33	6.06	2.42	2.50	10.73	1.77	5.06	121.67	3.60	41.33	24.31
RNR 2354	19.05	75.33	69.67	66.33	5.94	1.83	3.25	9.93	1.67	5.68	141.67	3.13	30.83	20.52
RNR 2458	19.37	78.33	68.33	59.67	6.18	2.19	2.82	11.33	1.83	4.74	120.00	4.93	30.33	23.61
RNR 6378	21.32	77.00	70.67	68.00	5.65	1.87	3.02	10.13	1.79	5.45	93.33	4.80	23.67	21.48
RNR 15038	22.21	77.33	69.67	60.00	4.95	1.42	3.48	9.60	1.94	5.08	91.67	2.87	35.83	20.78
RNR 15048	21.96	78.33	69.33	62.00	4.48	1.29	3.47	9.60	2.14	4.27	161.67	4.00	30.33	20.62
Minimum	17.63	75.10	65.80	55.33	4.48	1.29	2.29	8.60	1.48	3.07	91.67	2.20	22.33	17.81
Maximum	23.59	80.67	73.00	69.00	6.39	2.42	3.48	11.33	2.14	6.26	255.00	7.00	53.67	25.34
Mean	**19.85**	**78.01**	**70.28**	**63.48**	**5.45**	**1.92**	**2.87**	**9.55**	**1.76**	**4.69**	**140.95**	**4.21**	**36.06**	**21.39**
S.E.	0.62	0.43	0.60	1.01	0.05	0.02	0.04	0.13	0.05	0.36	3.82	0.24	1.55	0.45
C.D. at 5%	1.76	1.21	1.70	2.88	0.15	0.05	0.11	0.36	0.14	1.04	10.90	0.69	4.43	1.30

Table 2. Estimates of variability and genetic parameters for yield and quality characters in rice

Character	Mean	Range		Variance		Coefficient of Variation (%)		Heritability in broad sense (h^2_b)	Genetic Advance (%)	Genetic Advance as per cent mean
		Minimum	Maximum	Genotypic (Vg)	Phenotypic (Vp)	Genotypic (GCV)	Phenotypic (PCV)			
Hulling per cent (%)	78.01	75.10	80.67	1.13	1.67	1.36	1.66	67.66	1.80	2.31
Milling per cent (%)	70.28	65.80	73.00	1.50	2.56	1.74	2.28	58.54	1.93	2.74
Head rice recovery (%)	63.48	55.33	69.00	8.84	11.88	4.68	5.43	74.42	5.28	8.32
Kernel length (mm)	5.45	4.48	6.39	0.12	0.13	6.39	6.60	93.82	0.70	12.76
Kernel breadth (mm)	1.92	1.29	2.42	0.05	0.05	11.84	11.95	98.10	0.46	24.16
Kernel L/B ratio	2.87	2.29	3.48	0.06	0.11	8.53	11.56	54.55	0.37	12.98
Kernel length after cooking (mm)	9.55	8.60	11.33	0.57	0.61	7.91	8.18	93.44	1.50	15.74
Kernel elongation ratio	1.76	1.48	2.14	0.01	0.02	5.49	7.26	57.14	0.15	8.55
Volume expansion ratio	4.69	3.07	6.26	0.47	0.86	14.67	19.81	54.83	1.05	22.38
Water uptake (ml)	140.95	91.67	255.00	1322.18	1365.88	25.80	26.22	96.80	73.30	52.29
Alkali spreading value	4.21	2.20	7.00	1.55	1.72	29.54	31.12	90.10	2.43	57.76
Gel consistency (mm)	36.06	22.33	53.67	42.18	49.38	18.01	19.49	85.42	12.37	34.29
Amylose content (%)	21.39	17.81	25.34	3.39	4.00	8.61	9.35	84.76	3.49	16.33
Grain yield per plant (g)	19.85	17.63	23.59	6.61	7.77	12.95	14.04	85.06	4.88	24.60

uptake and alkali spreading value indicating the presence of large variation among the varieties studied for these characters and the effectiveness of simple selection for their improvement. These results are in agreement with the findings of Dhanwani *et al.* (2013).

The characters, gel consistency, volume expansion ratio and kernel breadth had however, recorded moderate (10-20%) estimates of genotypic and phenotypic coefficient of variation, in the present investigation. Similar results were reported earlier by Babu *et al.* (2012) for gel consistency and volume expansion ratio; and Bekele *et al.* (2013) for kernel breadth. Further, low (<10%) estimates of genotypic and phenotypic variance in addition to GCV and PCV were observed for hulling per cent, milling per cent, kernel length, kernel length after cooking, kernel elongation ratio and amylose content in the present study. Similarly, low variability was also reported earlier in the studies of Babu *et al.* (2012) for hulling per cent and milling per cent; Veerabadhiran *et al.* (2009) for kernel length after cooking and kernel elongation ratio; and Parvathi *et al.* (2011) for amylose content.

High (>60%) heritability estimates were noticed in the present study for hulling per cent, head rice recovery, kernel length, kernel breadth, kernel length after cooking, water uptake, alkali spreading value, gel consistency and amylose content, indicating minimum influence of environment on these characters. Similar observations were reported earlier by Subudhi *et al.* (2011). However, moderate (30-60%) estimates of heritability were recorded for milling percentage followed by kernel elongation ratio, volume expansion ratio and kernel L/B ratio. The findings are in conformity with the reports of Dhanwani *et al.* (2013) for kernel elongation ratio; and Shejul *et al.* (2013) for volume expansion ratio and kernel L/B ratio.

High heritability coupled with high genetic advance as per cent mean was recorded in the present study for alkali spreading value, water uptake, gel consistency and kernel breadth indicating that these characters are governed by additive gene action and therefore simple selection would be effective for improvement of these characters.The findings are in conformity with the reports of Dhanwani *et al.* (2013) for alkali spreading value, water uptake and gel consistency; and Veerabadhiran *et al.* (2009) for kernel breadth. Further, high heritability coupled with moderate genetic advance as per cent mean was recorded for kernel length, kernel length after cooking and amylose content, indicating that heritability for these traits was due to both additive and non-additive gene effects and hence, simple selection may not always be effective for improvement of these characters. These results are in conformity with the findings of Parvathi *et al.* (2011) for amylose content and Subudhi *et al.* (2011) for kernel length and kernel length after cooking. On contrary, the characters, hulling percentage and head rice recovery had recorded high heritability coupled with low genetic advance as per cent mean indicating the pre-dominant role of non-additive gene effects such as epistasis and dominance. Similar findings were reported earlier by Satish Chandra *et al.* (2009).

In the present study, high GCV coupled with high heritability and high genetic advance as per cent mean were observed for alkali spreading value and water uptake, indicating the predominance of additive gene action and scope for their improvement through selection. The results are in conformity with the reports of Parvathi *et al.* (2011).

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EFFECT OF SEWAGE SLUDGE ON TOMATO (*Lycopersicon esculentum* L.)

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India is the third largest producer of tomato after China and USA. Tomato is one of the most important vegetable crop from nutritional as well as consumption point of view. It tops the list of canned vegetables. In India, Andhra Pradesh leads in tomato production with an area of 95,000 hectares and an annual production of 19.14 lakh Mt.

Sewage sludge is a by-product of municipal sewage treatment processes. Land application of sewage sludge is one of the important disposal alternatives. Being rich in organic and inorganic plant nutrients, sewage sludge may substitute for fertilizers. Sewage sludge amendment to the soil modifies its physico-chemical and biological properties. Crop yield in adequately sludge-amended soil is generally more than that of well-fertilized and control (Singh and Agarwal, 2009).

Pot culture experiment was conducted on Alfisols (red soil) at green house farm of the Department of Horticulture, College of Agriculture, Hyderabad during *kharif* 2012 to study the effect of sewage sludge on growth and yield of tomato (*Lycopersicon esculentum* L.) The sewage sludge for present study was taken from Mir Alam Sewage Treatment Plant (MA-SIP) which is situated 5.2 km away from College of Agriculture, Hyderabad. The experiment was laid out in Completely Randomized Design (CRD) with three replications and necessary data was collected when ever required. There were seven treatments consisting of T_1 (20% sewage sludge), T_2 (sewage sludge), T_3 (60% sewage sludge), T_4 (80%sewage sludge), T_5 (100% sewage sludge), T_6 (RDF-Inorganic N, P and K @100, 100 and 100 kg ha^{-1}, respectively) and T_7 (Control). In all the treatments after adding sewage sludge as per the treatment schedule on air dry weight basis, rest of the pot volume was filled with air dried red soil, so that the total weight of the soil + sludge in each pot was 6 kg.

Application of sewage sludge increased the plant height of tomato at both vegetative and harvesting stages of crop (30 and 90 DAT). The plant height linearly increased with increase in sewage sludge application rates and it was significantly higher in 100% sewage sludge treatment (49.53 and 66.33 cm respectively) at both growth stages of crop. Similar effect was also noticed even in case of dry matter production. Significantly, higher dry matter production of 25 g $plant^{-1}$ (Table 1) was recorded in 100% sewage sludge treatment (T_5) at mid stage (45 DAT) of crop. Similar results were also reported by Kladivko and Nelson (1979).

Significantly higher number of leaves (92.3 $plant^{-1}$) was recorded at 30 DAT in 100% sewage sludge (T_5) followed by 80% sewage sludge (86.6 $plant^{-1}$) and lower number of leaves (38.0 $plant^{-1}$) was recorded in Control (T_7). Sewage sludge application at higher dose (20 t ha^{-1}) enhanced number of leaves, leaf area, shoot length and root length in maize (Qasim *et al.*,2001).

Application of sewage sludge increased the fruit yield (Table 2) and it was maximum in 100% sewage sludge treatment (184.2 g $plant^{-1}$) followed by 80% sewage sludge (164.9 g $plant^{-1}$), recommended dose of fertilizer (131.6 g $plant^{-1}$) and control (117.8 g $plant^{-1}$). The major nutrients viz., N, P, K and minor nutrient (Zn) of 1.68%, 0.56% and 25.93mg kg^{-1}, respectively found in sewage sludge resulted in increased fruit yield. The superior performance of sewage sludge treated plants might be due to improvement in physical, chemical and microbiological environment of soil favouring increased availability of plant nutrients, which affected the growth parameters that provided more photosynthetic area for the accumulation and translocation of photosynthetic sugars to the fruits and hence the number of fruits, fruit length, fruit width, fruit size and yield (Hossain, 2009).

The striking and interesting feature observed in tomato fruit parameters (Table 2) viz., lycopene content, ascorbic acid content, total soluble solids (TSS) was that unlike the growth parameters viz., plant height, number of leaves and dry matter production, maximum lycopene content (8.23mg / 100g), ascorbic acid content (36.3 mg/100g), and total soluble solids (6.21^0 Brix) was noticed in 80% sewage kludge (T_4) followed by 100% sewage sludge. Begum (2011) reported that application of municipal sewage sludge vermicompost (MSSVC) @ 20t ha^{-1} significantly increased the number of fruits per plant

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Table 1. Effect of sewage sludge on plant height, dry matter production and number of leaves per plant in tomato

Treatments		Plant height (cm)		Dry matter production (g plant^{-1})	Number of leaves per plant	
		30 DAT	90 DAT	45 DAT	30 DAT	90 DAT
T_1	20 % of sewage sludge	32.96	48.23	9.7	59.3	68.3
T_2	40 % of sewage sludge	34.86	54.40	13.0	65.6	76.6
T_3	60 % of sewage sludge	37.53	56.36	16.8	76.3	83.6
T_4	80 % of sewage sludge	41.73	59.23	19.8	86.6	98.0
T_5	100 % of sewage sludge	49.53	66.33	25.0	92.3	114.6
T_6	RDF (Recommended Dose of Fertilizer)	33.26	49.96	11.1	61.3	71.0
T_7	Control (Untreated)	24.43	30.50	8.5	38.0	42.3
	CD at 5%	1.35	2.33	1.21	2.41	3.11
	SEm$\pm$1	0.44	0.76	0.39	0.78	1.01
	SE (d)	0.62	1.07	0.55	1.11	1.43

DAT- Days after transplanting, vegetative stage- 30 DAT, mid stage-45 DAT, harvesting stage- 90 DAT

Table 2. Effect of sewage sludge on fruit yield and other fruit parameters in tomato

Treatments	Fruit yield (g plant-1)	Ascorbic acid (mg/100g)	Lycopene content (mg/100g)	Total soluble solids (^{0}Brix)	Fruit pH (%)
T_1 20 % of sewage sludge	128.9	24.2	3.96	4.32	4.18
T_2 40 % of sewage sludge	135.1	28.1	5.16	4.89	4.23
T_3 60 % of sewage sludge	143.8	33.4	5.83	5.28	4.33
T_4 80 % of sewage sludge	164.9	36.3	8.23	6.21	4.43
T_5 100 % of sewage sludge	184.2	25.4	7.83	5.53	4.57
T_6 RDF (Recommended Dose of Fertilizer)	131.6	28.3	5.70	4.54	4.21
T_7 Control (Untreated)	117.8	21.6	3.36	3.90	4.15
CD at 5%	5.169	0.98	0.32	0.18	0.02
SEm $\pm$ 1	1.835	0.32	0.10	0.05	0.00
SE (d)	2.595	0.45	0.14	0.08	0.01

DAT- Days after transplanting

and fruit weight of tomato than higher dose (30t/ha^{-1}) of MSSVC.

The highest fruit pH (4.57) in tomato was observed in treatment of 100% sewage sludge (T_5) and lowest (4.15) was observed in control (T_7). According to Irshad (2011) biochemical parameter, fruit pH was found maximum in 100% sewage sludge application, when compared with other amendments.

Thus, sewage sludge collected from municipal sewage treatment plant was found to be beneficial in increasing plant height, leaf area, number of leaves, dry matter production and quality parameter in tomato.However, further study is required to confirm the results.

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Research Note
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GROWTH TRENDS OF SUGARCANE *(Saccharum officinarum)* CROP IN ANDHRAPRADESH

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Sugarcane (*Saccharum officinarum*) is the important commercial crop in the world. India ranks second in the World in sugarcane production after Brazil. In India, sugarcane occupies three per cent of the total cultivated area and shares about 7.5 percent of total value of agricultural output. Sugarcane is an efficient source of sugar, thus provides raw material for the second largest agro-based industry. In India during 2011-12 sugarcane was cultivated in an area of 50.38 lakh hectares with production of 361.04 million tonnes and with a productivity of 71.7 tonnes ha^{-1}. In Andhra Pradesh during 2011-12, the area under sugarcane crop was 2.04 lakh hectares and production was 166.89 million tonnes with a productivity of 81.8 tonnes ha^{-1} (Source : Directorate of Economics and Statistics, 2012).

The present investigation was carried out to examine the trends in time series data of area, production and productivity of sugarcane crop in Andhra Pradesh state for the period 1971-72 to 2010-11 by fitting ten growth models viz., linear, logarithmic, inverse, quadratic, cubic, compound, S-curve, growth, power and exponential model (Table1). The model which showed relatively high significant Adj R^2 with least residual mean square (RMS) and significant runs (test for assumption of randomness of residuals) is chosen to fit a trend equation (Table2). Trend values was computed to study growth pattern.

The results revealed that the area of sugarcane in Andhra Pradesh showed an increasing growth pattern during the study period of 1971-72 to 2010-11 (Fig. 1). Among ten growth models fitted, the maximum Adj R^2 of 37.5% was observed in case of power function with least RMS (1072.33) and significant runs and hence this model was found suitable to fit the trend in area under the sugarcane crop cultivation. The Adj R^2 value implies that time trend as a variable was accounting for 37.5% of the variations noticed in area of sugarcane. The t coefficient for area (0.14) was positive and significant ($P<0.01$) suggesting that there has been a 0.14% per annum increase in the area devoted to sugarcane area during the period 1971-72 to 2010-11.

The Production results reveal that the maximum Adj R^2 of 63.3% was observed in case of cubic function with least RMS (427.38) and significant runs in comparision to that of in the other models and hence cubic model was found suitable to fit the trend (Fig. 2). The Adj R^2 value implies that time trend as a variable was very important accounting for 63.3% of the variations noticed in production of sugarcane crop. The t^3 coefficient of production (-0.01) was negative and significant ($P<0.01$) suggesting that there has been a 0.01% per annum deceleration in the sugarcane production during the period 1971-72 to 2010-11. The results are in line with the findings of Rajendra Prasad *et al., (2012)*.

The Productivity results revealed that the maximum Adj R^2 of 22.8% was observed in case of cubic function with least RMS (22.71) and significant runs relatively and hence cubic model was found suitable to fit the trend in productivity of sugarcane crop (Fig. 3). The Adj R^2 value implies that time trend as a variable was accounting for 22.8% of the variations noticed in productivity of sugarcane crop. The t^3 coefficient of productivity (-0.001) was negative and significant ($P<0.05$) suggesting that there has been a slow process of decline in the Sugarcane productivity during the period 1971-72 to 2010-11.

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Table 1. Mathematical equations for Ten Growth Models

S.No.	Growth models	Mathematical equation
1	Linear function	$Y_t = a + bt$
2	Logarithmic function	$Y_t = a + b \ln(t)$
3	Inverse function	$Y_t = a + b/t$
4	Quadratic function	$Y_t = a + bt + ct^2$
5	Cubic function	$Y_t = a + bt + ct^2 + dt^3$
6	Compound function	$Y_t = ab^t$ or $\ln Y_t = \ln a + t \ln b$
7	S-curve	$Y_t = \text{Exp}(a+b/t)$ or $\ln Y_t = a + b/t$
8	Growth function	$Y_t = \text{Exp}(a + bt)$ or $\ln Y_t = a + bt$
9	Power function	$Y_t = at^b$ or $\ln Y_t = \ln a + b \ln(t)$
10	Exponential fit	$Y_t = a \text{ Exp}(bt)$ or $\ln Y_t = \ln a + (bt)$

Table 2. Growth models of area, production and productivity of Sugarcane in Andhra Pradesh

Model	Area		Production		Productivity	
	$AdjR^2$	RMS	$AdjR^2$	RMS	$AdjR^2$	RMS
Linear	0.25**	1068.60	0.536**	540.07	0.015	28.96
Logarithmic	0.312**	981.33	0.364**	740.09	-0.025	30.16
Inverse	0.238**	1087.93	0.099*	1047.97	0.073*	27.26
Quadratic	0.307**	988.05	0.529**	548.22	0.159*	24.74
Cubic	0.308**	986.22	0.633**	427.38	0.228**	22.71
Compound	0.282**	1095.72	0.538**	540.83	0.019	28.96
Power	0.375**	1072.33	0.365**	1046.761	-0.026	27.18
S	0.327**	1095.72	0.098*	540.83	0.06	28.96
Growth	0.282**	989.72	0.538**	705.79	0.019	30.20
Exponential	0.282**	1095.72	0.538**	540.83	0.019	28.96

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

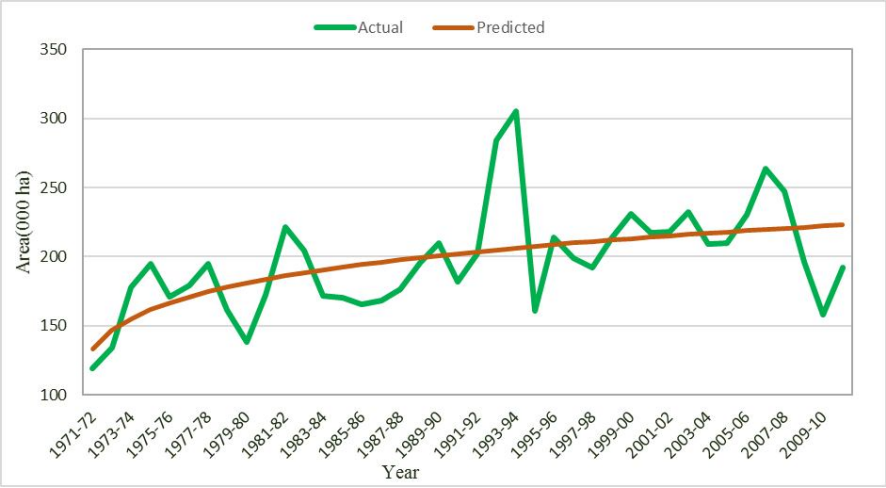

Fig. 1. Trend of Sugarcane Area in Andhra Pradesh

Fig. 2. Trend of Sugarcane Production in Andhra Pradesh

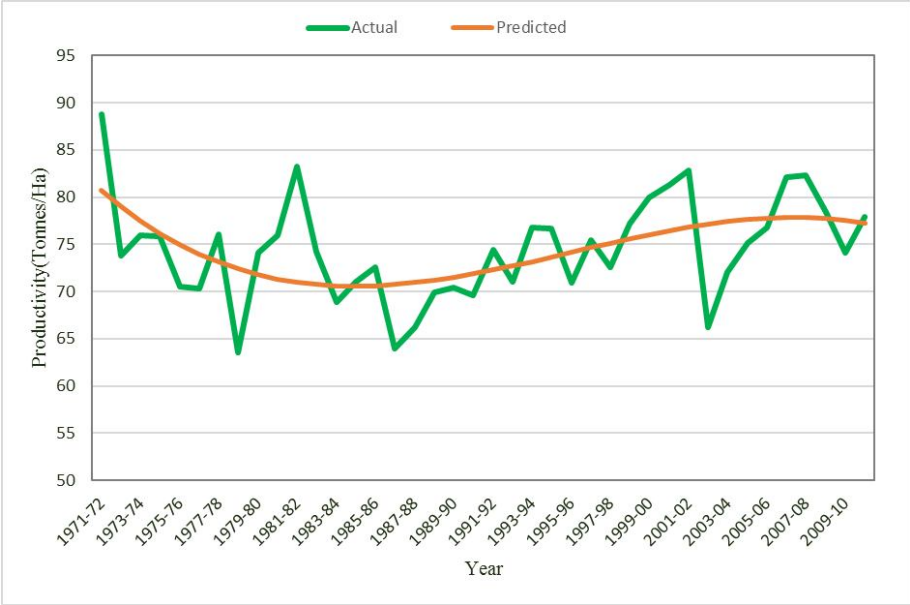

Fig. 3. Trend of Sugarcane Productivity in Andhra Pradesh

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Research Note
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EFFECT OF LAND CONFIGURATIONS AND MULCHES ON SOIL MOISTURE CONSERVATION, GROWTH AND YIELD OF MAIZE (*Zea mays* L.) UNDER RAINFED CONDITIONS

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Maize is cultivated in an area of about 8.12 million ha with a production of 19.77 million tones and a productivity of 2.43 t ha^{-1} in Andhra Pradesh. Agronomic practices such as ridge and furrow, broad bed and furrow, intercropping, strip cropping and cover cropping etc. is recommended to increase infiltration rate of water and reduce the runoff.Mulching is one of the most important moisture conservation practices in rain fed agriculture among various mechanical and agronomic measures that have been reported to reduce the soil erosion and increase *in-situ* soil moisture storage. Super absorbent polymers (SAP's) or hydrogels are loosely cross-linked, three dimensional networks of flexible polymer chains that carry dissociated, ionic functional groups and that can absorb fluids of greater than 15 times of their own dry weight (Zohuriaan and Kourosh, 2008).

The field experiment was conducted during *kharif,* 2012 in a split plot design with three replications at Water Technology Center, College Farm, Hyderabad. The experimental soil was sandy loam in texture, neutral in reaction and non-saline. The fertility status of the experimental soil was medium in organic carbon, low in available nitrogen, high in available phosphorus and available potassium.The infiltration rate was moderate (3.2 cm ha^{-1}) and field capacity moisture content was 16.12 per cent. Total rainfall received during the crop growth period was 524 mm, July month was wettest which favour the initial crop growth but the crop experienced a mild stress at development stage due to moderate dry spell prevailed during second fortnight of August. Three land configurations consisting of flat beds (M_1), broad bed and furrows (M_2) and ridge and furrows (M_3) formed as main treatments and four types of mulches viz., control (S_1), paddy straw mulch (S_2), mulch made from old gunny bags (S_3) and hydrogel (S_4) formed as sub-treatments. The ridge and furrow land configurations were formed at a spacing of 60 cm between the rows, broad bed and furrow land configurations were formed at 80 cm bed and 40 cm furrow spacing with 60 cm between the row to row on the bed. The paddy straw mulch was applied @ 3 t ha^{-1} with 90 per cent ground coverage. The old gunny bags were applied as mulch with 60 per cent ground coverage. The hydrogel was applied at the rate of 15 kg ha^{-1} as soil application at the time of sowing.

The maize crop was sown on 3rd July, 2012 at a spacing of 60 cm x 20 cm and fertilized with 120: 60: 40 N,P_2O_5, K_2O Kg ha^{-1}. All the recommended package of practices were followed. Soil moisture content was estimated volumetrically using surface probe (PR2) at 0-20 and 20-40 cm soil depth in weekly intervals to observe the soil moisture trends during crop growth period.

The plant height of maize increased progressively up to harvest and there was no significant difference observed with respect to plant height between land configurations and mulches (Table 1). The LAI progressively increased with growth stages irrespective of the treatment up to 60 DAS and then decreased at 90 DAS and at harvest. Leaf area index values observed in ridge and furrow (3.03) method of land configuration was significantly higher at harvest than broad bed furrow (3.00) due to better moisture available in the root zone of the crop throughout the crop growth period. The LAI observed in broad bed and furrow was on par with flat bed method. These results were in conformity with the results of Thakur *et al*. (2011). At 90 DAS, highest leaf area index (3.76) was obtained with mulch made from gunny bags and was significantly superior to rest of the mulch treatments. The LAI of maize was significantly higher in mulched plots compared to control (Pramanik and Bandyopadhyay, 1998).

Dry matter production increased progressively with advance in age of the maize crop up to 90 days and then it is decreased as the crop attained maturity (Table 1). At 60 DAS, maize grown on ridge and furrow method resulted in producing significantly higher (71.81 g $plant^{-1}$) dry matter production compared to dry matter production observed on broad bed and furrow (69.82 g $plant^{-1}$) and flat bed (67.77 g $plant^{-1}$). Significantly higher dry matter production was associated with mulch made from gunny bags (73.51 g $plant^{-1}$) compared to all other mulch treatments at 60 DAS where as the dry

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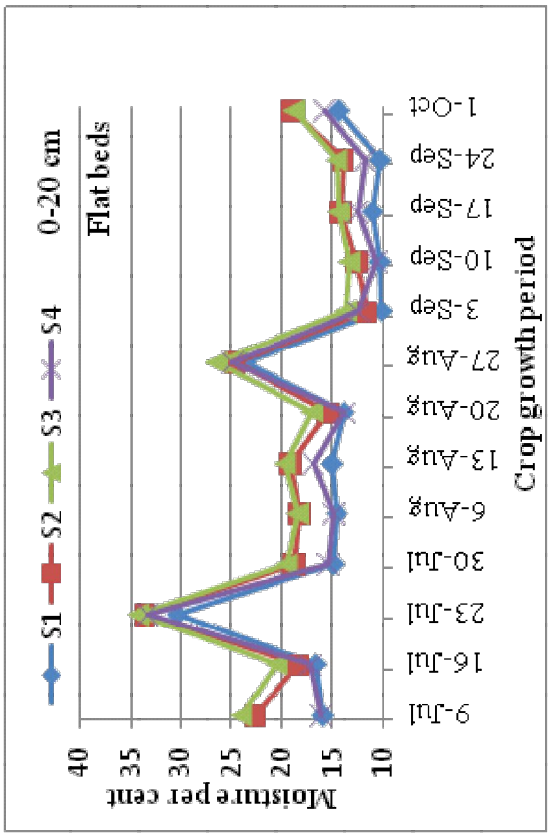
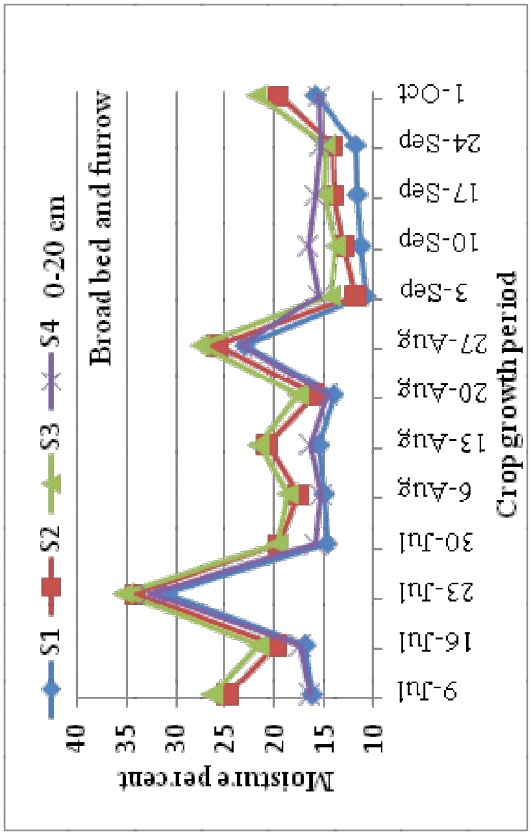
Table 1. Growth parameters of *kharif* maize as influenced by land configurations and mulches under rain fed conditions

Treatments	Leaf Area Index (LAI)				Dry matter production (g plant^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
Land configurations								
M_1 – Flat bed	1.13	4.07	3.61	2.93	32.63	67.78	229.38	219.63
M_2 – Broad bed and furrow	1.11	4.08	3.64	3.00	33.08	69.83	233.53	223.35
M_3 – Ridge and furrow	1.17	4.09	3.68	3.03	33.98	71.82	236.15	228.33
S.Em ±	0.02	0.03	0.03	0.03	0.43	0.21	2.48	2.76
C.D at 5%	NS	NS	NS	0.11	NS	0.83	NS	NS
Mulches								
S_1 – Control	1.10	4.02	3.59	2.97	32.24	69.24	228.24	221.14
S_2 – Paddy straw muclh	1.11	4.07	3.62	2.98	34.18	69.89	233.13	226.33
S_3 – Mulch made from gunny bags	1.17	4.19	3.76	3.00	33.94	73.51	241.51	231.00
S_4 – Hydrogel	1.16	4.03	3.60	3.00	32.52	66.58	229.21	216.60
S.Em ±	0.02	0.03	0.02	0.03	0.72	0.67	2.80	2.77
C.D at 5%	NS	NS	0.06	NS	NS	1.99	8.32	8.23
Land configuration at same level of mulch								
S.Em ±	0.04	0.05	0.03	0.05	1.24	1.16	4.85	4.80
C.D at 5%	NS	NS	NS	NS	NS	NS	NS	NS
Mulch at same level of land configuration								
S.Em ±	0.04	0.06	0.04	0.05	1.16	1.02	4.88	4.99
C.D at 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Yield attributes, yield and rainfall use efficiency of *kharif* maize as influenced by land configurations and mulches under rain fed conditions

Treatments	Test weight(g)	Grain yield Plant $^{-1}$	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)	Rainfall use efficiency (kg ha $^{-1}$ mm^{-1})
Land configurations						
M_1 – Flat bed	23.98	117.44	5970	17966	24.87	11.39
M_2 – Broad bed and furrow	24.99	119.84	6508	18750	25.72	12.42
M_3 – Ridge and furrow	25.33	121.36	7612	21508	26.09	14.52
S.Em ±	0.15	0.51	173	272	0.28	-
C.D at 5%	0.59	2.01	679	1071	1.13	-
Mulches						
S_1 – Control	24.50	118.40	6675	18914	24.19	12.73
S_2 – Paddy straw muclh	25.04	120.58	6934	19588	26.14	13.23
S_3 – Mulch made from gunny bags	26.23	122.31	7531	19858	27.34	14.37
S_4 – Hydrogel	23.29	116.90	5649	17271	24.58	10.78
S.Em ±	0.46	0.97	218	437	0.32	-
C.D at 5%	1.39	2.90	647	1300	0.97	-
Land configuration at same level of mulch						
S.Em ±	0.81	1.69	738	757	0.57	-
C.D at 5%	NS	NS	NS	NS	NS	-
Mulch at same level of land configuration						
S.Em ±	0.71	1.55	713	710	0.57	-
C.D at 5%	NS	NS	NS	NS	NS	-





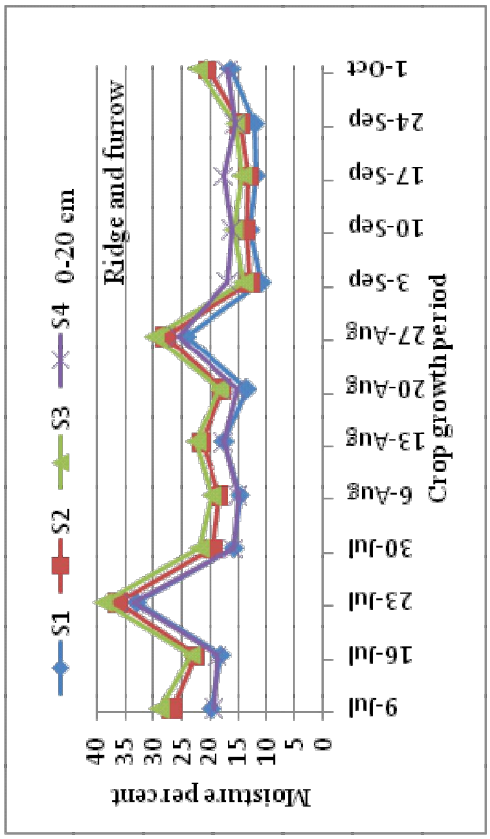


Fig. 1 : Soil moisture trends in different land configurations and mulches in *kharif* maize, 2012

matter production observed with paddy straw mulch (69.89 g plant^{-1}) at 60 DAS was on par with control treatment (69.24 g plant^{-1}). These findings are in line with the findings of Kaushik and Gautham (1994) and Kaushik and Lal (1997).

The number of cobs plant^{1}, number of grains rows cob^{-1}, number of grains cob^{-1}, test weight, yield plant^{-1} were higher with ridge and furrow in combination with mulch made from gunny bags (Table 2). The maize grain yield (7612 kg ha^{-1}) obtained on ridge and furrow method of sowing was significantly higher compared to broad bed and furrow (6508 kg ha^{-1}) and flat bed (5970 kg ha^{-1}). The higher grain yield of maize realized on ridge and furrow method of sowing might be due to significantly higher number of grains cob^{-1}, grain yield plant^{-1} and test weight observed in ridge and furrow method of sowing as a result of maintaining a favourable moisture regime to the plants. These results are in conformity with the results of Thakur *et al*. (2011). Significantly highest grain yield (7531 kg ha^{-1}) of maize was associated with mulch made from gunny bags. This might be due to increase in growth parameters viz., plant height, LAI, dry matter production under high soil moisture regime which was on par with paddy straw mulch. The increase in grain yield of corn under mulching conditions may be due to increased soil moisture storage and suppressing weed growth (Mastana, 1988). Highest rainfall use efficiency (14.52 kg ha^{-1}mm^{-1}) was obtained in case of ridge and furrow method of sowing as compared to broad bed and furrow (12.42 kg ha^{-1} mm^{-1}). This might be due to better infiltration of rain water into the soil under these treatments resulting in higher growth, yield and yield attributes. Where as in mulches, highest rainfall use efficiency (14.37 Kg ha^{-1}mm^{-1}) was with mulch made from gunny bags compared to all other mulch treatments.

The periodical volumetric soil moisture content was monitored using profile probe (PR-2) at weekly intervals at 0-20 cm and 20-40 cm soil depths. The trends showed that higher soil moisture content was observed in ridge and furrow method of sowing than that of any other land configurations studied in two soil depths throughout the crop growth period. Regarding the mulch treatments, higher soil moisture content was observed under mulch made from gunny bags compared to any other mulch applied. The soil moisture trends in different land configurations and mulches at 0-20 cm soil depth were presented in Fig.1. The soil moisture at 20-40 cm depth also follows similar to that of 0-20 cm.

The above study clearly indicated that sowing of *kharif* maize in ridge and furrow method followed by surface covering with mulch made from gunny bags realized higher grain yield by efficient use of rainfall under rain fed conditions.

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DEVELOPMENT AND EVALUATION FOR EXTRUDED CHARACTERISTICS AND SENSORY ACCEPTABILITY OF EXTRUDED PRODUCTS WITH COMPOSITE FLOURS OF CORN AND SORGHUM

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The extrusion cooking process is high temperature short time(HTST) process in which moist, soft grain is fed into the extruder where the desired temperature and pressure are obtained over the required period of residence time. For cooking of the product generally external heat is not supplied, heat for cooking is achieved through shear and friction in extruder. Extrusion cooking is used worldwide for the production of expanded snack foods, modified starches ready- to- eat cereals, baby foods, pasta and pet foods. (Toft, 1979). This technology has many distinct advantages viz., versatility, low cost, better product quality and no process effluents. Extrusion is accomplished by single screw and twin screw extruders. Extrusion cooking not only enhances the acceptability of the product by improving its appearance, taste and texture but also inactivates anti-nutritional factors such as trypsin inhibitor and urease activity etc. in legumes (Phillips, 1989).

The objective of the present study was to develop new extruded products with sorghum flour, corn flour and a combination of sorghum and corn flour and to study the effect of extrusion on the physical properties (mass flow rate, density, moisture retention, expansion ratio, water absorption index, water solubility index, water holding capacity, oil absorption capacity) of extrudates and sensory acceptability of the product. Individual flours and blends of sorghum and corn flour were prepared in different ratios on a dry-to-dry weight basis shown in the Table 1. The individual sample of sorghum and corn and the blended sample of corn and sorghum flour were conditioned to 21–22% (w.b) moisture by spraying with a calculated amount of water and mixing continuously at medium speed in a blender.

The samples were put in buckets and stored at 4^0C overnight. The feed material was then allowed to stay for 3hrs to equilibrate at room temperature prior to extrusion. This preconditioning procedure was employed to ensure uniform mixing, hydration and to minimize variability in the state of feed material. Moisture content of samples was determined by hot air oven method AOAC (1990). Extrusion was performed using a laboratory-scale co-rotating corrugated twin-screw extruder (MEPL-12).

Feeding of the pre conditioned composite flour to a twin screw extruder was accomplished by using a twin screw volumetric gravity feeder. The temperature of the two barrel zones of extruder from feeder end were set at 90^0C and 110^0C respectively.

Mass flow rate was measured by collecting the extrudates in polyethylene bags for a specific period of time, as soon as it comes out of the die its weight taken instantly after its cooling to ambient temperature (Singh *et al.,* 1996).The extrudates after grinding were filled in measuring cylinder of capacity 50ml up to 20ml and tapped 5-10 times to measure the tap density. Weight of this 20ml of extrudates sample was taken.

True Density was calculated by filling the approximate 1gm of ground sample of extrudates in a burette containing toluene. Then raise in toluene level was measured and an average of two readings of true density was calculated. Bulk density is an average diameter and average length of 25 readings of extrudates sample. The moisture content (w.b) of the feed and extruded samples was determined by AOAC method. The expansion ratio is the ratio of diameter of extrudate and the diameter of die (Fan *et al.,* 1996). The diameter of extrudate was determined

Table 1. Standardization of formulation

S.No.	INGREDIENT	QUANTITY(gm)
A	Sorghum	100
B	Corn	100
C	Sorghum & Corn	40 & 60

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as the mean of 10 random measurements made with a Vernier caliper. Water absorption index (WAI) and water solubility index (WSI) was determined by the method of Anderson (1982). Oil absorption capacity denotes how much oil is bound to matrices in particular food system which could be used as the index of hydro-phobicity of the food. Oil absorption capacity is expressed as the grams of oil bound per gram of the extrudate on dry basis.The sensory assessment was conducted using nine-point hedonic scale (Meilgaard *et al.,* 1999). The physical properties viz., flour particle size, moisture level, feed rate, temperature, screw speed and die speed were kept constant throughout the experiments. The effect of different flours on physical properties of extrudates are presented in Table 2.

Table 2. Physicasl properties of extrudates

Properties	Samples			Mean	C.D at 5%	SED
	A	B	C			
Mass flow rate (g/s)	3.26	3.28	3.30	3.22	0.08	0.04
Tap density (g/cc)	0.34	0.37	0.36	0.36	0.01	0.01
True density	0.6	0.5	0.4	0.52	0.13	0.08
Bulk density (Kg/cm^3)	0.10	0.10	0.12	0.11	0.01	0.01
Water Solubility Index (%)	0.24	0.32	0.33	0.29	0.04	0.02
Water Holding Capacity (WHC)	400	440	420	420.00	20.00	11.49
Moisture Retention	22.72	27.7	25.0	25.14	2.49	1.43
Expansion Ratio	2.17	2.32	2.0	2.16	0.16	0.09
Water Absorption Index (%)	5.0	5.2	5.4	5.20	0.20	0.11
Oil Absorption Capacity (%)	5.00	7.00	6.00	6.00	1.00	1.00

* Each value was an average of three determinations

*- Significant at 0.05% level of probability

The results are expressed in the form of mean± standard deviation.

Mass flow rate (MFR) was minimum for extruded sample-A (3.26) followed by sample-B (3.28) and sample –C (3.30). The variations in the mass flow rate of extrudate samples were very less, as constant maintaining of barrel temperature as well as moisture content in the feed mixtures. The tap density decreased. The tap density was less for sample-A (0.34) than sample –C (0.36) and sample-B (0.37). The true density was less in case of extrudates produced from combination flour sample-C (0.4) followed by sample –B (0.5) and sample –A (0.6). The true density increased with increase in cereals starch in extrudates. Similar findings were quoted by Quing *et al.,* (2005) in scientific literature. The bulk density of extrudates samples A and B were same (0.10), the same was 0.12 for sample- C. The higher bulk density may be due to the presence of more crude fiber in the combination flour sample. Similar types of results were observed by Singh *et al.* (1996) in scientific literature.

The water solubility index was more for the extrudates made from combination flour sample –C (0.33) followed by extruded sample –B (0.32) and it was less for the sample-A (0.24) because of the less water holding capacity of sorghum. The water absorption index was found to be more for extruded sample –C (5.4) followed by extruded sample –B (5.2) and sample –A (5.0).These results are conformity with the scientific literature by Shirani and Ganeshranee (2009).

The water holding capacity was maximum for extruded sample-B (440) than sample –C (420) and sample-A (400). This may be due to higher level of cereal starch and crude fiber in the Corn. The less water holding capacity of sorghum is due to the tough bonds present between the particles. Similar results were observed by Shirani and Ganeshranee (2009). The highest moisture retention was found in the extruded product prepared using flour sample –B (27.7). This may be due to the presence of protein zein.

The results of expansion ratios of extrudates indicating that the expansion ratio was decreasing with increased level of cereals starch and decreased

amount of proteins in the sorghum flour –A (2.17).This decrease in expansion ratio may be because of sorghum flour, which is rich in dietary fiber. Protein affects expansion through their ability to effect water distribution in the matrix and through their macro molecular structure and confirmation. The extruded sample –B has more expansion ratio than extruded sample –C and extruded sample-A. Similar findings were reported by Singh *et al.,* (1996). Oil absorption was found to be more for extruded sample-A (7%) than sample-C (6%) and B (5%). However, higher absorption of oil may be attributed to presence of less fat and more crude fiber in case of extrudate sample prepared from composite flour-A.

Table 3. Mean sensory scores of the Extruded snack food

Extruded samples	Sensory attributes					Overall acceptability
	Appearance	Colour	Flavour	Texture	Taste	
A	7.5	7.0	7.0	7.9	7.0	7.7
B	7.8	7.9	7.8	8.9	8.2	8.5
C	7.2	7.4	7.2	8.0	8.0	7.7
Mean	7.7	7.7	7.6	8.4	8.3	8.2
C.D at 5%	0.47	0.7	0.63	0.53	0.67	0.6
SED	0.2353	0.3516	0.3142	0.2664	0.2976	0.2985

*- Significant at 0.05% level of probability

The results are expressed in the form of mean± standard deviation.

The panel of semi- trained judges consisting of 25 members was given the extruded snack food samples for evaluation of organoleptic characteristics viz., appearance, colour, taste, flavour, texture and overall acceptability. The mean scores of sensory evaluation showed that the extruded products prepared in combination were within the acceptable range, while those extruded products prepared with whole corn flour sample-B had significantly better appearance (7.8), color (7.9), flavour (7.8), texture (8.9), taste (8.2) and overall acceptability (8.5) when compared to extruded products prepared with sorghum and the combination of sorghum and corn. The present study revealed that combination of sorghum and corn together could be used to produce quality extrudates with acceptable sensory properties.

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Research Note
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INFLUENCE OF GAMMA RADIATION AND PACKAGING MATERIALS ON GERMINATION PARAMETERS IN AROMATIC RICE VARIETY SUGANDHA SAMBA DURING STORAGE

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Aromatic rice constitute a small but special group in India considered as the best for eating quality parameters. Majority of the indigenous non-basmati aromatic rice, constitute small and medium grain types, possessing excellent aroma and good cooking qualities with respect to kernel elongation after cooking, softness, mouth feel and taste.A short grain variety Sugandha Samba released in Telangana for commercial cultivation facilitates availability of scented rice at relatively affordable price for an average consumer. Sugandha samba gives 5.5-6.0 t ha^{-1} of yield along with strong scent owing to the presence of higher percentage of aroma component 2-acetyl-1-pyrroline.

Storage is an integral part of the post-harvest handling of rice and is an essential segment of seed industry. Hence, an appropriate cost effective storage methodologies with minimum interference with seed quality parameters would be of immense practical value for the farming community. In many countries, both fumigation with chemicals and heat sterilization have been applied with varying degree of success. Many of synthetic chemicals used for seed storage look effective but are not readily degradable physically or biologically and yield more toxic residues. To counter these factors, present seed storage methods advocate use of containers like Gunny bag, HDPE bag, Grain pro bag or any sealed container to maintain the quality for longer period.

Irradiation is a physical method which uniformly disinfests stored food grains from insect pests. It can complement or replace existing methods of chemical treatment, such as fumigation. Therefore, the present study was taken up to investigate the changes in both seed quality and storability of scented rice seed cv.Sugandha samba at different doses of gamma radiation in combination with selected packaging material for nine months to optimize the storage procedure at affordable cost. The seed of Sugandha **s**amba was collected from the Rice section, Agricultural Research Institute, Rajendranagar. The seed of 400 gm is packed in three packaging materials Gunny, HDPE (700 guage) and grain pro bags were exposed to selected doses of gamma radiation (0, 100, 200, 300 and 400 Gy) in GC 5000 radiation chamber with CO^{60} source having 3.02 kGy hr^{-1} dose rate. The lab experiment was conducted in Factorial Completely Randomized Design and replicated thrice. Data at bi-monthly (3^{rd}, 5^{th}, 7^{th} and 9^{th} months) intervals on germination parameters was generated for a period of nine months starting in third month after irradiation and storage and the changes during storage were recorded as per following details.

Germination test was conducted on pure seed fraction using 100 seeds in three replicates following between paper (BP) method at 25^0C temperature and 93 ± 2 per cent relative humidity (ISTA, 1985). Daily counts from above germination test were performed until no further germination was observed for seven days. An index of the speed of germination was calculated by adding the quotients of the daily counts divided by the number of days of germination as given by Maguire(1962).Peak value and co-efficient of velocity of germination were computed using relevant formula (Czabater, 1962).

The stimulatory effects of gamma rays on germination earlier were attributed to the activation of RNA or protein synthesis during the early stage of germination after seeds were irradiated(Lucky, 1980).Maximum germination values were noticed in Sugandha samba irradiated at 100, 200 with the Grain pro bag and 100 Gy with the HDPE bag (98%) followed by HDPE bag /200 Gy (97.7%) and Grain pro bag / 300 Gy (97%). Further, germination was significantly influenced by gamma doses and packaging material. Among the packaging material, maximum germination percentage was observed in all the packaging material used which were irradiated with 100 and 200 Gy (98%).Among these treatments HDPE and Grain Pro at 100 and 200 Gy exhibited consistent results. Results from experiment on storability also indicated that, maximum germination was observed in combinations 200, 300 Gy with HDPE bag and at 100, 200 Gy with Grain pro bag at the end of 9^{th} month (Table 1).

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Highest speed of germination was recorded in the treatment gunny bag/ 0 Gy, grain pro bag / 100, 200 Gy followed by HDPE bag / 0, 100 Gy following radiation and while under storage HDPE bag / 0, 100, 200 Gy followed by Grain pro bag / 100, 200 Gy at the end of 9th month recorded superior and desirable values.The speed of germination exhibited positive correlation with germination. The peak value of germination for fresh seed ranged from 10.00 (Grain pro bag / 400 Gy) to 49.00 in respect of all three packaging material at 0 Gy, followed by HDPE and Gunny bag / 100 Gy (32.67) respectively. Both peak value and coefficient of velocity of germination were drastically affected at 400 Gy.

Similarly,during storage, in all the packaging material except Gunny bag, peak value of germination had increased up to 200 Gy and were superior to 0 Gy and decreased with increasing gamma dose. Among significant interaction effects, higher peak value of 32.78 was registered for Grain pro bag at 100 Gy at 3rd month and increased to maximum value (46.50) at the end of the 9th month and was followed by HDPE bag / 100 Gy (32.67), Gunny bag / 200 Gy (24.00) got increased to 44.83 and 41.50 respectively at the end of 9th month storage.

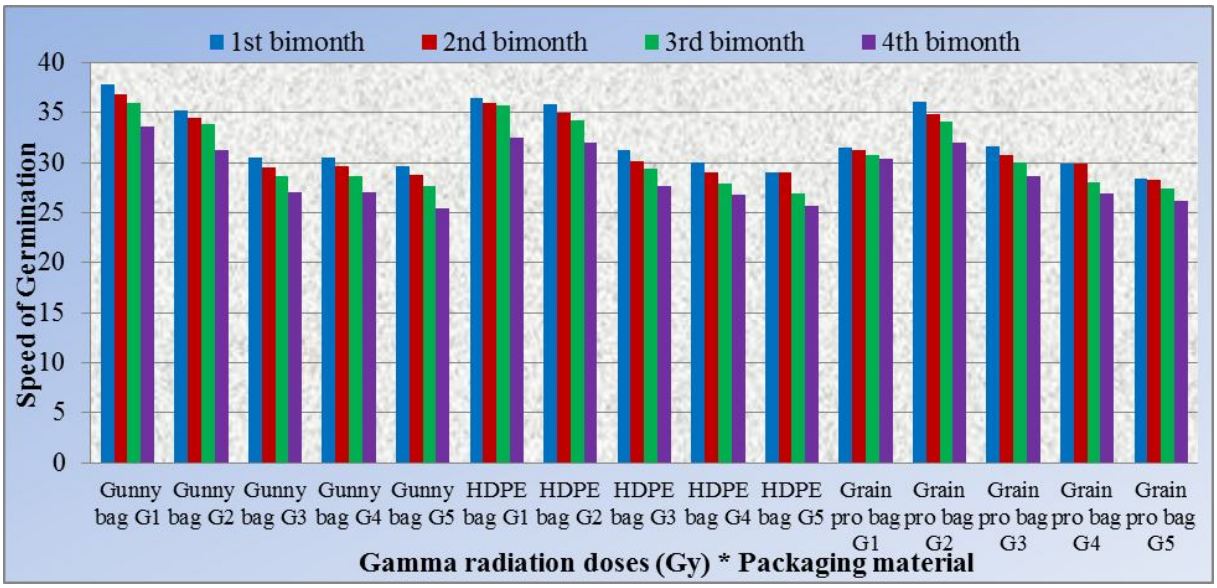

Fig. 1 : Speed of germination influenced by gamma dose, packaging material and storage period
1st bimonth=3rd month, 2nd bimonth=5th month, 3rd bimonth=7th month and 4th bimonth=9thmonth

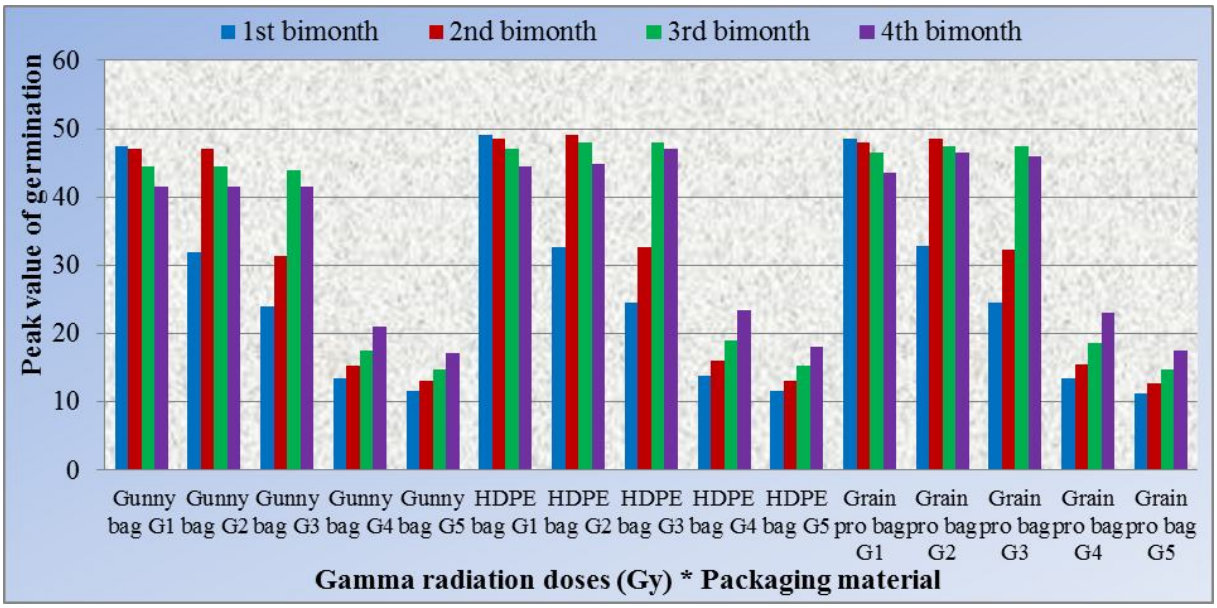

Fig. 2 : Peak value of germination influenced by gamma dose, packaging material and storage period

Table 1. Germination (%) as influenced by the interaction among gamma dose, packaging material and storage period

Gamma Dose	Influence of gamma dose, packaging material and storage period															
	3rd month				5th month				7th month				9th month			
	Gunny bag	HDPE bag	Grain pro bag	Mean	Gunny bag	HDPE bag	Grain pro bag	Mean	Gunny bag	HDPE bag	Grain pro bag	Mean	Gunny bag	HDPE bag	Grain pro bag	Mean
0 Gy	95	98	97	96.67	94	97	96	95.67	89	94	93	92.00	83	89	87	86.33
100 Gy	96	98	98	97.44	94	98	97	96.33	89	96	95	93.33	83	89	93	88.56
200 Gy	96	98	98	97.33	94	98	97	96.33	88	96	95	93.00	83	94	92	89.67
300 Gy	94	97	94	95.00	92	96	93	93.67	88	95	93	92.00	84	94	92	90.00
400 Gy	93	93	90	92.00	92	92	89	91.00	89	92	88	89.67	86	90	88	88.00
Mean	94.80	96.80	95.47	95.69	93.40	96.20	94.40	94.60	88.60	94.60	92.20	92.00	83.00	91.33	90.40	88.51
	Gamma Dose x storage period				Gamma Dose x Packing material				Packing material x storage period				Gamma Dose x packing material x storage Period			
SED ±	0.56				0.37				0.43				0.97			
CD at 5%	1.10				0.72				0.85				1.90			

Maximum co-efficient of velocity of germination was recorded at HDPE, Grain pro bag / 100 Gy. As per the results from the experimentation with fresh rice seed following radiation treatment it could be concluded that Gamma doses up to 200 Gy were found to exercise positive influence in enhancing the germination, seedling and biochemical parameters in all the packaging materials. The doses beyond 300 Gy had detrimental effect by interfering with various seed quality attributes.

Grain pro bag and HDPE bag exhibited better performance than gunny bag to irradiation during storage in terms of maintenance of seed quality. It can be finally concluded that semi commercial gamma units for large scale seed treatment of aromatic rice varieties can be established in areas of production and can be employed for the service of farmers and seed growers on a business incubator model basis.

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