STUDY OF GENETIC PARAMETERS IN THERMO-SENSITIVE GENIC MALE STERILE LINES (TGMS) OF RICE (*Oryza sativa* L.)

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ABSTRACT

Twenty eight suspected TGMS lines in rice developed from various sources were evaluated for genetic variability and heritability parameters along with correlation coefficients based on morphological traits and pollen fertility studies. Highest PCV and GCV were observed for pollen fertility, spikelet fertility and number of productive tillers suggesting that these characters are under the influence of genetic control. High heritability was recorded for stigma length and panicle length. High heritability coupled with high genetic advance as per cent of mean was observed for panicle length. Pollen fertility was positively and significantly associated with panicle exertion, spikelet fertility, number of seeds per panicle and single plant yield at genotypic level. Emphasis may be given on characters like stigma length, panicle length and single plant yield for improvement of these lines, since majority of other traits are environment dependant.

KEY WORDS: Correlation, Genetic advance, Heritability, Rice, TGMS lines, Variability

INTRODUCTION

Today, rice is synonymous with food security in most parts of the Asia. Recent progress in plant breeding research indicated that a significant shift in the yield frontier could be made possible through hybrid rice. Three-line breeding utilizing the Cytoplasmic Genic Male Sterility (CMS) system has been found to be effective in the development of commercial hybrids, but this system has some constraints such as a yield plateau in rice hybrids, dependency on a single CMS source, restriction on the choice of male parents due to problems associated with fertility restoration, complex seed production procedures, and high seed cost (Yuan, 1998). To overcome these problems, the two-line system of hybrid breeding utilizing Environment Sensitive Genetic Male Sterility (EGMS) especially the Thermo Sensitive Genetic Male Sterile lines (TGMS) is considered as an alternative to CGMS system. Use of the thermo sensitive genic male sterility system in two line breeding is simple, inexpensive, efficient and eliminates the limitations associated with the cytoplasmic-genetic male sterility (CGMS) system in rice due to the different weather conditions prevailing in India. Hence, an understanding of genetic variability, heritability and correlation of pollen fertility with other traits will help in the effective selection of parents to exploit the maximum heterosis.

MATERIAL AND METHODS

A total of 28 medium and late maturing TGMS lines were selected for the present study. They were evaluated at Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore during *Rabi,* 2009-10, in a randomized block design with three replications. The data was recorded for twelve traits *viz.,* days to first flowering, plant height (cm), number of productive tillers per plant, panicle length (cm), spikelet fertility (%), grain yield per plant (g), angle of glume opening, stigma exertion (%), stigma length (cm), pollen fertility (%), panicle exertion (%) and no. of spikelets per primary panicle in five randomly selected plants of each genotype.

The analysis of variance was carried out statistically utilizing the mean values (Panse and Sukhatme, 1995) for the twelve characters studied in selected 28 TGMS lines. GCV and PCV were calculated using the formula suggested by Burton (1952). The heritability estimate in the broad sense was calculated by the method proposed by Lush (1940).

RESULTS AND DISCUSSION

The analysis of variance revealed the significant difference among 28 TGMS lines for the twelve characters studied, indicating sufficient scope for further

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improvement. The mean, GCV, PCV, heritability (broad sense) and genetic advance as percentage of mean worked out for twelve characters are presented in Table 1. The mean values of panicle exertion (50.94%), panicle length (20.90) and stigma length (2.27) were good, indicating that the genotypes were of superior quality for executing the hybrid breeding in rice. To have more outcrossing rate in male sterile lines of rice, in turn for more hybrid seed set, the traits panicle exertion, angle of glume opening, stigma exertion and stigma length are important. PCV was higher than GCV for all the characters studied. PCV ranged from 9.94 (panicle length) to 127.98 per cent (number of productive tillers) and GCV ranged from 3.07 (angle of glume opening) to 59.39 (pollen fertility). GCV was found to be moderate (10-20%) for plant height, stigma length, panicle exertion, panicle length and number of seeds per panicle. Similar findings of moderate GCV was reported earlier for plant height and panicle length (Umadevi *et al.,* 2009). Difference between the PCV and GCV was low for panicle length and stigma length indicating the less influence of environment. The quantitative traits, viz., pollen fertility (109.67), spikelet fertility (106.02), number of spikelets per panicle (82.86), plant height (82.14), number of productive tillers (127.98) and days to first flowering (78.21) expressed high variability at phenotypic level and low variability at genotypic level. This shows the high influence of environment for the expression of these traits in the TGMS lines studied.

The heritability and genetic advance estimates were interpreted as low, medium and high as per the classification of Johnson *et al.* (1955). Broad sense heritability ranged from 0.206 (angle of glume opening) to 88.55 per cent (stigma length). As heritability alone cannot serve as an indication of the expected genetic improvement, the genetic advance is also taken into consideration. High heritability estimates coupled with high genetic advance was observed for stigma length and panicle length. This indicated the lesser influence of environment in expression of these characters and prevalence of additive gene action in their inheritance which is amenable for direct selection. It was earlier reported for panicle length by Ushakumari *et al.* (2002) and Umadevi *et al.* (2009). High heritability coupled with very low genetic advance as per cent of mean was recorded for single plant yield indicating the non additive gene action hence, selection for this trait may not be rewarding. Low heritability with low genetic advance observed for days to first flowering, plant height, panicle exertion, angle

of glume opening and number of spikelets per panicle indicated the high influence of environment in the expression of these traits.

The genotypic correlations were of higher magnitude than the corresponding phenotypic correlation coefficients for the majority of trait combinations observed (Table 2). This is due to the predominant role of heritable factors. This study revealed that the pollen fertility had significant and positive correlation with panicle exertion, spikelet fertility, number of seeds per panicle and single plant yield at genotypic level. The observation supports earlier findings by Borbora *et al.* (2005) and Panwar and Mashiat Ali (2007) for number of filled grains per panicle. Highly significant and negative correlation of pollen fertility was observed with plant height, stigma exertion and stigma length at genotypic level. This indicates the traits panicle exertion, spikelet fertility, number of seeds per panicle and single plant yield are to be concentrated for the selection of plants while improving the TGMS lines.

Path coefficient analysis was worked out to get an insight into the direct and indirect effects of different characters on pollen fertility and the results are presented in Table 3. The moderate residual effect of 0.4551 in the present study indicated that some more characters are to be included for accounting purpose. Spikelet fertility (0.6482), panicle exertion (0.4456), number of seeds per panicle (0.1573) and single plant yield (0.1385) had the positive direct effect on the expression of pollen fertility. Days to fifty per cent flowering is having the highest negative direct effect on the expression of pollen fertility. The traits number of productive tillers, panicle exertion, stigma exertion, stigma length and single plant yield are having both positive direct and indirect effects on pollen fertility. Though plant height (-0.1849), angle of glume opening (-0.1625) and panicle length (-0.0164) are having negative direct effect on pollen fertility, these traits are having the positive indirect effect through majority of other traits studied. Similarly, number of seeds per panicle and spikelet fertility are having negative indirect effect, though the traits are having positive direct effect on the expression of pollen fertility.

The materials used for this study are the thermo sensitive genic male sterile lines, where majority of the reproductive traits are determined by environment. This study suggested that due emphasis may be given on characters like stigma length, panicle length and single plant yield for improvement of these lines, since majority of other traits are environment dependant.

Table 1. Estimates of genetic components for quantitative characters of rice TGMS lines

Traits	Mean	PCV	GCV	H$_2$ (BS)	GA	GA (% over mean)
Days to first flowering (DFF)	68.45	78.21	4.57	0.341	0.376	0.549
Plant height (PH)	94.1 cm	82.14	19.57	5.67	9.03	9.60
No. of productive tillers (NPT)	14.35	127.98	36.14	18.45	10.43	48.97
Pollen fertility (PF)	29.48%	109.67	59.39	29.33	19.53	66.26
Stigma exertion (SE)	19.28%	70.36	27.14	14.88	4.16	21.57
Stigma length (SL)	2.27 mm	13.87	13.06	88.55	57.48	85.01
Angle of glume opening (AGO)	14.33°	67.68	3.07	0.206	4.12	0.29
Panicle exertion (PE)	50.94%	74.81	13.3	3.16	2.48	4.87
Panicle length (PL)	20.90 cm	9.94	8.89	80.09	82.79	93.78
Spikelet fertility (SF)	27.14%	106.02	55.94	27.85	16.51	60.82
No. of seeds / panicle (NSP)	81.28	82.86	10.00	1.46	2.02	2.49
Single plant yield (SPY)	21 g	47.97	43.56	82.45	1.43	28.97

PCV : Phenotypic coefficient of variance
GCV : Genotypic coefficient of variance
H$_2$(BS) : Heritability in broadsense
GA : Genetic advance

Table 2. Genotypic and phenotypic correlations of rice TGMS lines

Traits		DFF	PH	NPT	SE	SL	AGO	PE	PL	SF	NSP	SPY	PF
DFF	G	1.000	-0.033	-0.172	0.195	-0.236	-0.123	-0.017	-0.464	0.122	0.451	0.103	-0.004
	P		-0.066	-0.132	0.128	-0.148	-0.073	0.030	-0.267	0.074	0.320	0.142	-0.026
PH	G		1.000	-0.132	0.256	0.180	-0.061	-0.115	-0.051	0.305	-0.180	0.533	-0.526**
	P		1.000	-0.014	0.166	0.076	0.018	-0.073	-0.007	0.203	-0.095	0.313	-0.149*
NPT	G			1.000	-0.190	0.153	0.082	-0.189	-0.105	-0.212	-0.115	-0.290	-0.264*
	P			1.000	-0.178	0.150	0.077	-0.170	-0.097	-0.191	-0.114	-0.246	-0.052
SE	G				1.000	0.058	-0.100	0.159	-0.154	0.986	0.132	0.249	-0.628**
	P				1.000	0.051	-0.095	0.154	-0.140	0.959	0.127	0.228	-0.289*
SL	G					1.000	0.117	0.239	0.056	0.061	0.239	0.295	-0.867**
	P					1.000	0.078	0.192	0.047	0.039	0.208	0.240	-0.235*
AGO	G						1.000	-0.048	0.390	-0.025	-0.040	0.005	-0.052
	P						1.000	-0.050	0.325	-0.024	-0.021	0.027	-0.013
PE	G							1.000	0.157	0.208	0.044	0.263	0.154*
	P							1.000	0.151	0.196	0.044	0.240	0.043
PL	G								1.000	-0.122	-0.283	0.104	-0.199
	P								1.000	-0.119	-0.242	0.095	-0.137
SF	G									1.000	0.081	0.259	0.646**
	P									1.000	0.074	0.245	0.271*
NSP	G										1.000	0.191	0.454**
	P										1.000	0.177	0.159
SPY	G											1.000	0.404**
	P											1.000	0.150
PF	G												1.000
	P												1.000

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

Table 3. Path coefficient analysis of pollen fertility and contributing characters in TGMS lines of rice

Traits	DFF	PH	NPT	PE	AGO	SE	SL	SF	NSP	PL	SPY	Genotypic correlation
DFF	**-0.4696**	0.0602	0.0350	0.0012	0.4371	0.0339	0.0462	-0.0035	-0.0533	0.1568	0.0235	0.2675
PH	-0.1529	**-0.1849**	0.0672	0.0798	0.1122	0.0442	0.0324	-0.0072	-0.0890	0.2618	0.0254	0.5587
NPT	-0.1912	0.1447	**0.0859**	0.0860	0.1379	0.0555	0.0510	-0.0080	-0.0948	0.2828	0.0313	0.5811
PE	-0.0037	0.0938	0.0469	**0.4456**	-0.0393	0.0301	0.0437	-0.0026	-0.0408	0.0735	0.0355	0.3944
AGO	-0.4607	0.0466	0.0266	-0.0139	**-0.1625**	0.0268	0.0428	-0.0032	-0.0466	0.1034	0.0180	0.1854
SE	-0.1843	0.0946	0.0552	0.0549	0.1382	**0.0863**	0.1237	-0.0116	-0.1501	0.5171	0.0683	0.7923
SL	-0.1444	0.0399	0.0291	0.0458	0.1269	0.0710	**0.1503**	-0.0099	-0.1342	0.4092	0.0522	0.6359
SF	-0.1007	0.0812	0.0415	0.0247	0.0869	0.0609	0.0904	**0.6482**	-0.1248	0.4146	0.0425	0.6009
NSP	-0.1540	0.1013	0.0501	0.0395	0.1277	0.0797	0.1242	-0.0126	**0.1573**	0.5182	0.0735	0.7850
PL	-0.1136	0.0747	0.0375	0.0178	0.0711	0.0689	0.0949	-0.0105	-0.1299	**-0.0164**	0.0555	0.8145
SPY	-0.0796	0.0339	0.0194	0.0403	0.0579	0.0425	0.0566	-0.0050	-0.0863	0.2595	**0.1385**	0.4778

Residual effect = 0.4551

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SOIL-SITE SUITABILITY EVALUATION FOR THE MAJOR CROPS GROWN IN CHILLAKUR MANDAL OF SPSR NELLORE DISTRICT, ANDHRA PRADESH

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ABSTRACT

A survey was undertaken in Chillakur mandal of SPSR Nellore district to evaluate the suitability of soils for rice, groundnut, sunflower and sesame crops. These soils belongs to Entisols and Inceptisols. Pedons 1, 3 and 4 (Typic Ustorthent), showed texture, organic carbon and shallow depth as major limitations. Organic carbon and pH are the major limitations in pedon 2 (Typic Haplustept). Pedons 5 and 6 (Typic Haplustept) exhibited organic carbon as major limitation whereas pedon 7 (Typic Ustipsamment) had texture and organic carbon as major limitations. The limitation levels of the land characteristics varied from crop to crop. The soil-suitability classes can be improved if the correctable limitations (soil fertility characteristics) were altered through soil amelioration measures. On the basis of soil potentials and constraints, suitable management practices were suggested to achieve sustainable yields in these crops grown on these soils.

KEY WORDS: Crop suitability, Land Evaluation, Limitations, Potentials.

INTRODUCTION

The performance of any crop was largely dependent on soil parameters (depth, texture, drainage *etc.*) as conditioned by climate and topography. Soil-site characterization for predicting the crop performance of an area forms land evaluation.The yield influencing factors for important crops have to be evaluated and the results obtained may be applied for higher production of these crops through proper utilization of similar soils occur elsewhere in same agro-climatic sub-region under scientific management practices (Khadse and Gaikwad, 1995).Studies on soil-site suitability evaluation is not available for crops in Chillakur mandal, in particular and SPSR Nellore district of Andhra Pradesh, in general. Hence, an attempt has been made to evaluate the soil suitability for four major crops *viz.,* rice, groundnut, sunflower and sesame on Entisols and Inceptisols in Chillakur mandal of SPSR Nellore district in Andhra Pradesh.

MATERIAL AND METHODS

Study area

The study area lies in between 14°01′and 14°12′ N latitudes and 79°51′ and 80°04′ E longitudes with an altitude ranging from 3 to 41 m (MSL). The soils have been developed from granite-gneiss and alluvium parent material. The area qualifies for semi-arid monsoonic climate with distinct summer, winter and rainy seasons. The area experiences mean annual (2005-2014) precipitation of 1113 mm. The mean annual temperature was 28.7°C with a mean summer temperature of 32.9°C and the mean winter temperature of 25.6°C. The soil moisture regime has been computed as ustic and soil temperature regime as isohyperthermic. The natural vegetation comprises of *Acacia nilotica, Parthenium hysterophorus, Cynodon dactylon, Azadirachta indica, Calotropis gigantia, Cyprus rotundus, Pongamia pinneta etc*.

Methodology

Seven typical pedons were studied on different landforms (plains and uplands) for their morphological characteristics following the procedure given by Soil Survey Staff (1951). Horizon-wise soil samples were collected from the typifying pedons and analyzed for their physical, physico-chemical and chemical properties following the standard procedures (Table 2). Soils were classified according to keys to Soil Taxonomy (Soil Survey Staff, 2014).These pedons were selected for

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evaluation and their suitability assessed using limitation method regarding number and intensity of limitations (Sys *et al.,* 1991).

The land scape and soil requirements for these crops (Sys *et al.,* 1991) were matched with generated data at different limitation levels: no (0), slight (1), moderate (2), severe (3), very severe (4). The number and degrees of limitations suggested the suitability of class of each soil for a particular crop (Sys *et al.,* 1991). The potential land suitability (Table 3) sub-classes were determined after considering the improvement measures to correct these limitations (Sys *et al.,* 1993). The present suitability classes can be improved if the correctable limitations such as pH, organic carbon and low fertility status are corrected / altered through soil amelioration measures.

RESULTS AND DISCUSSION

Soil characteristics were given in table 1 and the site and weighted means of soil characteristics were given in table 2. These soils were developed from granite-gneiss and alluvium parent material. The kind and degree of limitations for the four commonly growing crops were presented in table 3. Soils with more than four slight limitations, and / or with more than three moderate limitations were grouped under moderately suitability class (S2); the soil with more than three moderate limitations, and / or one or more severe limitation (s) was grouped under marginally suitability (S3) class; the soils with very severe limitations which can be corrected was categorized as N1 (temporarily not suitable); the soils with very severe limitations which cannot be corrected grouped under unsuitable class N2 (Sys *et al.*, 1991). This method also identifies the dominant limitation that restricts the crop growth in the sub-class symbol such as climatic (c), topographic (t), wetness (w), physical soil characteristics (s), soil fertility (f) and soil salinity / alkalinity (n). The suitability classes and sub-classes were decided by the most limiting soil characteristics. The soils vary in their suitability for different crops according to the criteria for the determination of the land suitability classes (Table 3).

Pedons1, 3 and 4, which were classified under Typic Ustorthents were marginally suitable (S3) for rice, groundnut, sesame and sunflower crops. The major limiting factors for growth of rice, groundnut, sesame and sunflower in these soils were wetness, texture, shallow depth and low organic carbon. Kumar and Naidu (2012) reported that Typic Ustorthents were marginally suitable for growing rice crop in Vadamalapeta mandal of Chittoor district in Andhra Pradesh.

Pedons 2, 5 and 6 were grouped under Typic Haplustepts. All pedons were marginally suitable (S3) for crops like rice, groundnut, sesame and sunflower. Soil fertility characteristics *viz.*, pH and organic carbon and physical soil characteristics like texture and drainage were the limitations. Organic carbon and pH were major limitations for all the four crops whereas soil texture was a limitation for rice crop. However, heavy texture and improper drainage were found to be important soil related constraints in growing these crops. Leelavathi *et al*. (2010) reported that Typic Haplustepts were marginally suitable (S3) for growing paddy crop in Yerpedu mandal of Chittoor district in Andhra Pradesh.

Pedon 7 was grouped under Typic Ustipsamment, was marginally suitable (S3) for growing groundnut, sesame and sunflower crops and temporarily not suitable (N1) for rice crop. This soil had limitations of excessively drained, physical characteristics like sandy texture and fertility characteristics like low sum of basic cations (low fertility) and low organic carbon. These findings were in good agreement with results of Sekhar *et al*. (2014) who stated that Typic Ustipsamment was temporarily not suitable (N1) for growing rice crop in soils of central and eastern parts in Prakasam district of Andhra Pradesh.

CONCLUSION

The soil-site suitability for different crops like rice, groundnut, sunflower and sesame revealed that all the pedons (1, 2, 3, 4, 5, 6 and 7) exhibited low organic carbon as severe limitation. Shallow depth was a major limitation for pedons 1, 3 and 4 whereas texture was a major limitation for growing rice crop in pedon 7. High pH is a major limitation in pedon 2. Organic carbon status in these soils can be improved by the application of farm yard manure, green manuring and inclusion of legumes in rotation and pH can be controlled by application of organic manures and sulphur. Soil texture can be improved by mixing with tank silt year after year. By correcting the above limitations sustainable yields can be achieved in rice, groundnut, sunflower and sesame crops. Hence, green manuring, addition of crop residues and organic manures in combination with chemical fertilizers in balanced form not only helps to achieve sustainable yields of crops but also maintains the soil health without undergoing deterioration.

Table 1. Relevant characteristics of the selected pedons

Depth (m)	Sand (2-0.05%)	Silt (0.05-0.002)	Clay (<0.002)	CaCO$_3$ (%)	CEC [cmol (p+) kg^{-1} soil]	BS (%)	Sum of basic cations [cmol (p+) kg^{-1} soil]	pH (1:2.5 H$_2$O)	OC (%)	EC (dSm^{-1})	ESP
	— % of <2 mm soil —										
Pedon 1: Typic Ustorthent											
0.00-0.20	49.10	22.30	28.60	4.50	9.67	79.94	7.57	6.60	0.32	0.01	1.65
0.20-0.52	25.40	40.70	33.90	4.00	14.78	75.51	10.96	6.73	0.30	0.02	1.35
0.52+	Weathered gneiss										
Pedon 2: Typic Haplustept											
0.00-0.18	15.70	53.80	30.50	9.50	16.52	72.76	11.69	7.43	0.61	0.08	2.00
0.18-0.33	43.70	27.70	28.60	11.50	14.78	79.84	11.48	7.93	0.57	0.02	2.17
0.33-0.55	41.60	25.80	32.60	10.00	17.93	70.50	12.21	8.40	0.46	0.03	2.40
0.55-0.80	37.70	24.00	38.30	12.00	20.87	64.21	13.05	8.50	0.43	0.05	1.68
0.80-1.15	38.00	29.70	32.30	15.00	21.84	69.96	14.99	8.20	0.38	0.03	1.33
1.15-1.50+	41.00	28.20	30.80	16.00	25.52	70.53	17.62	8.40	0.41	0.30	1.49
Pedon 3: Typic Ustorthent											
0.00-0.20	54.00	33.60	12.40	6.00	5.15	85.44	4.28	7.70	0.28	0.03	2.33
0.20-0.33	49.80	23.80	26.40	6.50	14.34	74.97	10.57	7.58	0.26	0.02	1.26
0.33-0.52+	50.30	18.50	34.60	5.50	18.69	71.70	13.25	7.60	0.23	0.02	0.80
0.52 +	Weathered gneiss										
Pedon 4: Typic Ustorthent											
0.00-0.25	33.30	32.10	31.20	4.50	6.30	84.29	5.25	6.10	0.24	0.02	0.95
0.25-0.55	62.30	15.60	22.10	3.50	5.10	98.24	4.94	6.33	0.22	0.03	1.37
0.55+	Weathered gneiss										

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Depth (m)	Sand (2-0.05%)	Silt (0.05 -0.002)	Clay (<0.002)	CaCO₃ (%)	CEC [cmol (p+) kg⁻¹ soil]	BS (%)	Sum of basic cations [cmol (p+) kg⁻¹ soil]	pH (1:2.5 H₂O)	OC (%)	EC (dSm⁻¹)	ESP
	—— % of <2 mm soil ——										
Pedon 5: Typic Haplustept											
0.00-0.21	55.20	21.10	23.70	5.50	13.80	59.06	8.06	6.20	0.57	0.03	0.65
0.21-0.35	51.50	19.10	29.40	6.00	14.24	66.64	9.32	6.21	0.54	0.03	1.19
0.35-0.57	33.20	28.50	32.10	7.50	14.56	60.99	8.70	6.38	0.49	0.03	1.24
0.57-0.78	42.30	25.60	38.30	6.50	22.82	60.65	13.69	6.17	0.46	0.03	0.66
0.78-1.00	40.60	28.40	31.00	7.00	15.43	72.33	11.07	6.60	0.41	0.03	0.58
1.00+	Weathered gneiss										
Pedon 6: Typic Haplustept											
0.00-0.27	58.70	18.20	23.10	8.50	10.22	66.93	6.74	6.30	0.46	0.32	0.98
0.27-0.37	54.80	20.40	24.10	7.00	6.74	88.43	5.79	6.80	0.43	0.02	2.52
0.37-0.58	52.40	21.70	25.90	5.50	9.46	67.34	6.19	7.12	0.42	0.03	1.90
0.58-0.78	18.70	50.40	30.90	6.50	12.06	66.42	7.88	7.24	0.32	0.06	1.08
0.78-0.91	17.40	52.60	30.00	6.00	10.00	63.50	6.20	7.28	0.35	0.02	1.50
0.91-1.20	15.20	53.40	31.40	8.00	10.90	61.56	6.60	7.20	0.22	0.21	1.01
1.20-1.50+	14.30	55.00	30.70	8.50	9.45	70.26	6.46	6.90	0.20	0.02	1.90
Pedon 7: Typic Ustipsamment											
0.00-0.30	88.4	5.30	6.30	1.50	5.40	57.59	3.04	6.23	0.24	0.05	1.30
0.30-0.58	90.6	4.20	5.20	2.00	4.70	61.91	2.84	6.40	0.22	0.04	1.49
0.58-0.80	90.5	3.70	5.80	2.00	5.10	76.67	3.83	6.45	0.18	0.03	1.57
0.80-0.98	90.6	3.20	6.20	2.50	5.30	71.51	3.71	6.50	0.14	0.03	1.51
0.98-1.27	89.6	4.30	6.10	2.00	5.10	65.10	3.26	6.20	0.16	0.31	1.18
1.27-1.48	90.6	3.70	5.70	2.00	4.90	55.10	2.64	6.10	0.12	0.02	1.22
1.48-1.90+	91.2	3.30	5.50	2.50	4.80	53.96	2.54	7.50	0.12	0.31	1.04

Table 2. Site and soil characteristics of studied profiles for crop suitability classification

Pedon No.	Land form	Parent material	Wetness (W) drainage	Physical soil characteristics (s)				Soil fertility characteristics (f)					Salinity and alkalinity (n)	
				Texture	Coarse fragments Volume (%)	Soil depth (m)	CaCO$_3$ (%)	Apparent CEC [c mol (p+) kg^{-1} soil]	Sum of basic cations [c mol (p+)kg^{-1} soil]	BSP	pH 1:2.5	OC (%)	EC (dSm^{-1})	ESP
1	Upland	Weathered gneiss	Well drained	scl	Nil	0.52+	4.19	39.68	8.25	77.21	6.63	0.32	0.02	1.65
2	Plain	Weathered gneiss	Somewhat poorly drained	sicl	Nil	1.50+	11.64	53.70	11.63	70.63	7.57	0.60	0.04	2.40
3	Upland	Weathered gneiss	Well drained	sl	<15	0.52+	5.94	49.10	5.54	77.80	7.68	0.28	0.02	2.33
4	Upland	Weathered gneiss	Well drained	scl	Nil	0.55+	3.95	21.64	5.25	91.90	6.20	0.24	0.02	1.37
5	Plain	Weathered gneiss	Well drained	scl	Nil	1.00+	6.55	51.63	8.26	63.80	6.20	0.57	0.02	1.24
6	Plain	Weathered gneiss	Well drained	scl	Nil	1.50+	6.95	38.98	6.74	68.13	6.3	0.46	0.12	2.52
7	Plain	Coastal alluvium	Excessively drained	s	Nil	1.90+	1.94	87.58	3.04	65.65	6.23	0.24	0.04	1.57

Table 3. Limitation levels of the land characteristics and land suitability classes

| Soil | Crop | Wetness (w) drainage | Physical soil characteristics (s) | | | | Soil fertility characteristics (f) | | | Alkalinity (n) | Actual land suitability sub-class | Potential land suitability sub-class |
			Texture	Coarse fragments (Vol. %)	Soil depth (cm)	CaCO₃ (%)	Sum of basis cations [cmol (p+) kg⁻¹ soil]	pH 1:2.5	OC (%)	ESP		
Typic Ustorthents	Rice	2	2	0	2	1	0	0	3	0	S3wsf	S2ws
	Groundnut	0	0	0	2	0	0	0	3	0	S3sf	S2s
	Sesame	0	0	0	2	-	0	1	3	0	S3sf	S2s
	Sunflower	0	1	0	3	0	0	0	3	0	S3sf	S3s
Typic Haplustepts	Rice	2	2	0	0	1	0	1	3	0	S3wsf	S2ws
	Groundnut	1	1	0	0	0	0	2	3	0	S3sf	S1
	Sesame	2	0	0	0	-	0	3	3	0	S3wf	S1w
	Sunflower	2	0	0	0	1	0	2	3	0	S3wsf	S1w
Typic Ustorthents	Rice	2	3	2	2	1	1	1	3	0	S3wsf	S3ws
	Groundnut	0	0	2	2	0	0	2	3	0	S3sf	S2s
	Sesame	0	0	1	2	-	1	2	3	0	S3sf	S2s
	Sunflower	0	2	1	3	0	0	2	3	0	S3sf	S3s
Typic Ustorthents	Rice	2	2	0	2	1	0	0	3	0	S3wsf	S2ws
	Groundnut	0	0	0	2	0	0	1	3	0	S3sf	S2s
	Sesame	0	0	0	2	-	0	0	3	0	S3sf	S2s
	Sunflower	0	1	0	3	1	0	1	3	0	S3sf	S3s
Typic Haplustepts	Rice	2	2	0	0	2	0	0	3	0	S3wsf	S2ws
	Groundnut	0	0	0	1	0	0	1	3	0	S3f	S1
	Sesame	0	0	0	1	-	0	0	3	0	S3f	S1
	Sunflower	0	1	0	2	1	0	1	3	0	S3sf	S2s
Typic Haplustepts	Rice	2	2	0	0	2	0	0	3	0	S3wsf	S2ws
	Groundnut	0	0	0	0	0	0	1	3	0	S3f	S1
	Sesame	0	0	0	0	-	0	1	3	0	S3f	S1
	Sunflower	0	1	0	0	1	0	1	3	0	S3f	S1
Typic Ustisamments	Rice	2	4	0	0	0	2	1	3	0	N1wsf	N1ws
	Groundnut	0	3	0	0	0	1	1	3	0	S3sf	S3s
	Sesame	0	3	0	0	-	2	1	3	0	S3sf	S3s
	Sunflower	0	3	0	0	0	1	1	3	0	S3sf	S3s

Limitations: 0-No; 1-Slight; 2-Moderate; 3-Severe; 4-Very severe; Suitability classes: f-Soil fertility limitations; s-Physical soil limitations;

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IMPACT OF CROP GEOMETRY AND NITROGEN LEVELS ON THE PERFORMANCE OF FODDER MAIZE

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ABSTRACT

An investigation on the performance of fodder maize to varied crop geometry and nitrogen levels was conducted during *kharif*, 2013 at S.V.Agricultural College, Tirupati on sandy loam soil. There were eighteen treatment combinations consisted of six crop geometries *viz.,* 30 × 10 cm, 30 × 15 cm , 30 × 20 cm, 45 × 10 cm , 45 × 15 cm and 45 × 20 cm assigned to the main plots and three nitrogen levels *viz.,* 140 kg ha^{-1}, 180 kg ha^{-1} and 220 kg ha^{-1} applied to sub plots in split plot design with three replications. The crop geometry of 30 × 10 cm (3,33,333 plants ha^{-1}) recorded the highest values of growth parameters and green fodder yield of fodder maize while they were found to be the lowest with 45 × 20 cm (1,11,111 plants ha^{-1}). Growth characters like number of leaves plant^{-1} and dry matter accumulation as well as green fodder yield were increased due to increased levels of nitrogen application from 140 to 220 kg ha^{-1}. The treatment combination of a crop geometry of 30 × 10 cm with application of 220 kg N ha^{-1} resulted in the maximum green fodder yield (412 q ha^{-1}) and benefit-cost ratio (4.0) followed by 30 × 15 cm with 220 kg N ha^{-1}.

KEY WORDS: Crop geometry, Fodder maize, Green fodder and Nitrogen levels

INTRODUCTION

Against the projected need of 1025 million tonnes of green fodder in the country, the present availability is to the tune of 390 million tonnes only. Andhra Pradesh supports 59.8 million heads of livestock with a vast deficit of about 50 per cent of green fodder. The area under fodder crops is negligible with 4.6 per cent of the cultivated area. Maize (*Zea mays* L.) is a miracle crop grown for food as well as fodder having an edge over other fodder crops due to its higher production potential of green herbage, which is highly succulent, sweet, palatable, nutritious with lactogenic effect and highly relished by the milch cattle at any stage of the crop growth. The plant population that can be maintained with crop geometry influences the canopy architecture, alters growth and developmental pattern and paves the way for efficient utilization of available resources. Therefore, among the agronomic practices, the optimum plant population with suitable crop geometry is an extremely simple and monetary practice for enhancing the productivity of fodder maize. On the other hand, maize is a nitro positive crop and needs ample quantity of nitrogen for the expression of its full yield potential. Keeping all the above points in view, to evolve best agronomic practices for higher yield and quality of fodder maize, the present investigation was carried out to identify the best combination of crop geometry and nitrogen levels for higher productivity and quality of fodder maize.

MATERIAL AND METHODS

A field experiment was carried out during *kharif*, 2013 on sandy loam soils of dryland farm, S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University. The soil was sandy loam in texture, low in organic carbon and available nitrogen (188 kg ha^{-1}) and medium in available phosphorus (14 kg ha^{-1}) and potassium (164 kg ha^{-1}) .The experiment was laid out in a split plot design and replicated thrice. The treatments consisted of six crop geometries *viz.,* 30 × 10 cm, 30 × 15 cm, 30 × 20 cm , 45 × 10 cm, 45 × 15 cm and 45 × 20 cm assigned to the main plots and three nitrogen levels *viz.,* 140 , 180 and 220 kg ha^{-1} applied to sub plots. The test variety of fodder maize was 'African Tall'. was sown on 26-07-2013 and harvested on 02-10-2013. Uniform dose of 75 kg ha^{-1} P$_2$O$_5$ through single super phosphate and 30 kg ha^{-1} K$_2$O through muriate of potash was applied basally, at the time of sowing in furrows

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5 cm away from the seed rows. Nitrogen was applied through urea as per the treatments in two equal splits at the time of sowing as basal and at 30 DAS as top dressing. The growth parameters *viz.*, number of leaves plant[-1], drymatter production along with green fodder yield were recorded and statistically analyzed by the method of analysis of variance as outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Crop Geometry

The highest number of leaves plant[-1] and dry matter production of fodder maize at harvest were produced with the crop geometry of 30 × 10 cm, while the reduced growth stature was observed with 45 × 20 cm. Higher plant density unit area[-1] (3,33,333 plants ha^{-1}) might have produced more number of green leaves per unit area though the number of leaves plant[-1] was found to be the lowest. Optimum plant density at this geometry might have promoted better light interception by the leaves and enhanced photosynthesis leading to higher dry matter production, which was noticed in the present study corroborates with earlier findings of Sheraz Mahdi *et al.* (2010).

Higher plant density of 3,33,333 plants ha^{-1} might have resulted in better light absorbance by more number of flag leaves which have higher photosynthesis efficiency and enhanced green fodder yield. (Tetio-Kagho and Gardnar, 1988). Decreased row spacing with 30 × 10 cm also promotes more equidistant plant spacing which decreases plant competition, while improves better resource capture and utilization in maize. (Duncan, 1958). The crop geometry of 30 × 10 cm recorded 102.6% of higher green fodder yield than 45 × 20 cm. Though the leaf number plant[-1] was found to be the highest with the crop geometry of 45 × 20 cm, it resulted in the lowest leaf area index and dry matter production due to sparse plant density unit area[-1] and thus recorded the lowest green fodder yield. Enhanced fodder yield with the closer crop geometry of fodder maize, as in the present study corroborates with earlier findings of Muhammad Aslam *et al.* (2011). The highest net returns and benefit-cost ratio were realized with fodder maize under the crop geometry of 30 × 10 cm, which was superior to all other crop geometries tried.

Nitrogen Levels

Increasing the nitrogen levels from 140 to 220 kg ha^{-1} resulted in progressively improved growth stature of maize

viz., higher number of leaves plant[-1] and dry matter production. The increase in growth parameters with increased levels of nitrogen might be due to enhanced synthesis of chlorophyll, induced cell division and cell expansion leading to stimulated cell elongation along the main axis, which resulted in increased number and length of internodes and conspicuous increase in number of leaves plant[-1]. Therefore, the increased photosynthetic efficiency with higher nitrogen supply might have resulted in higher dry matter accrual. The findings evidenced in this investigation corroborates with the reports of Safdar Ali *et al.* (2012).

Nitrogen in plants has many functions for enhancement of morphological and physiological traits *viz.,* shoot development, leaf emergence, plant stuffiness and dry matter accumulation. The highest level of nitrogen tried at 220 kg ha^{-1} resulted in 43.5% of higher green fodder yield compared to the lowest level at 140 kg ha^{-1}. There was linear and significant increase in benefit-cost ratio with increase in nitrogen level. Higher nitrogen level of 220 kg ha^{-1} proved to be economically advantageous with higher green fodder yield of maize.

Interaction effect of crop geometry and nitrogen levels

With regard to interaction effect, the highest number of leaves plant[-1] was observed with 45 × 20 cm of crop geometry and 220 kg N ha^{-1} due to the advantage of increased availability of nitrogen and other growth resources under higher level of nitrogen supply with lower plant population. Whereas, the lowest level of nitrogen @ 140 kg N ha^{-1} might not be sufficient to meet the requirement of higher plant population of 3,33,333 under 30 × 10 cm, which was reflected through production of the lowest number of leaves plant[-1.]. Biomass production is the function of leaf area development and consequential photosynthetic activity. Therefore, the highest green fodder yield of fodder maize was registered with narrow crop geometry of 30 × 10 cm along with the application of highest nitrogen level at 220 kg ha^{-1}. The positive effect of higher plant density under higher level of nitrogen nutrition was resulted through the production of maximum biological yield. The next best combination in producing higher dry matter production was the application of 220 kg N ha^{-1} and 45 × 10 cm. The lowest green fodder yield recorded with the crop geometry of 45 × 20 cm along with 140 kg N ha^{-1} was due to the fact that reduced plants unit area[-1] with the crop geometry of 45 × 20 cm might have prevented the exploitation of available resources

Table 1. Number of leaves plant⁻¹ and dry matter production (kg ha⁻¹) of fodder maize as influenced by crop geometry and nitrogen levels

Treatments	Number of leaves plant⁻¹ Nitrogen levels (kg ha⁻¹)				Dry matter production (kg ha⁻¹) Nitrogen levels (kg ha⁻¹)			
	140	180	220	Mean	140	180	220	Mean
Crop geometry								
30 × 10 cm	11.2	12.3	13.3	12.2	7150	7912	10314	8459
30 × 15 cm	11.9	12.9	13.7	12.8	4926	5991	8135	6351
30 × 20 cm	12.7	13.1	14.1	13.3	4138	5308	6141	5196
45 × 10 cm	11.9	14.1	13.7	13.2	4892	6118	7492	6167
45 × 15 cm	12.7	13.3	14.3	13.4	4044	5156	6094	5098
45 × 20 cm	13.1	13.9	14.8	13.9	3319	4335	4910	4188
Mean	12.3	13.3	14.0		4745	5803	7181	
	CD(P=0.05)				**CD(P=0.05)**			
Crop geometry	0.08				339			
Nitrogen levels	0.29				501			
P at N	0.14				587			
N at P	0.32				726			

Table 2. Green fodder yield (q ha⁻¹) and benefit-cost ratio of fodder maize as influenced by crop geometry and nitrogen levels

| Treatments | Green fodder yield (q ha⁻¹) | | | | Benefit – cost ratio | | | |
| | Nitrogen levels (kg ha⁻¹) | | | | Nitrogen levels (kg ha⁻¹) | | | |
	140	180	220	Mean	140	180	220	Mean
Crop geometry								
30 × 10 cm	286	315	411	337	2.8	3.1	4.0	3.3
30 × 15 cm	198	239	239	226	2.1	2.5	3.4	2.7
30 × 20 cm	165	212	246	208	1.8	2.3	2.6	2.2
45 × 10 cm	196	245	299	246	2.1	2.6	3.1	2.6
45 × 15 cm	161	211	242	205	1.8	2.3	2.6	2.2
45 × 20 cm	133	170	196	166	1.5	1.9	2.2	1.8
Mean	189	232	272		2.1	2.5	2.9	
	CD(P=0.05)				**CD(P=0.05)**			
Crop geometry	13.0				0.14			
Nitrogen levels	18.9				0.19			
P at N	22.5				0.26			
N at P	27.6				0.29			

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under sub optimal supply of nitrogen at 140 kg ha^{-1} which eventually resulted in the lowest fodder yield under their combination. Sowing the crop with geometry of 30 × 10 cm and application of nitrogen at 220 kg ha^{-1} registered 209 per cent of higher green fodder yield and benefit-cost ratio than with wider crop geometry of 45 × 20 cm and 140 kg N ha^{-1}. These results are in conformity with the findings of ShafiNazir *et al.* (1997).

The present study has revealed that sowing of at 30 × 10 cm (3,33,333 plants ha^{-1}) and application of nitrogen at 220 kg ha^{-1} proved suitable agro technique for achieving higher productivity and remunerative returns of fodder maize.

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TRENDS AND VARIATIONS IN ARRIVALS AND PRICES OF COTTON

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ABSTRACT

Cotton is an important cash crop among the major commercial crops grown in Andhra Pradesh. The present study seeks to make a modest attempt to examine the nature and magnitude of the arrivals and price fluctuations in Khammam regulated market of Khammam district of Andhra Pradesh, considering secondary time-series data for the period of 14 years (From April 2000 to March 2014). The analysis of the data showed that seasonal indices of cotton arrivals were minimum during the month of September and maximum in the month of November. The maximum prices were observed during the month of July whereas minimum prices in the month of October. The results revealed that with regard to arrivals, there was a presence of seasonality within a year (p = 1.02E-32) and seasonal pattern did not change over the years (p = 0.8442). While in prices, there was no seasonality within a year (p = 0.7889) as well as between years (p = 0.6953) at five per cent level of significance. The results showed that there was an increasing trend in the arrivals and prices in the market over the years. Definite cycles were not observed in the market during the study period. A positive significant relationship was exhibited between arrivals and prices in the market for the study period.

KEY WORDS: Correlation, Cyclical, Irregular, Seasonal variations, Trend and two way ANOVA.

INTRODUCTION

Cotton is an important cash crop among the major commercial crops grown in India as well as in Andhra Pradesh. Cotton, popularly known as 'White Gold', dominates India's cash crops, and makes up 65 per cent of the raw material requirements of the Indian textile industry. India is the third largest cotton producer in the world behind China and the United States, accounting for 25 per cent of the world acreage but only 14 per cent of world production (*USDA 2001*).

Major Cotton producing countries are China, USA, India, Pakistan and Brazil. India ranks first in the world with respect to area and it ranks third and fifth with respect to production and productivity of cotton respectively. Cotton in India occupies area of 110 lakh hectares with a production of 325 lakh bales and productivity of 503 Kg/ha. (*www.indiastat.com*).

The major cotton growing States are Maharashtra, Gujarat, Andhra Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Karnataka and Tamil Nadu. Among the cotton growing states, Andhra Pradesh occupies third position in the country in respect of area, production and productivity of cotton.

It was observed that cotton production in Andhra Pradesh is fluctuating with the vagaries of rainfall. Over the years, it has witnessed several ups and downs in area, production and productivity.

Farmers always experience with lower prices for their produce when bumper crop is harvested. They always commit the mistakes in disposing off their produce at right time in order to get remunerative prices for their produces. Usually, they sell their produce when there is a glut in the market i.e., immediately after the harvest of the crop. For this inappropriate time of sale, one can quote several reasons, but among them the most important is lack of awareness and knowledge about the proper time to sell their produce. This kind of study helps in formulating appropriate policy measures to contain both over production as well as forecasting of the remunerative prices for the commodity.

The seasonal fluctuations are regularly recurring pattern that are completed once in twelve months. Such seasonality is seen in the arrivals as well as in the prices of farm products (*Nahatkar et al., 1998*). It arises from the nature of production, supply and demand in the markets and price formations for crops, seasonal variations that arise from climatic factors and biological growth process

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of plants. Following the seasonality in production and arrivals, the prices also exhibit seasonal variations. Normally the prices of storable produce are lower at harvest time and then rise as the season progresses, reaching their peak just prior to the next harvest. The study of seasonal fluctuations is considered to be an important as a guide to the consumer to purchase his needs at the right time. It also serves as guides to the Government operate its policy measures (procurement and buffer release) at the appropriate time.

The trends in arrivals and prices are the changes over years and are associated with changes in technology of production, input supply and infrastructure. The trends of prices are associated with increase in population, money supply, increased purchasing power and generally with inflation or deflation observed in the economy. The study of trends enables us to indicate the general direction of change in arrivals and prices in different markets.

The study of cyclical variations is extremely useful in framing suitable policies for stabilizing the level of business activity, i.e., for avoiding periods of booms and depression as both are bad for economy – particularly depression which brings about a complete disaster and shatters the economy. Amongst all the methods of arriving at estimates of the cyclic movements of time series, the residual method is most commonly used.

Irregular variations resulted from unpredictable forces which operate in irregular manner. Such variations do not exhibit any definite shape, so these are called irregular variations. Irregular variations are caused by sudden changes in demand or very rapid technological progresses may also be included in this category. By their very nature these movements are very irregular and unpredictable.

The study of relationship between market arrivals and prices is very useful. Large productions as well as large arrivals reflect adversely on the price which finally leads to their downfall. The behaviour of market arrivals and prices has been studied by Kumar et al., (2005), Munidinamani et al., (1993), Pawar and Misal (2005). Kumuda Keerthi et al., (2013), Mohan Naidu et al., (2014). Mohan Naidu (2014) have studied a statistical study on arrivals and prices of cotton in Karimnagar district of Andhra Pradesh.

MATERIAL AND METHODS

This study was undertaken with an overall objective of analysing the arrivals and prices of cotton from Khammam Agricultural Market Committees of Andhra Pradesh (A.P.). The secondary data collected for the study was monthly arrivals (Q) and prices (Rs/Q) of cotton from the Khammam Agricultural Market Committee of A.P. for a period of 14 years (2000-01 to 2013-14).

Methodology

Time series analysis was done to study the variations in monthly prices and arrivals of cotton for the period of 14 years. A time series is a complex mixture of four components namely, Trend (T_t), Seasonal (S_t), Cyclical (C_t) and irregular (I_t) variations. These four types of movements are frequently found either separately or in combination in a time series. The relationship among these components is assumed to be additive or multiplicative, but the multiplicative model is the most commonly used method in economic analysis, which can be represented as

$$y_t = T_t * S_t * C_t * I_t$$

where,

y_t = Original observation at time t

t = monthly data of cotton arrivals in quintals and prices (Rs/Q) i.e. t = 1,2,....,168

T_t = Trend component at period t; S_t = Seasonal component at period t

C_t = Cyclical component at period t; I_t = Irregular component at period t

Seasonal indices

This is one of the widely accepted sophisticated tools of analysis of time series data for season-wise variations in prices and arrivals. The first step is, to estimate the seasonal indices of 12 month centred moving averages.

The multiplicative model permits the estimation of each of the above four components. As a first step to estimate the seasonal indices, a 12-month moving averages was calculated as follows

$$M_1 = \frac{Y_1 + Y_2 + Y_3 + \text{.......} + Y_{12}}{12} \; ;$$

$$M_2 = \frac{Y_2 + Y_3 + Y_4 + \text{.......} + Y_{13}}{12} \; ; \dots etc.,$$

where, M_1, M_2, M_3,…….. etc., are called 12 months centered moving averages

This is in sequential manner for each point of time t. In this manner a 12 month centered moving average removes a large part of fluctuation due to seasonal effects, so that what remains is mainly suitable to other sources viz., long term effects (T_t), cyclical effect (C_t). The irregular variation (I_t) was due to random causes and the same was minimised as process of smoothing out effect. Thus, it affords a mean of not only estimating trend component effect but also estimating seasonal components.

Trend analysis

The polynomial regression analysis was adopted to study the trends in arrivals and prices of cotton in Khammam market of A.P. When definite mathematical model cannot be identified to fit trend data, the polynomials are used to determine the long term behaviour. These polynomials are fitted by the method of least squares

1st degree $Y_t = a + bt + e$

2nd degree polynomial $Y_t = a + bt + ct^2 + e$ etc.,

are the coefficients to be estimated. Since the objective is to find the polynomial of lowest degree that seems to be an adequate fit for the data, it is necessary to test for the significance of each 'b' regression coefficient in successive 'b's turn out to be non- significant. The suitable model for data is judged based on regression coefficient and adjusted R^2.

RESULTS AND DISCUSSION

Seasonal indices of cotton arrivals and prices

The patterns of variation in arrivals and prices within a year as revealed by the seasonal indices were computed for each month. The peak arrivals were observed during the months of November (254.32) and December (201.68) while the lowest arrivals were observed that during the months of September (11.42) and August (15.11). The prices were high during the month of July (106.77) and

August (104.33) whereas lowest prices were observed during the months of October (93.48) and November (96.06).

The results of two-way ANOVA reveal that with regard to arrivals, there was a presence of seasonality within a year ($p = 1.02E-32$) and seasonal pattern did not change over the years ($p = 0.8442$) at 5 per cent level of significance. While in prices, there was no seasonality within a year ($p = 0.7889$) as well as between years. Similar pattern of arrivals and prices of cotton was noticed by Mohan Naidu, 2014. The seasonal indices of arrivals and prices were presented in Table 1 and illustrated in Figure 1.

Table 1. Seasonal indices in arrivals and prices of cotton

Month	Arrivals	Prices
January	155.26	98.7
February	134.66	99.22
March	141.08	101.52
April	82.56	102.65
May	31.27	100.54
June	32.72	98.62
July	29.28	106.77
August	15.11	104.33
September	11.42	99.53
October	110.65	93.48
November	254.32	96.06
December	201.68	98.58

Secular trend in monthly arrivals of cotton

In order to determine the nature of trend movement in the arrivals of cotton in Khammam market, the data was fitted to the first degree polynomial equation. This model has adjusted R^2 equal to 0.0607, which means that about 6.07 per cent of arrivals can be explained in terms of time. The trend equation in the form of

$$Y_t = 29374.77 + 303.6123t$$

It can be seen from above equation the arrivals of cotton, displayed an increasing trend in arrivals over the years. The monthly increase in the arrivals of cotton was observed to be 304 quintals per month. The graph of the trend in arrivals over years was shown in Figure 2.

Secular trend in monthly prices of cotton

In order to determine the nature of trend movement in the prices of cotton in the market, the data was fitted to
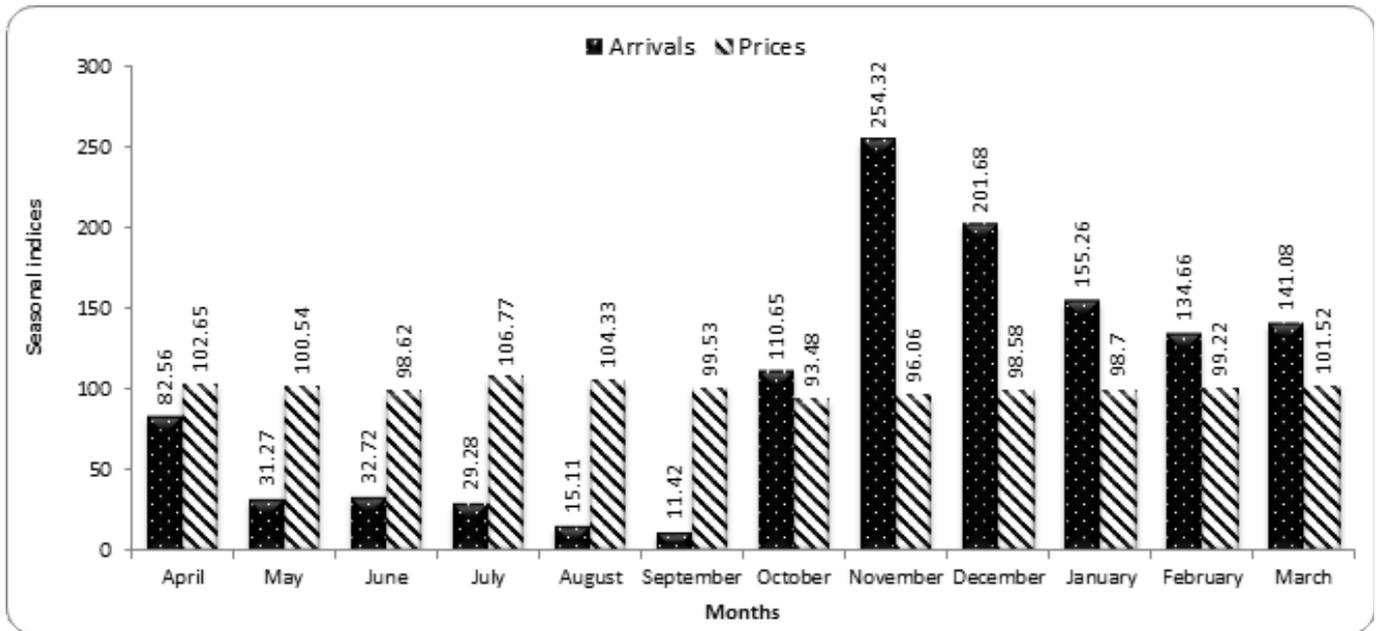
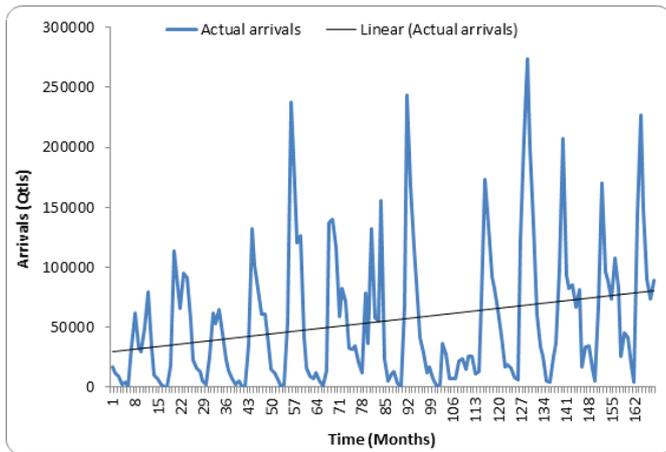Fig.1. Seasonal indices of arrivals and prices of cotton

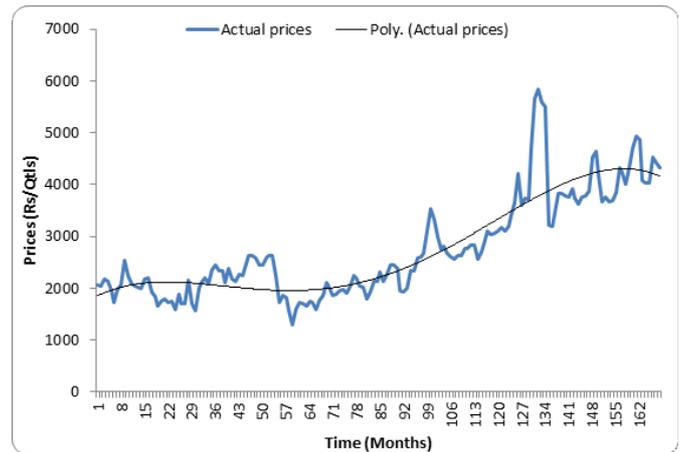Fig. 2. Secular trend in monthly arrivals of cotton
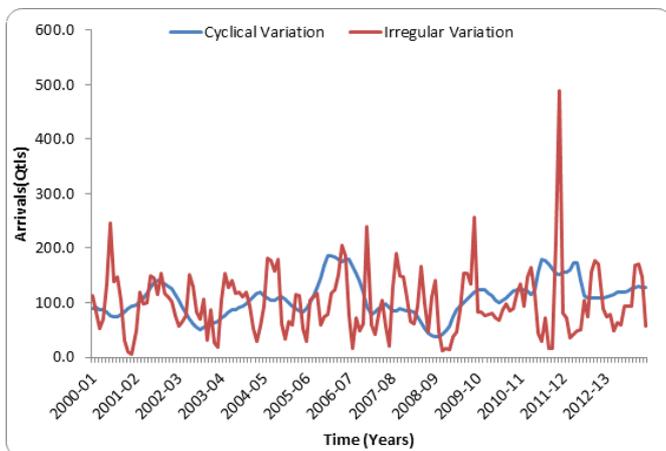

Fig. 3. Secular trend in monthly prices of cotton

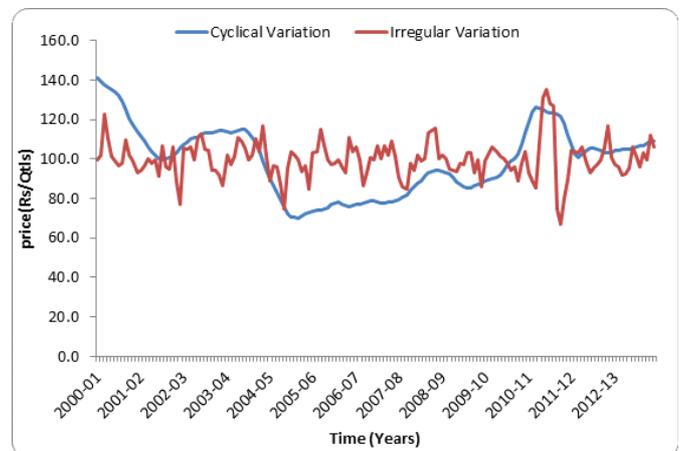Fig.4: Cyclical and irregular variations of cotton arrivals

Fig.4: Cyclical and irregular variations of cotton prices

the fourth degree polynomial equation. This model has adjusted R^2 equal to 0.7937, which means that about 79.37 per cent of prices can be explained in terms of time. The trend equation in the form of

$$Y_t = 1819.228 + 33.0718t - 1.1600t^2 + 0.0133t^3 - 4.2E - 05t^4$$

It can be seen from the above equation the prices of cotton, had showed an increasing trend in prices over the years. The graph of the trend in prices over the years was shown in Figure 3.

Cyclical and Irregular variations

The cyclical and irregular variations in arrivals and prices of cotton were illustrated in Figures 4 and 5. It can be seen from the figures that the cyclical variations showed a smooth trend whereas there existed fluctuations because of irregular variations. But these quit low as compared to the observed values. Form the figures it could be observed that there was no definite cycles existed in the selected market.

A positive significant relationship was seen between arrivals and prices in terms of correlation coefficient (0.1576) over the years and months in the market. The result is similar to Mohan Naidu, 2014.

CONCLUSIONS

The results showed that there was increasing trend in the arrivals as well as prices during the study period. The seasonal fluctuations revealed the peak arrivals during the month of November while lower arrivals during the month of September. The maximum prices were observed during the month of July whereas minimum prices were during the month of October.

From the foregoing, it may be concluded that with regard to arrivals, there was a presence of seasonality within a year and seasonal pattern did not change over the years. While in prices, there was no seasonality within a year (p =0.7889) as well as between years. The results of the study have confirmed the positive significant relationship between market arrivals and prices in terms of correlation coefficient over the years and across months in the market for the study period.

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STUDIES ON FRUIT DEVELOPMENT IN DIFFERENT CULTIVARS OF SAPOTA

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ABSTRACT

The different cultivars of sapota namely Cricket Ball, Singapore, CO-1, CO-2, PKM-1, PKM-2, PKM-3, DHS-1, DHS-2, Kalipatti and Pala took about 6-9 months from fruit set to harvestable maturity and followed double sigmoid curve in terms of fruit weight. The number of days required from fruit set to harvest differed significantly with the varieties. The cv. DHS-2 recorded the highest number of days (263.46) to attain harvestable maturity followed by cv. DHS-1 (258.00) and Cricket Ball (257.93) while the lowest was observed in cv. PKM-1 (189.33). The fruit weight was maximum in cv. Cricket Ball (123.20 g) followed by cv. DHS-1 (122.40 g) while it was minimum in cv. Pala (32.09 g) and PKM-1 (46.18 g). The pattern of fruit development in terms of fresh weight of the fruit followed double sigmoid growth curve and maximum increase in fruit weight was observed between 150- 210 days after set.

KEY WORDS:

INTRODUCTION

Sapota (*Manilkara achras (Mill). Fosberg*) is one of the most important fruits of India. It belongs to family sapotaceae and is a native of Tropical America. It is a sweet smelling, delicious fruit of commercial importance. The development of fruit taste palatability as well as ripening are markedly influenced by proper growth, development and fruit maturity . Fruits on attainment of harvestable stage fail to show a green tissue or latex when scratched with finger nail. The fruit shed off brown scaly external material and become smooth on attainment of physiological maturity. The varietal differences with regard to fruit growth and development of sapota were earlier reported (Sulladmath, 1975, Ingle *et al.*, 1982 and Paralkar *et al.*, 1987 and Dhua *et al.,* 2006).

MATERIAL AND METHODS

The canopy of the trees was divided into lower, middle and upper strata for recording observations on branching and flowering. The lower part of the canopy up to 1/3rd height was considered as lower strata, from 1/3rd to 2/3rd height as middle strata and the top 1/3rd. Height of the canopy as upper strata. Five randomly selected branches in all directions of the canopy were considered in lower, middle, and upper strata in each tree for recording the observations. Thus data were recorded on a total of 15 branches in each tree and 45 branches in each replication in a given variety.

For this purpose, all the branches in the three strata were recokened as one. The data were recorded at monthly intervals from fruit set to harvest to observe the fruit development pattern. Fruit weight in grams was recorded on fifteen randomly selected fruits from all the strata in each tree and the mean values were presented. Dry weight of the fruits was also recorded on all the sampled fruits at monthly intervals till harvest. The seed weight was also recorded along with fruit weight at monthly intervals till harvest. During the period of fruit growth and development the maximum and minimum temperature ranges from 29.5°C to37.2°C and 16.7°C to 26.8°C, respectively and relative humidity ranged from 66.10 to 86.23 per cent.

RESULT AND DISCUSSION

Days to harvest

Significant differences among the varieties were observed with regard to days to harvest (Table 1). The mean number of days from fruit set to harvest ranged from 189.3 to 263.4 days in with different cultivars. The fruits of cv. DHS-2 recorded the highest number of days to harvest (263.46) followed by the fruits of cv. DHS-1 (258.00), Cricket Ball (257.93) and CO-1 (257.930) which were at par with CO-2 (257.46) and PKM-3 (257.44).

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The cv. PKM-1 recorded the shortest period of fruit development (189.33 days) closely preceded by cv. Singapore (192.26) and Pala (194.66) and no significant difference were observed among these three.

Fresh and dry weight of the fruit (g)

A perusal of data on fruit growth indicated significant variation among varieties (Table 2 and 3). The average fresh fruit weight of different varieties at harvest ranged from 32.09 to 123.20 g. The fruits of Cricket Ball (123.20 g) were significantly superior over DHS-1 (122.40 g) and DHS-2 (120.70 g). The minimum fruit weight was recorded in cv. Pala (32.09 g) which was significantly inferior to others and was preceded by PKM-1 (46.18 g) and Singapore (71.23 g)

The fruit weight recorded from second month after set increased gradually towards harvest. The mean fruit weight increased from 0.810 g at second month after set to 65.35 g at seventh month after fruit set by which time four varieties attained the stage of harvest. Significant differences in fruit weight were observed among different months after set. However, the fruit growth continued till 9 months after set in 6 cultivars *viz.*, CO-1, PKM-3, Cricket Ball, DHS-1 and DHS-2.

The interaction between the varieties and the month of fruit development significantly influenced the fruit growth. The PKM-2 (0.740) and Pala (0.750) at second month after fruit set recorded the lowest weight while, the highest was observed in fruits of Cricket Ball (123.2 g), DHS-1 (122.4 g) at harvest.

Similar trends were also observed with the dry weight of fruits at different stages of development (Table 2 and 3). The mean dry weight of fruits ranged from 9.05 g in Pala to 39.567 g in Cricket Ball at harvest.

Seed weight (g)

The data on seed weight recorded from the third month after fruit set were presented in the Table 4. Which revealed significant differences among varieties.

The mean seed weight of different varieties at harvest ranged from 2.11 g to 5.81 g. Significantly higher seed weight was observed in Cricket Ball (5.81 g) followed by the DHS-2 (5.61 g). Significantly lowest seed weight was recorded in Pala (2.11 g) preceded by PKM-1 (2.42 g) and Kalipatti (3.73 g).

The seed weight recorded from third month after fruit set increased gradually towards harvest. The seed weight increased from 0.083g at third month after set to 4.135g at seventh month after set by which time four varieties attained harvest maturity. The seed growth continued till ninth month after fruit set in remaining six varieties.

DISCUSSION

These results correlated with those reported by earlier workers (Sundararajan and Rao, 1967) who observed a fruit development period of 8-9 months in different varieties under different agro-climatic conditions. Variability with regard to fruit set and fruit weight was reported by Shirol *et al.* (2009*)*. Considerable variation in fruit development period of sapota due to cultivars, agro climatic location and temperature of environment was earlier reported (Sulladmath, 1975) which supported the varietal differences observed in this study. Interestingly, the fruits which recorded higher fruit weight at harvest recoded higher number of days to attain maturity thus DHS-2 and Cricket Ball took maximum number of days to attain harvestable maturity while the small fruited Pala and PKM-1 were the earliest recording less number of days from fruit set to harvest. The influence of three main factors *viz.* fruit size, canopy spread and environmental temperature on earliness of cultivar was indicated earlier (Sulladmath, 1975) which support the findings of this investigation.

A perusal of the data revealed an initial increase in fruit size (in terms of fruit weight) up to 90 days after fruit set followed by decreased rate of growth up to 150 days from fruit set. There was a rapid increase from 150 to 210 days after which the rate of increase was low thus the fruit development in terms of weight followed a "Double sigmoid growth curve". This kind of growth pattern was typical in sapota fruits as reported by Rao (1978) and Dhua *et al*. (2006) and was observed in almost all the varieties studied in the present investigation.

The incremental improvement in dry weight of the fruit also followed the same trend as that of fresh fruit weight. As observed from the data, the seed was traceable from third month after set and growth of seed was at its peak between 180-210 days after which it was low till harvest. The cultivar which produced bigger fruits also recorded more seed weight. These findings are in consonance with those reported by Dhua *et al.* (2006)

Table 1. Number of days required from fruit set to harvest in different varieties of sapota

Varieties	R-1	R-2	R-3	Mean
Cricket Ball	255.40	258.80	259.60	257.93
Singapore	194.00	189.80	193.00	192.26
CO-1	256.60	255.40	257.80	257.93
CO-2	257.60	255.40	259.40	257.46
PKM-1	187.80	189.60	190.60	189.33
PKM-2	216.60	228.00	225.80	232.66
PKM-3	257.20	255.20	259.80	257.44
DHS-1	255.40	260.00	258.60	258.00
DHS-2	261.40	259.20	269.80	263.46
Kalipatti	232.40	234.60	231.00	232.66
Pala	203.00	196.40	184.60	194.66
		S.E(m)±		2.477
		C.D (P=0.05%)		7.359
		F-Test		*

* Significant at 5% level

Table 2. Fresh weights of the fruit (g) at various stages of growth in different varieties of sapota

Varieties	Days after set							
	60	90	120	150	180	210	240	270
Cricket Ball	1.037	3.450	5.740	21.50	36.89	74.55	104.00	123.20
Singapore	0.757	2.350	4.487	15.63	37.18	71.23	-	-
CO-1	0.807	3.160	5.333	18.93	39.78	78.95	102.7	119.38
CO-2	0.780	2.293	3.367	18.73	39.98	79.25	104.3	118.25
PKM-1	0.907	2.577	3.193	10.49	25.24	46.18	-	-
PKM-2	0.740	3.293	4.547	12.62	32.68	60.95	83.63	108.40
PKM-3	0.777	3.660	5.797	17.28	35.38	68.21	92.42	122.40
DHS-1	0.833	2.657	3.760	15.65	35.31	74.21	101.7	120.70
DHS-2	0.767	3.170	5.313	19.40	39.60	79.24	104.9	-
Kalipatti	0.757	2.673	4.000	13.63	28.83	53.99	74.49	-
Pala	0.750	2.600	3.267	8.90	18.85	32.09	-	-
	0.810	2.898	5.034	15.70	33.61	65.35	-	-

	S.E (m)±	C.D (P=0.05%)	F-Test
Days after set (D)	0.098	0.274	*
Variety (V)	0.836	0.233	*
D × V	0.277	0.774	*

* Significant at 5% level

Table 3. Dry weights of the fruit (g) at various stages of growth in different varieties of sapota

Varieties	Days after set							
	60	90	120	150	180	210	240	270
Cricket Ball	0.323	1.437	1.553	5.343	11.56	23.85	32.37	**39.567**
Singapore	0.273	1.080	1.360	4.277	12.12	21.81	-	-
CO-1	0.175	1.140	2.107	6.053	13.19	23.79	31.43	36.02
CO-2	0.274	0.533	0.993	4.670	12.88	24.57	31.39	34.96
PKM-1	0.260	0.653	1.107	3.543	7.85	15.11	-	-
PKM-2	0.163	1.207	1.753	4.607	10.86	22.53	24.48	-
PKM-3	0.197	1.353	1.893	5.230	10.7	18.85	28.26	31.93
DHS-1	0.317	0.873	1.200	5.940	11.27	23.35	29.53	38.847
DHS-2	0.320	1.107	1.953	5.530	11.71	24.27	31.97	37.173
Kalipatti	0.187	0.787	1.427	3.887	8.78	19.37	24.39	-
Pala	0.223	0.643	1.040	2.327	5.47	9.05	-	-
Mean	**0.247**	**0.983**	**1.490**	**4.673**	**10.59**	**21.81**	-	-

	S.E(m)±	C.D (P=0.05%)	F-Test
Days after set(D)	0.192	0.538	*
Variety(V)	0.142	0.397	*
D × V	0.471	1.318	*

* Significant at 5% level

Table 4. Seed weight at various stages of fruit growth in different varieties of sapota

Varieties	Days after set						
	90	120	150	180	210	240	270
Cricket Ball	0.099	0.196	0.940	2.700	4.727	4.812	**5.818**
Singapore	0.099	0.185	0.847	2.393	3.873	-	-
CO-1	0.074	0.250	0.953	2.607	5.087	4.979	5.326
CO-2	0.065	0.177	0.787	2.420	5.193	5.353	5.370
PKM-1	0.095	0.205	0.407	2.033	2.427	-	-
PKM-2	0.060	0.130	0.773	2.347	4.207	4.539	-
PKM-3	0.067	0.194	0.813	2.087	4.393	4.554	5.621
DHS-1	0.099	0.202	0.847	2.447	4.607	4.761	4.890
DHS-2	0.099	0.334	0.860	2.367	4.960	5.385	5.615
Kalipatti	0.065	0.229	0.820	1.993	3.733	3.644	-
Pala	0.095	0.217	0.800	1.380	2.113	-	-
Mean	**0.083**	**0.211**	**0.804**	**2.252**	**4.135**	-	-

	S.E(m)±	C.D (P=0.05%)	F-Test
Days after set (D)	0.185	0.077	*
Variety (V)	0.027	0.052	*
D x V	0.061	0.172	*

* Significant at 5% level

who observed peak fruit development between 180-195 days after set in Cricket Ball. Similarly, Paralkar *et al.* (1987) also reported fruit development period of eight months in cv. Kalipatti and indicated that the seeds were traceable early during the third month after fruit set (Sulladmath, 1975, Ingle *et al.* 1982).

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ANALYSIS OF VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR YIELD AND YIELD CONTRIBUTING TRAITS IN SUMMER MUNGBEAN (*Vigna radiata* L. Wilczek)

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ABSTRACT

Thirty one diverse mungbean (*Vigna radiata* L. Wilczek) genotypes were evaluated for the estimation of genetic variability, heritability and genetic advance for ten quantitative traits and five physiological traits. The genotypes differed significantly for all the characters studied. Higher genotypic and phenotypic coefficient of variation was observed for Relative Injury Percentage (RI), seed yield per plant and number of pods per cluster. High heritability coupled with high genetic advance was observed for the traits Viz., harvest index, seed yield per plant, relative injury, chlorophyll content, 100 seed weight, specific leaf area, number of pods per cluster, number of clusters per plant, number of pods per plant and plant height indicating the importance of additive gene effects in the expression of these characters. The present findings could be useful for establishing selection criteria for high seed yield in the summer mungbean breeding programmes.

KEY WORDS: Genetic advance, Genetic variability, Heritability and Mungbean.

INTRODUCTION

Mungbean is the third most leading pulse crop in India and mostly cultivated in the tropical and subtropical parts of the world. From nutritional point of view, mungbean is an excellent source of protein which contains nearly 27 per cent and its essential amino acids composition is 9.59 mg/100 g. Though, mungbean is generally grown in *kharif*, it is also grown in summer under normal as well as rice fallow situations or in crop rotation to enhance symbiotic nitrogen fixation in the soil. The main drawback in summer mungbean is coincidence of high temperatures with flowering and pod formation besides moisture stress thus resulting in poor yields. Hence there is an immediate need to develop suitable varieties for growing in summer season. However, the natural variability for yield and yield related traits is very narrow in highly self pollinated crops like mungbean and proper evaluation of the extent of genetic variation available for yield components, their heritability values and genetic advance could be of great help for the breeders in order to initiate selection criteria for improvement of yield in summer conditions. Estimates of genetic parameters provide an indication of relative importance of the various types of gene effects affecting total variation of a plant character. Genotypic and phenotypic coefficient of variation and heritability accompanied with genetic advance are very important genetic parameters in improving the traits. Therefore, the present study was conducted to assess genetic variability, heritability and genetic advance for yield and yield contributing traits using thirty one mungbean accessions in order to initiate the breeding programme aimed at yield improvement in summer conditions.

MATERIAL AND METHODS

The experimental material for the present investigation consisted of thirty one diverse mungbean genotypes obtained from the germplasm collections of Regional Agricultural Research Station, Lam, Guntur and Agricultural Research Station, Madhira. The experiment was conducted in randomized block design (RBD) with three replications during summer, 2013-14 at wet land farm, Sri Venkateswara Agricultural College, Tirupati. Each genotype was sown in three rows of 4 m length with a spacing of 30 cm between rows and 10 cm between plants within rows. Observations were recorded on five randomly selected plants per replication for traits namely plant height, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, 100 seed weight, harvest index, SPAD

chlorophyll meter reading (SCMR), Relative Water Injury (RWC), Relative Injury Percentage (RI), Chlorophyll content and Specific Leaf Area (SLA) whereas, days to 50% flowering and days to maturity were recorded on plot basis. The mean values for each trait over the replications were subjected to the analysis of variance. The phenotypic and genotypic variances and coefficient of variation were estimated according to the methods suggested by Burton and Devane (1953) whereas, estimation of heritability and estimation of expected genetic advance were computed using the formula adopted by Lush (1940) and Johnson *et al.* (1955), respectively.

RESULTS AND DISCUSSION

Estimates of phenotypic and genotypic variance, phenotypic and genotypic coefficient of variation, heritability (broad sense) and genetic advance as per cent of mean for fifteen characters in thirty one mungbean genotypes are presented in Table 1. The perusal of the results indicated that the estimates of PCV for all the characters were slightly higher than the estimates of GCV, which may be due to the interaction of genotypes with the environment. The characters, relative injury, seed yield per plant and number of pods per cluster showed higher estimates of genotypic and phenotypic coefficient of variation indicating the presence of ample variation among the genotypes for these traits. Therefore, simple selection could be effective for further improvement of these characters. Similar findings were also reported by Arpita Das *et al.* (2010), Rahim *et al.* (2010) and Kousar Makeen *et al.* (2007) for seed yield per plant in mungbean.

Any variation available in the genotypes is the basis of plant breeding, as the success of any crop improvement depends on the magnitude and range of variability in the genotypes. The magnitude of heritable variation in the traits studied has immense value in understanding the potential of the genotype for future breeding programmes. Assessment of variability for yield and its component characters becomes absolutely essential before planning for an appropriate breeding strategy for genetic improvement. In the present study moderate estimates of PCV and GCV were observed for the traits 100-seed weight, harvest index, number of pods per plant, chlorophyll content, specific leaf area, number of clusters per plant and plant height. However, low estimates of co-efficient of variation was observed for the characters number of seeds per pod, SCMR, days to 50% flowering, days to maturity and relative water content in the

decreasing order of their magnitude indicating the low range of variation for these characters in the genotypes, thus offering little scope for further improvement of these characters through simple selection. These results were also in consonance with the findings of Rahim *et al.* (2010) for days to maturity.

Genotypic coefficient of variation together with heritability estimates would give the best indication of the amount of gain due to selection. Therefore, there could be better chance for improvement of the above traits with the relatively highest value of genotypic coefficient of variation. High heritability estimates were recorded for all the characters which were in the range of 76.39 to 99.78 per cent. The highest heritability was registered for seed weight, followed by number of pods per cluster, relative injury, harvest index, number of seeds per pod, plant height, chlorophyll content, number of pods per plant, specific leaf area, SCMR, seed yield per plant, days to maturity, number of clusters per plant, days to 50% flowering and RWC in the decreasing order of their magnitude indicating the least influence of environment on these characters. These findings are also in consonance with the findings of Srivastava and Singh (2012) and Aqsa Tabasum *et al.* (2010) for harvest index, 100 seed weight and seed yield per plant.

Genetic advance provides information on expected genetic gain resulting from selection of superior individuals. Heritability and genetic advance are important selection parameters. Heritability values along with genetic advance would be more reliable and helpful in predicting the gain under selection than heritability estimates alone.

The maximum genetic advance as per cent of mean was registered for relative injury followed by seed yield, number of pods per cluster, seed weight, harvest index, chlorophyll content, number of pods per plant, specific leaf area, plant height and number of clusters per plant. The traits number of seeds per pod and SCMR recorded moderate genetic advance as per cent of mean. In contrast, low genetic advance was reported for days to 50% flowering, days to maturity and relative water content indicating that these characters are governed by non-additive gene effects and highly influenced by environmental effects. Hence, direct selection for such characters would be ineffective.

In the present investigation, high heritability coupled with high genetic advance as per cent of mean was

Table 1. Mean, coefficient of variability, heritability (broad sense) and genetic advance as per cent of mean for fifteen characters in thirty one mungbean genotypes in summer

Sl. No.	Character	Mean	Variance		Coefficient of Variation		Heritability (Broad sense) (%)	Genetic advance (GA)	Genetic advance as percent of mean (%)
			Genotypic	Phenotypic	Genotypic	Phenotypic			
1.	Days to 50% flowering	43.44	2.63	3.13	3.73	4.07	83.98	3.06	7.04
2.	Days to maturity	68.79	2.05	2.14	2.08	2.13	95.79	2.89	4.19
3.	Plant height (cm)	55.82	44.29	44.64	11.92	11.97	99.20	13.65	24.46
4.	No. of Clusters per plant	9.86	1.33	1.44	11.69	12.15	92.67	2.29	23.19
5.	No. of Pods per cluster	3.95	1.18	1.19	27.52	27.56	99.73	2.24	56.62
6.	No. of Pods per plant	23.80	16.23	16.44	16.92	17.03	98.79	8.25	34.63
7.	No. of Seeds per pod	10.23	0.77	0.78	8.57	8.59	99.28	1.79	17.58
8.	100 seed weight (g)	4.07	0.63	0.64	19.56	19.58	99.78	1.64	40.25
9.	Harvest index (%)	35.08	40.31	40.57	18.10	18.15	99.37	13.04	37.17
10.	SCMR	46.51	8.08	8.23	6.11	6.16	98.19	5.80	12.48
11.	Relative water content (%)	84.13	1.73	2.26	1.56	1.78	76.39	2.37	2.81
12.	Relative injury (%)	27.92	119.11	119.71	39.08	39.18	99.50	22.43	80.31
13.	Chlorophyll content	2.63	0.19	0.20	16.93	17.02	98.93	0.91	34.68
14.	Specific leaf area (cm^2 g^{-1})	125.58	420.03	426.66	16.32	16.44	98.45	41.89	33.36
15.	Seed yield per plant (g)	7.95	6.06	6.18	30.97	31.28	98.00	5.02	63.15

recorded for harvest index, seed yield per plant, relative injury, chlorophyll content, 100 seed weight, specific leaf area, number of pods per cluster, number of clusters per plant, number of pods per plant and plant height indicating the preponderance of additive gene action and phenotypic selection would be more effective for these characters for improvement of yield in summer conditions.

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SCREENING OF SUGARCANE GERMPLASM FOR TRAITS RELATED TO COGENERATION AND PAPER MAKING

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ABSTRACT

Sugarcane is one among the most efficient crops in the world in converting energy from sunlight into chemical energy that is usable as a fuel source for cogeneration and paper making purpose. Germplasm is the basic raw material with repository of beneficial traits. Constant evaluation and characterization of the existent, yet uncharacterized germplasm is useful and is the cornerstone for the development of new and better varieties. A systematic study was conducted to evaluate the one hundred and thirty one germplasm accessions including four checks for quality and yield attributes. All the varieties varied greatly for different traits. Germplasm accessions possessing traits related to cogeneration and paper making were grouped and elucidated. Germplasm accessions viz., 85R186, 97R383, BO91, 93R113, 97R7, 83V288, 97R424, 2000A213, 2002V2, 94A73, and 2005T89 are reservoirs for different parameters and they can be exploited in breeding programmes for production of promising sugarcane varieties suitable for cogeneration and paper making purpose.

KEY WORDS: Cogeneration, Germplasm, Paper making, Sugarcane

INTRODUCTION

Sugarcane (*Saccharum* spp.) is a large-stature perennial grass that is cultivated in approximately 80 nations in tropical, semi-tropical, and sub-tropical regions of the world, primarily for its ability to store high concentrations of sucrose in the stem. Approximately 70 per cent of the world's sugar supply in the form of sucrose originates from sugarcane. Sugarcane is one of the most efficient crops in the world in converting energy from sunlight into chemical energy that is usable as a fuel source. The fibrous residue, called bagasse, is used by most sugar mills to produce heat and steam for the operation of the mills. Sugarcane bagasse (fibrous residue) is the primary fuel source used in boilers, making most sugarcane mills effectively energy self-sufficient. Some mills also generate electricity (referred to as co-generation), and sell the excess to public utilities. Germplasm is the basic raw material where diversity of traits prevail and can be exploited for production of superior lines suitable for cogeneration and paper making purpose. High fibre content (Rao *et al.*, 2007), high biomass and higher total sugars (Govindaraj, 2009), optimum sugar content (Radhamani *et al.*, 2012) and high yield (Rakkiyappan and Pandiyan, 1992) are some of the traits useful in selecting varieties for cogeneration and paper making. The present study focus on screening and grouping of germplasm accessions of sugarcane for cogeneration and paper making and using them as parents in breeding programmes.

MATERIAL AND METHODS

The one hundred and thirty one germplasm accessions including four checks viz., 2003V46, Co6907, Co7219 and Co86032 were evaluated during 2012-13 at Agricultural Research Station, Perumallapalle, with plot size of $6m \times 2R \times 0.9m = 10.8 \ m^2$ in augmented design II. Recommended package of practices were adopted to raise a healthy crop. Necessary prophylactic measures were taken to safeguard the crop from pests and diseases. The germplasm accessions were evaluated for the quality and yield attributes viz., single cane weight, sucrose per cent, CCS per cent, fibre per cent and cane yield.

The single cane weight was derived by averaging the weight of 10 canes harvested randomly from each accession in the plot at the time of maturity. Sucrose percentage was obtained by direct polarisation of the

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undiluted juice after clarification with 3 to 4 gm of dry lead subacetate with the help of polariscope. The polarisation reading was then converted into per cent of sucrose using Schmitz's tables (Hawaiian Sug. Tech. Association, 1931). The Commercial cane sugar (%) was estimated from the following formula:

$$CCS \text{ per cent} = 1.05 \, (S) - 0.3 \, (B),$$

S = Sucrose per cent and B = Corrected Brix in juice

Fibre content was estimated from three randomly selected canes harvested at 360 days after transplanting. They were further sub-sampled to include top, middle and bottom portion from each cane. Cane was split vertically and the split cane was cut into small bits of 1cm length. All the bits of cane were pooled and 250g of fresh cut cane sample was taken for analysis. The sample was transferred to the bowl of the Rapipol extractor and 2 litres of water was added to the bowl. The motor was run for 5 minutes so that the cane bits were sheared into fibre. The contents of the bowl were then transferred to a muslin cloth filter and the fibrous material was washed in running water under the tap till the material was free from juice and dissolved solids. Then the fibre from the filter was transferred to a previously weighed cloth bag and the water was squeezed out. The contents of the bag were dried in an oven at 100^0C and then dry weight of the sample with bag was recorded. Fibre content was calculated as per the formula given by Thangavelu and Rao (1982).

$$\text{Fibre content (\%)} = \frac{A - B}{C} \times 100$$

where,

A = Dry weight of bag + bagasse after drying (g)

B = Dry weight of bag alone (g)

C = Fresh weight of cane (g)

RESULTS AND DISCUSSION

All the germplasm accessions showed significant variation for the traits under study (Table 1). All the germplasm lines including checks were evaluated for the traits under study and an exercise was carried out for grouping the genotypes based on their *per se* performance related to cogeneration and paper making traits *viz.*, high fibre percentage, low sucrose percentage, low CCS percentage and high single cane yield and cane yield per hectare (Table 3).

Single cane yield showed significant variation among the genotypes (Table 1). The range varied from 0.4 to 1.8 kg. Among the genotypes, single cane weight with more than 1.5 kg was recorded in 24 genotypes (Table 3). The genotypes *viz.*, 2002V48, 2003T129, CoA7602, 92A326 and 92A10 recorded the highest single cane weight (1.8 kg) and the lowest single cane weight was observed in genotype SES594 (0.4 kg) followed by BO91 and CoS767 with 0.7 kg (Table 2). Ravishankar *et al.* (2004) reported that a high positive association was present between number of tillers per plant and single cane weight, hence, selection of clones based on these traits will be effective in improving the cane yield.

Variation for sucrose % among genotypes was significant (Table 1) and it ranged from 10.1 to 19.04 per cent (Table 2). The genotypes with <16.5 per cent of sucrose were observed to be 47 (Table 3). Among the genotypes, the highest sucrose percent was recorded in 94V101 and 97R183 with 19.04 per cent followed by 95V74 (18.99%) and 93A145 (18.79%). The least percentage of sucrose was observed in the genotype SES594 (10.1%) followed by 95V303 (13.52%) (Table 2). Genotypes with low sucrose percent are preferred for cogeneration and pulp making.

Commercial Cane Sugar (CCS) percentage showed significant variation among the genotypes (Table 1). Genotypes ranged from 6.15 to 13.57 percent for CCS percentage (Table 2). The genotypes with <11 percent of commercial cane sugar percentage were 34 (Table 3). Among the genotypes, the highest CCS percent was recorded in 97R183 (13.57%) followed by 95V74 (13.42%) and 93A145 (13.26%). The least percentage of CCS was observed in SES594 (6.15%) followed by 95V303 (9.47%) and 97R395 (9.67%) (Table 2).

Significant variation among the genotypes was observed (Table 1) for fibre percentage which was ranging from 9.0 to 27.80 per cent. A total of 20 genotypes possessed high fibre percentage (>16%). Among the genotypes, the highest fibre percent was recorded in SES594 (27.80%) followed by 94A73 (18.48%) and 2005T89 (17.92%). The least percentage of fibre was observed in 2004A107 (9.0%) followed by CoC671 (10.32%) and 90A278 (10.40%) (Table 2). Kadian and Mehla (2006) used fibre percentage for grouping and classification of genotypes useful for cogeneration. Babu *et al.* (2009) observed a significant positive correlation between rind hardness and fibre content and advocated

Table 1. Analysis of variance for traits related to cogeneration and pulp making in sugarcane using Augmented design II

S. No.	Trait	Mean Squares				Mean	C.D
		Block df = 2	Entries df = 114	Checks df = 3	Error df = 6		
1.	Single cane weight (kg)	0.0175	0.069**	0.020	0.017	1.33	0.45(5)
2.	Sucrose (%)	0.7252	2.059**	0.048	0.210	16.66	1.58(5)
3.	CCS (%)	0.1517	1.172**	0.050	0.016	11.62	0.44(5)
4.	Fibre (%)	0.2514	4.610**	1.530	0.313	14.04	1.93(5)
5.	Cane yield (t ha^{-1})	70.4680	507.190**	599.850	51.210	126.13	24.76(5)
6.	CCS yield (t ha^{-1})	0.0777	9.736**	21.410	0.211	14.69	1.59(5)

** Significant at 1% level

Table 2. Evaluation of 131 sugarcane germplasm accessions for cogeneration, pulp and paper making

S.No.	Clone number	Co7508	90A272	93A145	99V30	2000V59	83R23	93R44
1.	Single cane weight (Kg)	1.72	1.20	1.50	0.90	1.40	1.20	1.20
2.	Sucrose%	17.80	15.75	18.79	14.68	16.04	16.35	17.09
3.	CCS %	12.28	10.67	13.26	10.28	11.21	11.67	11.57
4.	Purity %	87.86	84.83	92.28	90.82	90.31	94.72	84.75
5.	Fibre %	12.44	12.56	12.32	13.92	14.20	14.48	15.32
6.	Cane yield (t ha^{-1})	149.98	125.52	150.60	101.25	131.25	127.30	101.23
7.	CCS yield (t ha^{-1})	18.42	13.39	19.97	10.41	14.71	14.86	11.71

S.No.	Clone number	Co85004	Co94008	Co2001-13	Co2001-15	Co7219	CoT8201	83V15
1.	Single cane weight (Kg)	1.70	1.50	1.50	1.60	1.40	1.60	1.40
2.	Sucrose%	17.00	16.95	16.73	15.82	17.61	17.88	16.97
3.	CCS %	12.13	11.87	11.73	11.10	12.29	12.68	11.98
4.	Purity %	94.64	90.83	91.10	91.14	90.03	93.32	92.42
5.	Fibre %	14.36	14.36	13.32	13.68	14.60	13.56	13.68
6.	Cane yield (t ha^{-1})	147.56	150.15	142.05	144.80	118.83	147.20	129.36
7.	CCS yield (t ha^{-1})	17.90	17.82	16.66	16.07	14.60	18.66	15.50

S.No.	Clone number	2002V48	85R186	97R401	97R272	97R129	97R383	Co86032
1.	Single cane weight (Kg)	1.80	1.20	1.60	1.40	1.20	1.60	1.30
2.	Sucrose%	16.97	14.68	15.80	18.27	16.99	14.66	17.82
3.	CCS %	11.98	10.32	10.96	12.73	12.09	10.18	12.39
4.	Purity %	92.42	91.42	88.94	89.75	94.08	89.05	89.29
5.	Fibre %	14.36	17.72	14.84	13.84	13.64	17.64	14.72
6.	Cane yield (t ha^{-1})	138.24	119.81	111.87	118.16	100.32	128.48	128.44
7.	CCS yield (t ha^{-1})	16.56	12.36	12.26	15.04	12.13	13.08	15.91

S.No.	Clone number	Co99004	2003T129	81V48	2002A192	97A44	92A355	92A38
1.	Single cane weight (Kg)	1.50	1.80	1.50	1.40	1.20	1.30	1.30
2.	Sucrose%	17.33	18.11	-	-	-	-	-
3.	CCS %	11.86	12.62	-	-	-	-	-
4.	Purity %	86.40	89.81	-	-	-	-	-
5.	Fibre %	12.44	16.56	15.44	14.64	13.72	12.44	11.48
6.	Cane yield (t ha^{-1})	125.00	131.04	157.50	124.04	122.76	115.44	138.32
7.	CCS yield (t ha^{-1})	14.82	16.54	-	-	-	-	-

S.No.	Clone number	90A278	92A54	CoS8346	BO91	BARAGUA	KHAKAI	81V99
1.	Single cane weight (Kg)	1.30	1.40	1.00	0.70	0.90	1.00	1.60
2.	Sucrose%	-	17.00	15.32	15.35	17.20	-	16.90
3.	CCS %	-	12.00	10.37	10.69	12.17	-	11.64
4.	Purity %	-	92.46	84.57	89.69	92.91	-	87.52
5.	Fibre %	10.40	15.32	13.12	16.36	10.84	15.52	12.56
6.	Cane yield (t ha^{-1})	107.85	140.70	62.50	108.00	110.00	-	100.00
7.	CCS yield (t ha^{-1})	-	16.88	6.48	11.54	13.38	-	11.64

S.No.	Clone number	97A85	SES594	Co6907	84A125	CoA7602	CoC671	Co7717
1.	Single cane weight (Kg)	1.50	0.40	1.10	1.20	1.80	1.40	1.00
2.	Sucrose%	17.36	10.10	17.46	16.74	16.72	17.36	15.53
3.	CCS %	11.98	6.15	12.49	11.82	11.72	11.98	10.58
4.	Purity %	88.05	70.58	95.32	92.43	90.82	88.05	85.74
5.	Fibre %	15.04	27.80	13.96	13.60	12.44	10.32	12.36
6.	Cane yield (t ha^{-1})	93.75	83.30	101.64	114.36	153.00	110.12	92.40
7.	CCS yield (t ha^{-1})	11.23	5.12	12.69	13.52	17.93	13.19	9.78

S.No.	Clone number	Co975	Co1148	Co997	Co419	Co62399	Co364	Co38436
1.	Single cane weight (Kg)	1.40	1.20	1.50	1.60	1.40	0.90	1.00
2.	Sucrose%	15.34	17.21	18.13	15.16	14.46	17.87	17.42
3.	CCS %	10.62	12.21	12.94	10.62	10.69	12.62	12.31
4.	Purity %	88.58	93.45	94.83	90.72	0.86	92.52	92.60
5.	Fibre %	12.84	13.76	15.72	12.08	11.28	15.76	13.60
6.	Cane yield (t ha^{-1})	87.50	78.00	97.50	138.40	136.08	75.00	104.16
7.	CCS yield (t ha^{-1})	9.29	9.52	12.61	14.70	14.54	9.46	12.82

S.No.	Clone number	CoS767	2003V46	2004A75	2004A63	2004A55	2004A107	2004A103
1.	Single cane weight (Kg)	0.70	1.50	1.20	1.30	1.30	1.40	1.50
2.	Sucrose%	16.04	18.29	-	17.60	15.51	16.54	16.52
3.	CCS %	11.19	12.82	-	12.12	10.44	11.68	11.65
4.	Purity %	90.01	90.94	-	87.52	83.75	92.35	92.19
5.	Fibre %	14.48	12.04	14.60	13.68	14.08	9.00	12.40
6.	Cane yield (t ha^{-1})	87.50	153.90	111.60	104.65	136.50	145.88	153.60
7.	CCS yield (t ha^{-1})	9.79	19.73	-	12.68	14.25	17.04	17.89

S.No.	Clone number	2004A82	2006T34	2006T33	2006T10	2006T35	2006T13	2006T18
1.	Single cane weight (Kg)	1.40	1.20	1.60	1.20	1.00	1.50	1.40
2.	Sucrose%	15.32	15.83	16.65	18.33	17.89	15.98	14.46
3.	CCS %	10.51	11.12	11.20	13.01	12.73	10.86	10.01
4.	Purity %	86.97	91.40	83.62	94.45	94.09	85.37	88.60
5.	Fibre %	14.20	14.68	10.52	12.84	12.92	12.32	14.32
6.	Cane yield (t ha⁻¹)	151.20	153.60	165.12	146.40	112.03	159.45	151.20
7.	CCS yield (t ha⁻¹)	15.89	17.08	18.49	19.05	14.26	17.32	15.14

S.No.	Clone number	2006T36	2006T23	2006T19	2006T8	2006T3	95V221	89V74
1.	Single cane weight (Kg)	1.40	1.20	1.40	1.40	1.30	1.60	1.40
2.	Sucrose%	18.50	16.11	17.83	17.40	18.30	16.45	16.04
3.	CCS %	12.90	11.44	12.40	12.20	13.00	11.30	11.09
4.	Purity %	90.60	93.59	89.51	91.03	92.60	87.11	88.23
5.	Fibre %	16.08	11.00	13.60	12.08	17.20	11.36	12.76
6.	Cane yield (t ha⁻¹)	145.60	129.60	145.60	147.98	127.40	153.92	143.92
7.	CCS yield (t ha⁻¹)	18.78	14.83	18.05	18.05	16.56	17.39	15.96

S.No.	Clone number	97V178	92V225	95V48	97V118	94V101	93V297	92V104
1.	Single cane weight (Kg)	1.20	1.60	1.00	1.20	1.50	1.10	1.00
2.	Sucrose%	16.54	17.20	16.98	17.14	19.04	17.66	16.50
3.	CCS %	11.62	12.15	12.01	11.59	13.53	12.39	11.55
4.	Purity %	91.45	92.54	92.84	84.49	93.84	91.09	90.72
5.	Fibre %	13.68	14.56	12.48	15.32	12.52	12.60	12.16
6.	Cane yield (t ha⁻¹)	117.55	156.16	95.46	102.34	124.80	114.40	112.32
7.	CCS yield (t ha⁻¹)	13.66	18.97	11.46	11.86	16.89	14.17	12.97

S.No.	Clone number	94V104	95V423	95V74	97V163	95V428	92V206	95V72
1.	Single cane weight (Kg)	1.10	1.00	1.30	0.80	1.10	1.30	1.30
2.	Sucrose%	14.69	15.79	18.99	-	16.72	16.29	14.69
3.	CCS %	10.38	10.77	13.42	-	11.69	11.48	10.38
4.	Purity %	92.50	85.91	92.69	-	90.45	92.10	92.50
5.	Fibre %	11.36	12.40	16.12	16.64	15.52	13.48	14.84
6.	Cane yield (t ha⁻¹)	114.40	94.60	124.41	82.24	109.82	121.68	107.51
7.	CCS yield (t ha⁻¹)	11.87	10.19	16.70	-	12.84	13.97	11.16

S.No.	Clone number	94V108	97R199	97R267	97R276	93R113	97R7	97R183
1.	Single cane weight (Kg)	1.40	1.50	1.40	1.60	1.30	1.20	1.30
2.	Sucrose%	14.69	16.25	15.99	15.84	14.84	-	19.04
3.	CCS %	10.38	11.27	10.95	11.20	10.03	-	13.57
4.	Purity %	92.50	88.86	86.52	92.72	84.37	-	94.35
5.	Fibre %	13.00	13.84	13.08	15.68	17.84	16.52	14.88
6.	Cane yield (t ha⁻¹)	143.64	145.05	148.51	123.84	128.31	118.44	143.52
7.	CCS yield (t ha⁻¹)	14.91	16.35	16.26	13.87	12.87	-	19.47

S.No.	Clone number	97R15	85A146	83V288	82V12	86V96	92R62	93R129
1.	Single cane weight (Kg)	1.40	1.60	1.40	0.80	1.60	1.50	1.40
2.	Sucrose%	14.67	16.97	16.07	16.67	18.51	-	14.89
3.	CCS %	10.24	11.72	10.35	11.41	12.98	-	10.35
4.	Purity %	90.08	88.10	92.54	86.53	90.93	-	89.25
5.	Fibre %	15.40	13.24	17.16	14.84	14.24	14.68	15.28
6.	Cane yield (t ha⁻¹)	149.10	144.80	125.33	85.12	145.15	-	126.45
7.	CCS yield (t ha⁻¹)	15.27	16.97	12.97	9.71	18.84	-	13.09

S.No.	Clone number	97R134	97R123	97R163	97R424	97R395	97R217	97R6
1.	Single cane weight (Kg)	1.40	0.90	0.80	0.80	1.01	1.10	1.60
2.	Sucrose%	-	15.34	15.63	16.29	14.57	-	14.63
3.	CCS %	-	10.45	11.13	10.33	9.67	-	10.00
4.	Purity %	-	85.76	94.24	89.56	81.49	-	86.25
5.	Fibre %	12.60	16.16	13.68	17.52	14.28	15.12	12.00
6.	Cane yield (t ha⁻¹)	105.84	92.16	99.84	106.50	95.14	87.78	104.96
7.	CCS yield (t ha⁻¹)	-	9.63	11.11	11.07	9.20	-	10.50

S.No.	Clone number	93R217	97R174	97R167	92A326	2000A213	2000A225	2005T16
1.	Single cane weight (Kg)	0.80	1.10	0.80	1.80	1.30	1.30	1.60
2.	Sucrose%	15.60	16.53	-	15.99	-	16.55	18.08
3.	CCS %	11.00	11.70	11.19	10.95	-	11.84	12.59
4.	Purity %	92.00	93.04	-	86.52	-	95.21	89.68
5.	Fibre %	15.32	14.80	17.16	12.04	17.72	14.92	13.40
6.	Cane yield (t ha⁻¹)	118.14	125.84	82.00	149.76	109.46	111.54	166.40
7.	CCS yield (t ha⁻¹)	13.00	14.72	9.18	16.40	-	13.21	20.95

S.No.	Clone number	95V348	94V103	2002V2	95V303	92A10	88A189	94A73
1.	Single cane weight (Kg)	1.20	1.60	1.20	1.10	1.80	1.50	1.30
2.	Sucrose%	16.03	17.44	16.05	13.52	-	17.82	16.49
3.	CCS %	11.16	12.13	10.24	9.47	-	12.26	10.62
4.	Purity %	89.64	89.48	90.86	90.86	-	87.42	89.41
5.	Fibre %	15.32	12.64	16.00	13.44	14.16	12.56	18.48
6.	Cane yield (t ha^{-1})	104.04	155.65	125.52	113.52	126.70	152.10	149.56
7.	CCS yield (t ha^{-1})	11.61	18.88	12.85	10.75	-	18.65	15.88

S.No.	Clone number	92A374	93A53	92A126	87A298	92A130	2005T89	2005T52
1.	Single cane weight (Kg)	1.40	1.60	1.20	1.20	1.10	1.30	1.40
2.	Sucrose%	17.89	14.72	14.92	16.98	17.17	15.12	16.92
3.	CCS %	12.59	10.37	10.38	12.02	11.89	10.50	11.69
4.	Purity %	91.80	92.07	89.45	92.97	88.59	89.13	88.28
5.	Fibre %	13.84	12.00	15.44	10.84	14.88	17.92	13.64
6.	Cane yield (t ha^{-1})	120.67	173.76	137.28	118.75	127.57	140.40	148.40
7.	CCS yield (t ha^{-1})	15.19	18.02	14.25	14.27	15.17	14.74	17.35

S.No.	Clone number	2004T67	2003T123	2005T50	2004T68	2003T121
1.	Single cane weight (Kg)	1.40	1.60	1.40	1.10	1.50
2.	Sucrose%	16.94	18.29	18.27	16.97	17.21
3.	CCS %	11.84	12.80	12.73	11.98	12.19
4.	Purity %	90.31	90.71	89.75	92.42	93.20
5.	Fibre %	14.36	17.64	13.24	13.92	14.64
6.	Cane yield (t ha^{-1})	145.60	150.72	134.40	128.04	156.00
7.	CCS yield (t ha^{-1})	17.24	19.29	17.11	15.34	19.02

Table 3. Grouping of genotypes for traits related to cogeneration and pulp making in sugarcane

S. No.	Trait	Genotypes
1.	Single Cane Weight (Kg) (> 1.5 Kg)	Co7508, Co85004, Co2001-15, CoT8201, 2002V48, 97R401, 97R383, 2003T129, 81V99, CoA7602, Co419, 2006T33, 95V221, 92V225, 97R276, 85A146, 86V96, 97R6, 92A326, 2005T16, 94V103, 92A10, 93A53, 2003T123.
2.	High Fibre % (>16%)	85R186, 97R383, 2003T129, BO91, SES594, 2006T36, 2006T3, 95V74, 97V163, 93R113, 97R7, 83V288, 97R123, 97R424, 97R167, 2000A213, 2002V2, 94A73, 2005T89, 2003T123
3.	Cane yield (>100t ha⁻¹)	Co7508, 90A272, 93A145, 99V30, 2000V59, 83R23, 94R44, Co85004, Co94008, Co2001-13, Co2001-15, Co7219, CoT8201, 83V15, 2002V48, 85R186, 97R401, 97R272, 97R129, 97R383, Co86032, Co99004, 2003T129, 81V48, 2002A192, 97A44, 92A355, 92A38, 90A278, 92A54, BO91, BARAGUA, Co6907, 84A125, CoA7602, CoC671, Co419, Co62399, Co38436, 2003V46, 2004A75, 2004A63, 2004A55, 2004A107, 2004A103, 2004A82, 2006T34, 2006T33, 2006T10, 2006T35, 2006T13, 2006T18, 2006T36, 2006T23, 2006T19, 2006T8, 2006T3, 95V221, 89V74, 97V178, 92V225, 97V118, 94V101, 93V297, 92V104, 94V104, 95V74, 95V428, 92V206, 95V72, 94V108, 97R199, 97R267, 97R276, 93R113, 97R7, 97R183, 97R15, 85A146, 83V288, 86V96, 93R129, 97R134, 97R6, 93R217, 97R174, 92A326, 2000A213, 2000A225, 2005T16, 95V348, 94V103, 2002V2, 95V303, 92A10, 88A189, 94A73, 92A374, 93A53, 92A126, 87A298, 92A130, 2005T89, 2005T52, 2004T67, 2003T123, 2005T50, 2004T68, 2003T121.
4.	Low sucrose % (<16.5%)	90A272, 99V30, 2000V59, 83R23, Co2001-15, 85R186, 97R401, 97R383, CoS8346, BO91, SES594, Co7717, Co975, Co419, Co62399, CoS767, 2004A55, 2004A82, 2006T34, 2006T13, 2006T18, 2006T23, 95V221, 89V74, 92V104, 94V104, 95V423, 95V72, 94V108, 97R199, 97R267, 97R276, 93R113, 97R15, 83V288, 93R129, 97R123, 97R163, 97R424, 97R395, 97R6, 95V348, 2002V2, 95V303, 93A53, 92A126, 2005T89.
5.	Low CCS % (<11%)	90A272, 99V30, 85R186, 97R401, 97R383, CoS8346, BO91, SES594, Co7717, Co975, Co419,Co62399,2004A55,2004A82, 2006T18, 2006T13, 94V104, 95V423, 95V72, 94V108, 97R267, 97R7, 93R113,97R15, 83V288, 93R129, 97R123, 97R424, 97R395, 92A326, 2002V2, 94A73, 2005T89.
6.	High fibre %, Low sucrose %, Low CCS %, High cane yield and High single cane weight	85R186, 97R383, BO91, 93R113, 83V288, 97R424, 2000A213, 2002V2, 94A73, 2005T89. (Genotypes for cogeneration and pulp making)

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that it was beneficial for selection of erect and non-lodging canes suitable for mechanical harvesting and feedstock for co-generation. Radhamani *et al.* (2012) opined that high fibre sugarcane clones with optimum sugar and yield could be exploited for co-generation.

Cane yield showed significant variation among the genotypes (Table 1). The genotypes were ranged between 62.5 and 173.76 t ha^{-1}. There were 110 genotypes which produced more than 100 t ha^{-1} cane yield. Among them, 93A53 (173.76 t ha^{-1}) followed by 2005T16 (166.4 t ha^{-1}), 2006T33 (165.12 t ha^{-1}) and 81V48 (157.5 t ha^{-1}) showed higher cane yields in comparison to the check varieties *viz.*, 2003V46 (153.9 t ha^{-1}), Co6907 (101.64t ha^{-1}), Co7219 (118.83 t ha^{-1}) and Co86032 (128.44 t ha^{-1}) (Table 2). The lowest cane yield was recorded by the genotype, CoS8346 (62.5 t ha^{-1}) followed by Co364 (75 t ha^{-1}), Co1148 (78 t ha^{-1}), 97R167 (82 t ha^{-1}), 87A298 (82.17t ha^{-1}) and 97R62 (82.42 t ha^{-1}). Rakkiyappan and Pandiyan (1992) opined that a variety meant for cogeneration purpose should contain high cane yield.

Rao *et al.* (2007) reported that new multipurpose cane varieties with very high fibre content were found to produce more biomass per hectare and a wide range of brix values when compared to the traditional sugarcane varieties. High fibre multipurpose cane varieties with acceptable levels of fermentable sugars would extend the supply of bagasse and contribute to fuel ethanol production. Babu *et al.* (2009) conducted an experiment to ascertain whether the rind hardness of cane can be used as an index for fibre content in sugarcane and concluded that there was a significant positive correlation between rind hardness and fibre content which is beneficial for selection of erect non lodging canes suitable for mechanical harvesting and feedstock for co-generation. In order to support cogeneration and ethanol production there is need for developing varieties capable of high biomass with high fibre content and higher total sugars (Govindaraj, 2009).

Based on the review of literature high fibre percentage, low sucrose percentage, low CCS percentage and high cane yield are the important traits that were considered for selecting a genotype for cogeneration, pulp and paper making. An exercise was made to identify genotypes showing combination of all these traits (Table 3). It was observed that the genotypes 85R186, 97R383, BO91, 93R113, 97R7, 83V288, 97R424, 2000A213, 2002V2, 94A73 and 2005T89 possess the aforesaid traits

and can be considered as high biomass types useful for cogeneration, pulp and paper making. These genotypes can be better exploited in breeding programmes for generation of new promising lines suitable for cogeneration and paper making purposes along with other traits desirable by the farmers and industry.

CONCLUSION

Identification and development of the canes for cogeneration, pulp and paper making augments economic prosperity of sugar industries. Canes with traits like high fibre percentage, low sucrose percentage, low CCS percentage and high yield are suitable for allied uses in sugar industry. Among 131 germplasm accessions maintained at Agricultural Research Station, Perumallapalle, 11 accessions showed a combination of these traits. They are 85R186, 97R383, BO91, 93R113, 97R7, 83V288, 97R424, 2000A213, 2002V2, 94A73 and 2005T89. These accessions could be made as multipurpose and acceptable by farmers and industry by incorporating other useful traits in them.

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STUDIES ON INTEGRATED NUTRIENT MANAGEMENT PRACTICES ON DRY MATTER PRODUCTION AND NUTRIENT UPTAKE OF PALAK (*Beta vulgaris* var. *bengalensis* Hort.)

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ABSTRACT

A study on Palak (*Beta vulgaris* var. *bengalensis* Hort.) was carried out during *rabi* season, 2010-2011 at college farm of Horticulture College and Research Institute, Venkataramannagudem, West Godavari district, Andhra Pradesh, to determine the Studies on the effect of integrated nutrient management practices on dry matter production and nutrient uptake". It revealed that the highest dry matter production (5395 kg ha^{-1}) and nutrient uptake of nitrogen, phosphorus and potassium (102.81,18.06 and 98.667 kg ha^{-1}) was recorded with the application of 100% RDF through inorganic (80:40:50 kg of NPK ha^{-1}) and was on par with the dosage of 75% RDF through inorganic fertilizers + 25% recommended dose of nitrogen through poultry manure and 75% RDF through inorganic fertilizers + 25% recommended dose of nitrogen through vermicompost.

KEY WORDS: Palak, Dry matter and Nutrient uptake

INTRODUCTION

Palak (*Beta vulgaris var. bengalensis* Hort.) belonging to the family Chenopodiaceae is the most popular leafy vegetables with good nutritive value. It is a commonly grown leafy vegetable throughout the tropical and subtropical regions (Veeraragavathatham, 1998) for its tender succulent leaf and petiole and it is a cheap and rich source of Vitamin-A which helps in improving the eyesight. It is also a good source of Vitamin-C and mineral elements like iron, calcium, phosphorus and amino acids. In India, farm yard manure (FYM) remains as the most popular organic manure applied to fields and it can potentially supply about 6.8 million tons of N, P and K per year (Sarkar and Rattan, 1995). Bio-fertilizers and organic manures together can make significant contribution in maintaining soil health and balancing soil fertility through supply of plant nutrients at an optimum level. However, application of organic manures alone is not adequate to meet the nutrient demand of the recent high yielding varieties of crops because of their scarce availability, low nutrient content and slow nutrient releasing nature. Improved varieties require higher amount of nutrients to reap higher yields, but continuous usage of chemical fertilizers without any or little addition of organic manures may not sustain the soil fertility. The problem of nutrient depletion is being further aggravated with the decreasing availability and consequent low rates of application of organic manures. Therefore, combined use of chemical, organic manures and bio-fertilizers seems to be the only way out to replenish the soil nutrient reserve. In this context, Integrated Nutrient Management (INM) holds a great response in meeting the growing nutrient demands of intensive agriculture and maintaining crop productivity at fairly high level. The conjunctive use of organic and inorganic sources will improve soil health and help in maximizing production as it involves utilization of local resources and hence turned out to be rational, realistic, eco-friendly and economically viable way of supply of nutrients to the crops.

MATERIAL AND METHODS

The field experiment was laid out in a randomized block design with three replications during *rabi*, 2010-2011 at College Farm of Horticulture College and Research Institute, Venkataramannagudem, West Godavari district, Andhra Pradesh on red sandy loam soil. The studies were carried out using palak cv Arka Anupama with 11 treatments viz., 75% RDF + 25% RDN through VC (T$_1$), 75% RDF + 25% RDN through FYM (T$_2$), 75% RDF +25% RDN through PM (T$_3$), 50% RDF + 50% RDN

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through VC (T₄), 50% RDF + 50% RDN through FYM (T$_5$), 50% RDF + 50% RDN through PM (T$_6$), 25% RDF + 75% RDN through VC (T$_7$), 25% RDF + 75% RDN through FYM (T$_8$), 25% RDF + 75% RDN through PM (T$_9$), 100% RDF through organic (33%VC, 33% FYM and 33%PM) (T$_{10}$) and 100% through RDF (80:40:50 kg of NPK ha^{-1}). A common application of bio-fertilizers (*Azospirllum*@ 5 kg ha^{-1} and PSB @ 2 kg ha^{-1}) was given to all treatments. Total quantity of vermicompost, farm yard manure and poultry manure along with bio-fertilizers were applied to the soil as a basal dose as per the treatments. Dosages of different organic manures were arrived to meet the recommended dose of nitrogen as per the available nitrogen content in the respective organic manures. The inorganic source of nitrogen was applied in four equal splits in the form of urea as a basal dose (1/4th of the total nitrogen) and remaining thee splits were applied after each leaf cutting. The inorganic source of phosphorus and potassium were applied as a basal dose only in the form of single super phosphate and muriate of potash respectively. The seeds were sown at a spacing of 20 cm between rows and 10 cm within the row. To determine the dry matter production, the samples were dried in hot air oven at 60±2°C temperature till constant weights were obtained. The dry matter was worked out from the dried leaf samples and expressed in kg ha^{-1}. The available NPK was estimated through nitrogen by Micro-Kjeldahl distillation method, phosphorus by Colorimetric phosphor-Vando Molybdate method and potassium by Flame photometer method in the dried leaf samples of palak respectively. The uptake of nutrients was computed by using the following formulae.

Uptake of nutrient (kg ha^{-1}) =

$$\frac{\text{Percentag of nutrient} \times \text{Total drymatter in kg ha}^{-1}}{100}$$

The data were analyzed statistically applying the analysis of variance procedures for Randomized Block Design as stated by Panse and Sukhatme, (1967).

RESULTS AND DISCUSSION

The experiment conducted on the effect of integrated nutrient management practices on dry matter production and nutrient uptake of major nutrients of N, P and K in palak revealed that the application of 100% RDF through inorganic sources @ 80:40:50 kg of NPK ha^{-1} recorded the highest total production (Table 1) (5395.00 kg ha^{-1})

which was significantly superior to all other treatments. This was followed by 75% RDF through inorganic fertilizers + 25% RD of nitrogen through poultry manure 5298.88 kg ha^{-1} and the treatment dose of 75% RDF through inorganic fertilizers + 25% RD of nitrogen through vermicompost (5222.77 kg ha^{-1}) and they were significantly superior to rest of the treatments. The lowest total dry matter production (3517.77 kg ha^{-1}) was recorded with 100% RD of nutrients supplied through organic manures. This could be attributed to increased plant height, number of leaves and higher leaf area during the crop growth period in respective treatment doses. These factors might have contributed more to the photosynthetic leaf surface area, higher carbohydrate assimilation with better supply of nutrients and the inadequate availability of nitrogen due to its slow release from organic manures might have resulted in shorter plants and reduced leaf area which has ultimately resulted in reduced photosynthetic efficiency and crop growth leading to low dry matter production as conformed by Vachani and Patel 7(1993) and Raghava Rao (2003) in onion.

The nutrient uptake is a positive function of dry matter yield (Ramakal *et al.* 1988). The highest N, P and K uptake @ 102.81, 18.06, and 98.67 kg ha^{-1} and dry matter production respectively was recorded with 100% RDF through inorganic (5395.00 kg ha^{-1}) which was significantly superior to all other treatments but was on par with 75% RDF through inorganic fertilizers + 25% RD of nitrogen through poultry manure (5298.88 kg ha^{-1}). The lowest N, P and K uptake at harvest was observed with 100% nitrogen through organic sources along with bio-fertilizers application (Table 2). The increased N, P, and K uptake resulted in increased dry matter yield and the lowest N, P, and K uptake in 100% organic sources of nutrients resulted in the decreased dry matter yield. This is in consonance with the findings of Mallangouda *et al.* (1995) in onion and Prabakaran (2003) in tomato. The uptake of N P K was higher with poultry manure because of higher nutritive value in respect to major nutrients and also the improvement of soil condition by the organic manure. Similar results were reported by Raghava Rao, (2003) in garlic.

Table 1. Studies on integrated nutrient management practices on dry matter production in leaves (kg ha^{-1}) in palak cv. Arka Anupama

Treatments	Total
T$_1$: 75% RDF through inorganic fertilizers + 25% RD of nitrogen through VC	5222.77
T$_2$: 75% RDF through inorganic fertilizers + 25% RD of nitrogen through FYM	5092.22
T$_3$: 75% RDF through inorganic fertilizers + 25% RD of nitrogen through PM	5298.88
T$_4$: 50% RDF through inorganic fertilizers + 50% RD of nitrogen through VC	4670.55
T$_5$: 50% RDF through inorganic fertilizers + 50% RD of nitrogen through FYM	4506.66
T$_6$: 50% RDF through inorganic fertilizers + 50% RD of nitrogen through PM	4787.77
T$_7$: 25% RDF through inorganic fertilizers + 75% RD of nitrogen through VC	4006.66
T$_8$: 25% RDF through inorganic fertilizers + 75% RD of nitrogen through FYM	3866.66
T$_9$: 25% RDF through inorganic fertilizers + 75% RD of nitrogen through PM	4168.89
T$_{10}$: 100% RD of nutrients through organic manures (33.3% VC + 33.3% FYM + 33.3% PM)	3517.77
T$_{11}$: 100% RDF through inorganic (80:40:50 kg of NPK ha^{-1})	5395.00
Mean	4593.99
SEm±	45.71
C.D at 5%	135.81

Table 2. Studies on integrated nutrient management practices on nutrient uptake (kg ha^{-1}) at harvest in palak cv. ArkaAnupama

Treatments	N	P	K
T$_1$: 75% RDF through inorganic fertilizers + 25% RD of nitrogen through VC	98.60	16.18	95.91
T$_2$: 75% RDF through inorganic fertilizers + 25% RD of nitrogen through FYM	95.53	15.42	94.60
T$_3$: 75% RDF through inorganic fertilizers + 25% RD of nitrogen through PM	100.00	17.83	96.54
T$_4$: 50% RDF through inorganic fertilizers + 50% RD of nitrogen through VC	88.56	12.76	90.80
T$_5$: 50% RDF through inorganic fertilizers + 50% RD of nitrogen through FYM	85.60	12.39	89.66
T$_6$: 50% RDF through inorganic fertilizers + 50% RD of nitrogen through PM	90.86	13.39	91.80
T$_7$: 25% RDF through inorganic fertilizers + 75% RD of nitrogen through VC	78.36	10.14	85.93
T$_8$: 25% RDF through inorganic fertilizers + 75% RD of nitrogen through FYM	76.56	9.69	84.50
T$_9$: 25% RDF through inorganic fertilizers + 75% RD of nitrogen through PM	80.42	10.38	86.83
T$_{10}$: 100% RD of nutrients through organic manures (33.3% VC + 33.3% FYM + 33.3% PM)	70.93	7.68	81.27
T$_{11}$: 100% RDF through inorganic (80:40:50 kg of NPK ha^{-1})	102.81	18.06	98.67
Mean	88.02	13.11	90.57
SEm±	1.56	0.57	0.93
C.D at 5%	4.63	1.71	2.78

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GROWTH RATES OF AREA, PRODUCTION, PRODUCTIVITY OF CHILLIES - A STATE - WISE ANALYSIS

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ABSTRACT

India has recorded an export compound annual growth rate of 12.74 per cent. The compound growth rate of area was 0.15 per cent over the 40 years period. But production growth was 2.94 per cent, which was more driven by productivity growth 2.71 per cent. In the overall period of 1960-62 to 2007-08 the growth in area was more a less stabilized with only Gujarat state recording a negative growth rate of 5.78 per cent. Rajasthan in the recent decade of 2001-02 to 2007-08, stood out as the highest achiever of production growth of 7.58 per cent. It was Andhra Pradesh which recorded the highest growth of 4.98 per cent during the period of 1961-62 to 2007-08 in production. In Andhra Pradesh, the compound growth rate of area was 1.07 per cent, while that of production and productivity were 5.69 and 4.47 per cent respectively.

KEY WORDS: Area, Chillies, Export, Production, Productivity

INTRODUCTION

India is the leading producer of chilli contributing close to 43 per cent of world's production followed by China (8.6 per cent) and Peru (5.6 per cent). Besides India, other major producers and exporters are China, Pakistan, Morocco, Mexico and Turkey. This shows that the bulk share of chilli production is in Asian countries, though it is produced throughout the world. The top 10 chilli producing countries, India, China, Ethiopia, Myanmar, Mexico, Vietnam, Peru, Pakistan, Ghana and Bangladesh accounted for more than 85 per cent of the world's production in 2009. With an estimated global production of 29.6 lakh tonnes in 2009, chilli is grown in an area of approximately 18.3 lakh hectares. Against this background the present study has been taken up to estimate growth rates of area, production and productivity in the country as well as in Andhra Pradesh along with the growth rate in chilli exports.

MATERIAL AND METHODS

For evaluating the trend in area, production and productivity under chillies, the following growth model was employed.

$$Y_t = ab^t u_t \dots\dots\dots\dots\dots\dots (1)$$

where,

Y_t = area/production/productivity in the year 't'

a = intercept indicating Y in the base period (t = 0)

b = Regression coefficient

t = Time period in years

u_t = Disturbance term for the year 't'.

Equation (1) was converted into the logarithmic form in order to facilitate the use of linear regression. Taking logarithm on both sides of the equation (1).

$$\ln Y = \ln a + t \ln b + \ln U_t \dots\dots\dots\dots (2)$$

This is of the following form,

$$Q_t = A + B_t + e_t$$

where,

$Q_t = \ln Y_t$

$A = \ln a$

$B = \ln b$

$e_t = \ln e_t$

The linear regression of the above form was fitted separately for area, production and productivity of Chillies.

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The values of 'a' and 'b' were estimated by using ordinary least squares technique Later, the original 'a' and 'b' parameters in equation (1) were obtained by taking antilogarithms of 'a' and 'b' values as,

$$a = Anti\ A$$

$$b = Anti\ B$$

Average annual compound rate was calculated as

$$g = b - 1$$

To obtain percentage compound growth rate, the value of g was multiplied by 100.

RESULTS AND DISCUSSION

India is the largest producer, consumer and exporter of chillies in the world. The global area which was 18.81 lakh ha in 2000 slipped slightly to 18.30 lakh ha in 2009 (Table 1). However, the global production increased from 23.87 lakh tonnes to 29.6 lakh tonnes during the corresponding period. This is due to increase in productivity from 1.27 tonnes / ha in the year 2000 to 1.62 tonnes/ha in 2009. The CAGR during the period was estimated at -3.15,-1.33 and 1.02 per cent for area, production and productivity respectively.

Table 1. Global area and production of chilli (2000-2009)

Years	Area (lakh ha)	Production (lakh tonnes)	Productivity (tonnes / ha)
2000	18.81	23.87	1.27
2001	19.06	24.32	1.28
2002	18.83	22.92	1.22
2003	18.32	26.41	1.44
2004	17.97	26.31	1.46
2005	17.42	26.25	1.51
2006	15.81	21.48	1.36
2007	15.18	20.98	1.38
2008	18.30	29.60	1.62
CAGR (%)	-3.15	-1.33	1.02

Source: FAO

Area, production and productivity of chilli in India

The area under chilli in the country in the last 40 years ranged from 7.83 lakh ha in 1971-72 to 8.29 lakh ha in 2003 (Table 2). There after there is a fall in the area till 2006-07 and in 2008-09 the area rose to 8.06 lakh ha. In 2009-10 the area under the crop was 7.67 lakh ha. The

Table 2. Area, production and productivity of chilli in India (1970-71 to 2009-10)

Year	Area (lakh.ha)	Production (lakh.tonnes)	Productivity (Kg/ha)
1970-71	7.83	5.20	664
1980-81	8.35	5.09	610
1990-91	8.16	7.19	881
2000-01	8.37	9.84	1,176
2001-02	8.80	10.69	1,215
2002-03	8.29	8.97	1,082
2003-04	7.74	12.36	1,596
2004-05	7.38	11.86	1,607
2005-06	6.54	10.15	1,551
2006-07	7.58	12.34	1,628
2007-08	8.06	12.97	1,611
2008-09	7.50	13.0	1,550
2009-10	7.67	13.2	1,600
CAGR%	0.15	2.93	2.71

Source: Ministry of Agriculture

production had substantially increased from a minimum of 5.20 lakh tonnes in 1970-71 to a maximum of 12.03 lakh tonnes in 2009-10, which was more than double and it was piloted by the yield increase. It is also evident as yield too increased from 664 kg/ha in 1971 to 1,600 kg/ ha in 2010. The steady increase in productivity was on account of hybrids viz., Birds eye chilli (Dhani), Byadagi (Kaddi), Ellachipur (Sannam S4 type), etc. The compound growth rate of area was 0.15 per cent over the 40 years period. But production growth was 2.94 per cent, which was more driven by productivity growth of 2.71 per cent.

Area, Production and Productivity of Chilli in major Producing States of India

Andhra Pradesh occupied about 1/4th of the total area under chillies in the country contributing 57 per cent of production (Table 3) during the triennium ending 2009-10, Karnataka was the next state in terms of area with 14 per cent followed by Maharashtra. The three states found to cultivate more than 50 per cent of the area. Orissa, Gujarat, West Bengal and Tamil Nadu were the other important states.

The productivity was highest in Andhra Pradesh with 3,462 kgs and no other state in the country could achieve even 50 per cent Andhra Pradesh's productivity. The nearest productivity that was traced was 1,502 kg attained by West

Bengal. The productivity was 1330 kg in Rajasthan, 1,140 in Karnataka and 1,040 in Madhya Pradesh.

State- wise Annual Growth Rates of Area under chillies

Orissa recorded the highest growth of 13.25 per cent in the decadal period of 1961-62 to 1970-71 compared to any other state (Table 4). In the same decade, it is Andhra Pradesh which recorded the next highest compound annual growth rate of 5.24 per cent. In the following decade of 1971-72 to 80-81, it is West Bengal which was the forerunner in achieving the area growth of 14.39 per cent. In the decades to follow i.e., 1981-82 to 1990-91 and 1991-92 to 2000-2001, it is once again ,West Bengal which stood out as the highest growth achiever of area with a CAGR of 8.68 per cent and 2.27 per cent respectively. In the overall period of 1961-62 to 2007-08, the growth in area was more or less stabilized with only Gujarat state recording a negative growth rate of 5.78 per cent.

State - wise annual growth rates of production of dry chillies

Regarding production growth, Orissa recorded highest CAGR of 19.04 per cent during the period from 1961-62 to 1970-71, while it was West Bengal in second decadal period of 1971-72 to 1980-81 with a growth rate of 12.75 per cent (Table 5). During 1981-82 to 1990-91 it was Andhra Pradesh with 8.89 per cent and Karnataka in the following decade of 1991-92 to 2000-01 with a CAGR of 11.39 per cent. Rajasthan in the recent decade of 2001-02 to 2007-08 stood out as the top achiever of production growth of 7.58 per cent. During the overall period of 1961-62 to 2007-08 highest growth of 4.98 was achieved by Andhra Pradesh with productivity being the most powerful causative factor.

Area, production and productivity of chilli in Andhra Pradesh

The particulars furnished in Table 6. Indicate that the chilli area in Andhra Pradesh hovered around 2 lakh hectares during the period from 1971-72 to 2009-10 barring the years 1980-81 and 2005-06. On the other hand, the production rose phenomenally from 1,38,730 tonnes in 1971-72 to 8,31,000 tonnes in 2009-10, a productivity induced rise as it spiraled from less than a tonne to about 4 tonnes during the corresponding period. The emergence of hybrids and intensive cultivation, for which the state is known were the prime factors for such a spectacular growth in productivity.

In Andhra Pradesh, the compound growth rate of area was 1.07 per cent, while that of production and productivity were 5.69 and 4.47 per cent respectively. This amply demonstrates productivity was the more powerful factor for the increased production. Similar findings were reported by Goudra *et al.* (2011)

India's chilli exports

After 1980s India's export performance was excellent and higher international and domestic demand can further push the exports. India exports chilli in the different processed forms like chilli powder, dried chillies, pickled chillies etc. Indian chillies are mostly exported to Sri Lanka, USA, Nepal, Mexico, Malaysia and Bangladesh. Among these countries, Malaysia, Sri Lanka and Bangladesh are the major importers of Indian chillies.

The total export of chilli from India during 1999-00 was 63,591 tonnes valued at ₹ 254.72 crore which increased to 2, 40,000 tonnes valued at ₹ 1535.54 crore during 2010-11 (Table 7). Over the years, exports were increasing at a faster rate, which is evident from high compound growth rates of 14.47 per cent in quantity and 20.90 per cent by value.

Exports of chilli to different countries

Though, almost all items in the spice basket have registered a growth during the past five years, the phenomenal rise in chilli has led boom to exports from India.

Asian countries are the main buyers of chillies and consumption is increasing in these countries with the rising population. Chillies have notched up substantial increase in volume in 2010-11 against the previous year. The exports stood at 2, 40,000 tonnes in 2010-11 against 2, 04,000 in 2009-10 (Table 8). As can be observed that exports during 2009-10 and 2010-11 to the major exporting countries i.e. Malaysia and Srilanka are more or less stable, but the floods in China, Pakistan and Bangladesh have sparked exports to increase in 2010-11 to these countries compared to the previous year. Generally if China's chilli production is good, it stands as a strong competitor to India in terms of exports.

Table 3. Area, production and productivity of chilli in major producing states in India (Triennium ending 2009-10)

States/UTs	Area (lakh.ha)	Per cent total	Production (lakh.tonnes)	Per cent to total	Productivity (kg/ha)
Andhra Pradesh	2.03	26	7.72	57	3,462
Karnataka	1.13	14	1.55	12	1,140
West Bengal	0.56	7	0.93	7	1,502
Orissa	0.76	9	0.63	5	840
Madhya Pradesh	0.45	6	0.44	3	1,040
Maharashtra	0.99	12	0.44	3	440
Tamil Nadu	0.59	7	0.34	3	506
Rajasthan	0.18	2	0.27	2	1,330
Uttar Pradesh	0.16	2	0.15	1	938
Assam	0.15	2	0.10	1	625
Gujarat	0.70	9	0.60	4	1,000
Others	0.32	4	0.30	2	477
India	**7.39**	**100**	**11.8**	**100**	**1,596**

Source: Indiastat.com

Table 4. State-wise CAGR of area under chillies

States	1961-62 to 1970-71	1971-72 to 1980-81	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2007-08	1961-62 to 2007-08
Andhra Pradesh	5.24	-1.38	3.67	1.00	-1.71	0.99
Karnataka	0.11	6.02	-1.45	0.07	-5.28	0.20
West Bengal	0.16	14.39	8.68	2.27	-1.48	1.50
Orissa	13.25	-0.17	4.19	-1.21	1.01	2.42
Madhya Pradesh	-0.29	3.70	-2.22	-0.11	0.97	0.13
Maharashtra	-0.64	0.51	-1.73	-1.75	-0.35	0.40
Tamil Nadu	-1.24	2.65	-5.37	0.38	0.51	0.09
Rajasthan	0.66	3.90	0.64	-4.14	-7.28	0.75
Uttar Pradesh	1.03	2.21	-1.12	-3.27	-1.38	1.40
Assam	2.40	3.09	3.38	1.89	0.92	0.33
Gujarat	1.97	-0.97	-0.40	0.07	-10.86	-5.78

Table 5. State- wise CAGR of production of chillies

State	1961-62 to 1970-71	1971-72 to 1980-81	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2007-08	1961-62 to 2007-08
Andhra Pradesh	1.58	4.64	8.89	6.84	5.97	4.98
Karnataka	-0.55	5.63	-4.38	11.39	6.20	0.95
West Bengal	-2.62	12.75	7.31	3.51	4.55	1.25
Orissa	19.04	7.69	4.46	-0.39	0.48	3.24
Madhya Pradesh	-1.63	4.36	-3.32	3.41	5.74	0.66
Maharashtra	-0.56	0.61	-1.01	-0.50	-2.03	0.01
Tamil Nadu	-0.82	-5.59	-6.93	3.29	-2.36	1.17
Rajasthan	0.13	0.50	8.25	-0.86	7.58	-0.70
Uttar Pradesh	0.26	6.35	-1.67	-1.23	4.73	1.83
Assam	3.30	1.09	3.40	2.53	0.40	0.40
Gujarat	-2.45	0.37	3.29	1.46	-8.11	0.31

Table 6. Area, production and productivity of chilli in Andhra Pradesh (1971-72 to 2009-10)

Year	Area (ha)	Production (tonnes)	Productivity (Kg/ha)
1971-72	2,02,320	1,38,730	686
1980-81	1,62,012	1,49,098	920
1990-91	2,08,167	3,46,592	1,665
2000-01	2,38,003	5,26,171	2,211
2001-02	2,25,000	5,91,000	2,631
2002-3	2,23,000	4,09,000	1,831
2003-04	2,50,000	7,97,000	3,184
2004-05	2,37,000	7,48,000	3,164
2005-06	1,72,000	5,38,000	3,136
2006-07	2,14,000	7,66,000	3,579
2007-08	2,23,000	7,72,000	3,463
2008-09	2,03,000	7,73,000	3,554
2009-10	2,07,000	8,31,000	4,023
CAGR%	1.07246	5.692739	4.47278

Source: Indiastat.com

Table 7. Exports of chillies from India

Year	Quantity (tonnes)	Value (₹ in Cr)
1999 -00	63,591	254.72
2000-01	62,448	229.73
2001-02	69,998	252.44
2002-03	81,022	315.15
2003-04	86,575	366.88
2004-05	1,38,073	499.01
2005-06	1,13,174	403.01
2006-07	1,48,500	807.75
2007-08	2,09,000	1097.50
2008-09	1,88,000	1080.95
2009-10	2,04,000	1291.72
2010-11	2,40,000	1535.54
CAGR (%)	14.47	20.90

Source: Spices Board of India

Chilli exports by value to different countries

Spice exports have risen three–fold in value terms in the last five years. Exports of spices and spice products stood at ₹ 6030.74 crore during the April-February period of 2010-11. They were around ₹ 2,100 crore in the April-February period of 2005-06. The value of chilli exports stood at ₹ 1,535.55 crore during 2010-11 compared to ₹ 1,291.72 crore in 2009-10 (Table 9).

Growth rates of chilli exports for major exporting countries

Global demand for chilli was pronounced to be increasing as revealed by the export CAGR of 9.42 per cent during the period from 1996 to 2006. Being the lead producer of chillies in the world, India has recorded an export CAGR of 12.74 per cent (Table 10). The same for China, which was the fierce competitor to India, was 10.63 per cent. The growth rates for Peru, Myanmar and Pakistan were 85.92, 28.85 and 27.69 respectively evidently due to lower quantities of exports in the base year.

CONCLUSIONS

Global demand for chilli was pronounced to be increasing as revealed by the export CAGR of 9.42 per cent during the period from 1996 to 2006. Being the lead producer of chillies in the world, India has recorded an export CAGR of 12.74 per cent. The same for China, which was the fierce competitor to India, was 10.63 per cent. The growth rates for Peru, Myanmar and Pakistan were 85.92, 28.85 and 27.69 respectively evidently due to lower quantities of exports in the base year.

CAGR during 2000-2009 was estimated at -3.15, -1.33 and 1.02 per cent for global area, production and yield respectively.

Orissa recorded the highest growth of 13.25 per cent in the area during the decadal period of 1961-62 to 1970-71 compared to any other state. In the same decade, it is Andhra Pradesh which recorded the next highest compound annual growth rate of 5.24 per cent. In the following decade of 1971-72 to 80-81, it is West Bengal which was the forerunner in achieving the area growth of 14.39 per cent. In the decades to follow i.e., 1981-82 to 1990-91 and 1991-92 to 2000-2001, it is once again ,West Bengal which stood out as the highest growth achiever of area with a CAGR of 8.68 per cent and 2.27 per cent respectively. In the overall period of 1961-62 to 2007-08, the growth in area was more or less stabilized with only Gujarat state recording a negative growth rate of 5.78 per cent.

Orissa recorded highest CAGR of 19.04 per cent in the production during the period from 1961-62 to 1970-71, while it was West Bengal in second decadal period of

Table 8. Chilli exports from India to different countries (tonnes)

S. No.	Country	2009-10	% to total	2010-11	% to Total
1	Malaysia	45,545	22.33	48,248	20.10
2	Srilanka	34,788	17.05	34,072	14.20
3	Bangladesh	28,173	13.81	32,742	13.64
4	USA	17,744	8.70	17,362	7.23
5	Pakistan	160	0.08	25,712	10.71
6	UAE	23,232	11.39	20,703	8.63
7	Mexico	2,256	1.11	8,500	3.54
8	Indonesia	10,267	5.03	10,242	4.27
9	China	1,769	0.87	6,771	2.82
10	UK	3,205	1.57	3,612	1.51
11	Others	36,861	18.07	32,036	13.35
	Total	2,04,000	100.00	2,40,000	100.00

Source: Spices Board of India

Table 9. Chilli Exports from India by Value (in ₹ crore)

S. No.	Country	2009-10	% to Total	2010-11	% to total
1	Malaysia	323.03	25.01	356.42	23.21
2	Srilanka	199.42	15.44	197.29	12.85
3	Bangladesh	151.58	11.73	182.08	11.86
4	U.S.A	151.37	11.72	138.01	8.99
5	Pakistan	0.81	0.06	134.92	8.79
6	U.A.E	89.98	6.97	84.79	5.52
7	Mexico	18.28	1.42	76.28	4.97
8	Indonesia	55.64	4.31	60.35	3.93
9	China	12.84	0.99	46.99	3.06
10	U.K	32.71	2.53	37.45	2.44
11	Others	256.06	19.82	220.97	14.39
	Total	1,291.72	100.00	1,535.55	100.00

Source: Spices Board of India

Table 10. CAGR for major exporting countries (1996-2006)

S. No.	Country	CAGR (%)
1	Peru	85.92
2	Myanmar	28.85
3	Pakistan	27.69
4	India	12.74
5	Malaysia	11.64
6	China	10.63
7	Mexico	9.12
8	Spain	3.12
	World 9.42	

1971-72 to 1980-81 with a growth rate of 12.75 per cent. During 1981-82 to 1990-91 it was Andhra Pradesh with 8.89 per cent and Karnataka in the following decade of 1991-92 to 2000-01 with a CAGR of 11.39 per cent. Rajasthan in the recent decade of 2001-02 to 2007-08 stood out as the top achiever of production growth of 7.58 per cent. During the overall period of 1961-62 to 2007-08 highest growth of 4.98 was achieved by Andhra Pradesh with productivity being the most powerful causative factor.

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TRADE LIBERALISATION, GROWTH AND COMPOSITION OF AGRICULTURAL EXPORTS IN INDIA – SOME EMERGING TRENDS

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ABSTRACT

The present study explores the growth performance of India's agricultural exports from 1970-71 to 2010-11, using compound annual growth rate and percentage share in total exports of India. The study also examines the changing dynamics of the contribution of individual group of commodities in the basket of agricultural export.

INTRODUCTION

In the wake of liberalization and globalization, agricultural sector in most of the developing countries are inward looking in nature and mostly insulated from the global economy. Indian agriculture has greatly contributed to foreign trade even in its traditional form. However, Indian products have been facing stiff competition from Asian countries for quite some time. Due to globalisation and liberalised regime, this competition is likely to increase further and new initiatives in agricultural development shall have to meet the emerging challenges. The performance of agriculture after integration with the world markets is linked to the success of exports. The developing countries, like in India have a large proportion of small and marginal farmers. These countries face severe problems of inadequate investment, underdeveloped public infrastructure, labour intensive technology, low agricultural export subsidies, lack of information about international competitiveness, high volatility of global prices, foreign protection of tariffs, non-tariff barriers, anti dumping regulations etc.,

In the scenario of free trade in agriculture as mandated under WTO the internal market mechanism of price formation in world market have a crucial bearing on food security for the developing countries (Chand, 2002) and a decline in agricultural exports in the late nineties is probably due to sharp reduction in the international prices of agricultural commodities (Bhattacharyya, 2003). It is pointed out that the price volatility in the international commodity market was high and tariff rate adjustment can work quite effective. In this framework an attempt is made to assess the performance of Indian agricultural exports during the pre and post reforms period and the determinants.

DATA AND METHODOLOGY

This study employs the annual data over the period of 40 years for analyzing the determinants of agricultural exports in India. The data are collected from National Account Statistics (NAS) and Economic Survey, Ministry of Agriculture, Government of India, covering the period from 1970-71 to 2010-11. The trends in the agricultural exports during study period have been analysed by employing compound annual growth rates. In order to identify the differences in the growth trend during pre and post reform period, data on the exports of 13 major agricultural and allied commodities have been divided into two segments covering the periods from 1970-71 to 1990-91 and from 1991-92 to 2010-11.

RESULTS AND DISCUSSION

Performance of Indian agriculture exports and its share in total national exports

India's share in the world agricultural exports was very low in many items. Until the beginning of the early seventies India has been an importer of a number of agricultural commodities. With the exception of a few commodities like rice, cotton, tea, coffee, oilseeds, oil cakes, tobacco and spices, the share of agricultural exports of India in total world trade was very insignificant. The share was particularly low in the world trade of fish, meat, chicken, vegetables and fruits. During the study period the gap between agricultural exports and non-agricultural exports has increased. Agricultural exports experienced

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Table 1. Performance of Indian agriculture exports and its share in total national exports

Year	Total exports (₹ crore)	Agricultural exports (₹ crore)	Percentage share of agricultural exports	Percentage share of non-agricultural exports	Ratio of agricultural to non agricultural exports
1970-71	1,535	487	31.73	68.27	1:2
1980-81	6,711	2,057	30.65	69.35	1:2
1990-91	32,553	6,317	19.41	80.59	1:4
1994-95	82,673	13,223	15.99	84.01	1:5
2000-01	2,03,571	28,582	14.04	85.96	1:6
2004-05	3,75,339	41,603	11.08	88.92	1:8
2005-06	4,55,617	49,217	10.80	89.08	1:8
2006-07	5,71,774	62,411	10.92	89.08	1:8
2007-08	6,40,172	77,769	12.15	87.85	1:7
2008-09	8,40,075	81,710	9.73	90.27	1:9
2009-10	8,45,534	85,211	10.08	89.92	1:9
2010-11	11,42,922	1,11,393	9.75	90.25	1:9

Source: Directorate General of Commercial Intelligence and Statistics, and Economic Survey 2012-13 Government of India

very slow rise compared to the total exports. India's exports in absolute figures have increased since the reforms in 1991 whereas, in percentage share declined.

Table 1 shows that the share of agricultural exports in the total exports was 31.73 in 1970- 71 and thereafter the share was continuously declining and it reduced to

Table 2. Commodity-wise compound annual growth rate of agricultural exports

Commodity	1991-2000	2001-2010	1991-2010
Coffee	18.95	5.54	10.98
Tea	5.20	5.11	5.17
Oil cakes	10.11	14.37	13.47
Tobacco	14.39	20.25	15.05
Cashew	18.60	3.26	9.66
Spices	22.42	14.30	17.79
Sugar	1.94	-12.69	6.48
Cotton	-12.65	45.70	12.81
Rice	21.66	14.40	17.60
Fish	18.23	4.51	12.37
Meat	19.24	15.64	20.91
Vegetables and fruits	19.85	14.32	18.41
Miscellaneous	26.02	10.15	19.19
Total Agri. exports	15.34	11.54	13.89
Total exports	17.19	15.43	17.69

Source: Reports of economic survey

9.75 per cent in 2010-11. Between the year 2006-07 and 2007-08 there was an increase of 1.23 per cent and again fall in 2008-09 to 9.73 per cent. The slow rise in agricultural export in the above said period calls for the change in strategic approach of Indian agriculture in a big way to achieve higher levels of production in crops in which India has comparative advantage and generate surpluses for exports. There is an increase in the volume of agricultural export from ₹ 6, 317 crore in 1990-91 to 1,11,393 in 2010-11.

Growth rates of agricultural exports

The compound annual growth rate for these 20 years was 13.89 per cent (Table 2). The export of tobacco and oil cakes have increased after liberalization period and at the same time the growth rates of coffee, tea, cashew, rice, fish and other miscellaneous products decreased during the post liberalization period, The growth rate of export of sugar decreased enormously during the post liberalization period.

A comparison of CAGR values of all the commodity groups between the two periods viz 1991 to 2000 and 2001 to 2010 showed that only oil cakes, tobacco and cotton registered higher values of CAGR for the second period. For the total agricultural export there was a declining trend in the CAGR from 15.34 in first period to 11.54 in second periods. The CAGR value for total

agricultural export for the entire period under observation was 13.8 per cent.

CONCLUSION

The growth analysis showed that there was a high fluctuation in the exports of agricultural commodities during the study period. Though India placed in the top list of agricultural production in the world, it failed to achieve advantage in its export performance due to heavy competitiveness in the global market. The growth of agricultural exports did not differ much between pre and post reform period.

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IDENTIFICATION OF GROUNDNUT GENOTYPES FOR HEAT TOLERANCE AND HIGH YIELD FOR EARLY KHARIF SITUATION

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ABSTRACT

Field experiment was conducted at Regional Agricultural Research Station, Tirupati during early *kharif* 2013 with 16 pre release and released groundnut genotypes. Heat stress tolerance of these genotypes across the important growth phenophases were measured using reliable traits *viz.,* Relative injury to the cell membranes and Chlorophyll Stability Index. Among the pre release genotypes, TCGS-1375 recorded high CSI, moderate RI and high pod yield. TCGS-1375 possess high heat stress tolerance and high yield and hence farmers can grow this cultivar and is suitable for early *kharif* situation. Other genotypes, TCGS-1350, TCGS-1173, TCGS-1349, TCGS-1157 possess heat stress tolerance with moderate yields. These genotypes can be used as donor source in resistant breeding programmes.

KEY WORDS: Early *kharif*, Groundnut, Heat stress tolerance

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the important oilseed crop grown in India, which accounts for 45% of total area under oilseeds and 55% of total oilseed production. Though area and production of groundnut in India is high, average productivity is relatively low as groundnut is mostly grown under rainfed condition. Because of high productivity under assured irrigation, groundnut cultivation in summer season is gaining popularity (Patel *et al.*, 2008). In Southern zone of Andhra Pradesh area under early *kharif* is increasing year by year. The early crop growth and flowering suffered due to high temperatures, low humidity, however genotypic variability exists in tolerating this adverse situation.

Heat stress due to high ambient temperatures is a serious threat to crop production worldwide (Hall, 2001). High temperature is often accompanied by drought stress under field conditions. Heat can be one of the major abiotic stresses that adversely affect crop production worldwide at different stages of development. High temperature causes irreversible damage to plant function and development.

Breeding of heat tolerant genotypes in crop species is therefore necessary. This requires sources of heat tolerance to be identified, an understanding of the mechanisms of heat tolerance and screening methods to rapidly measure tolerance to be produced.

Although several plant processes are more sensitive to heat, plant adaptation to high temperature essentially requires a cell membrane system that remains functional during heat stress (Raison, 1980). Hence the present study was taken up to study the identification of groundnut genotypes with heat stress tolerance for early *Kharif*.

MATERIAL AND METHODS

The present experiment was conducted during early *kharif* 2013 at Regional Agricultural Research Station, Tirupati. The experiment was laid out in a Randomized Block Design (RBD) with fourteen pre release and two released groundnut genotypes replicated thrice. The soil was sandy loam in texture, neutral in soil reaction, medium in organic carbon and available nitrogen, medium in available phosphorus and potassium. Recommended dose of fertilizers were applied. Prophylactic measures were taken for protecting the crop from pest and diseases. From sowing (May 25th) to 40 DAS (June 30th) crop was exposed to high temperature ranges from 38°C to 42°C. Mean evaporation from sowing to 40 DAS was also high and crop exposed to tissue water stress. The leaf samples were collected at two stages of crop growth *viz.*, 30 and 60

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days after sowing for computing the relative injury and chlorophyll stability index. Cell membrane integrity is tested by exposing leaves to high temperature and computing relative injury to the membranes in terms of electrolytes leakage. Relative injury per cent was measured using third leaf from top of respective genotypes. The method used for measuring membrane damage was similar to the method given by Leopald *et al*. (1981). Per cent

leakage (%) = $\dfrac{Ia}{Fa} \times 100$ (where, Ia: Initial absorbance, Fa:

Final absorbance). Chlorophyll stability index CSI (%) was measured using third leaf from top of respective groundnut genotypes. Fresh leaf sample (0.1 g) was collected from the selected groundnut genotypes and placed in a 100 ml flask and heated it in a water bath for 60 min at 65°C. 10 ml of DMSO solution was added to treated and untreated samples. Respective check samples were also maintained without imposing heat treatment. Both treated and untreated conical flasks were kept for overnight and the concentration of total chlorophyll is quantified by reading the optical density at 663 nm and 645 nm.

Total Chl mg/g = 20.02 (D645) + 8.02 (D663) X V/ 1000 x W.

The CSI of the leaf sample was calculated using the following formula

$$CSI\% = \dfrac{\text{Total chlorophyll of the heated sample}}{\text{Total chlorophyll of unheated sample}} \times 100$$

RESULTS AND DISCUSSION

The results of the study indicated that genotypic variability existed between 16 groundnut genotypes for Relative injury. Mean genotypic variability for Relative injury (10.08 to 17.78%) and Chlorophyll Stability Index (32.25 to 69.75%) was observed during the crop growth, which denotes usefulness of these traits for screening groundnut genotypes for high heat stress tolerance (Table 1). Such genotypic variations in relative membrane injury were also reported in sorghum (Sullivan and Ross, 1979), blackgram (Sudhakar *et al*., 2006) and groundnut (Pranusha *et al*., 2012).

Relative membrane injury

Data presented in Table 1 revealed that relative injury values were high at 30 DAS compared to 60 DAS, as the crop suffers high temperature stress before 40 DAS. Significant differences in relative injury values were recorded between genotypes in both stages of crop growth. At flowering stage, among the pre release cultivars TCGS-1173 recorded low RI of 9.97 per cent compared to other genotypes. Cultivars, TCGS-1350 (11.16%) and Check, Narayani (10.70%) also recorded low RI values. Other cultivars TCGS-1360, TCGS-1323, TCGS-1375 and TCGS-1349 also recorded moderate RI values. Hence these genotypes had moderate tolerance for high temperature.

Thermostability of plasmamembranes can be considered important for detriment of heat tolerance (Talwar *et al*., 1999). Hence measuring cell membrane thermostability in terms of relative injury percentage was a useful trait in screening genotypes for heat stress tolerance. It was reported that relative injury percentage could be useful trait in screening genotypes for thermostability at high temperatures in groundnut (Babitha *et al*., 2006) and blackgram (Sudhakar *et al*., 2006).

Chlorophyll stability index

The chlorophyll stability index is an indication of the stress tolerance capacity of plants. This leads to increased photosynthetic rate, more drymatter production and higher productivity. Hence, a high CSI value means that the temperature stress did not have much effect on chlorophyll content of plants.

Among the pre release genotypes, TCGS-1375, TCGS-1157 recorded significantly higher CSI compared to checks and other entries at two stages of crop growth (Table 1). These genotypes are considered to be temperature tolerant types.

The data on pod yield revealed that the genotype TCGS-1375 recorded high CSI (62%), moderate RI (11.73%) and high pod yield (3961.53 Kg ha^{-1}) (Table 2). TCGS-1375 possesses high heat stress tolerance and high yield and hence farmers can grow this cultivar and is suitable for early *kharif* situation. Other genotypes TCGS-1350, TCGS-1173, TCGS-1349, TCGS-1157 possess heat stress tolerance with moderate yields. These genotypes can be used as donor source in resistant breeding programmes.

Table 1. **Relative injury (%) and chlorophyll stability index (%) of groundnut genotypes grown during early** *kharif*, 2013

S. No.	Genotypes	Relative injury (%)		Chlorophyll stability index (%)	
		30 DAS	60 DAS	30 DAS	60 DAS
1.	TCGS-1330	15.27	13.30	70.00	40.00
2.	TCGS-1323	13.49	11.96	36.00	28.50
3.	TCGS-1342	17.26	13.02	70.00	45.00
4.	TCGS-1343	14.28	12.02	77.00	43.00
5.	TCGS-1346	16.37	13.42	66.00	36.00
6.	TCGS-1349	14.48	8.46	39.00	34.00
7.	TCGS-1350	11.16	9.81	59.76	41.50
8.	TCGS-1374	13.29	12.50	65.50	39.00
9.	TCGS-1375	13.50	11.73	69.00	62.00
10.	TCGS-1360	12.99	12.46	44.09	42.00
11.	TCGS-1073	14.94	14.38	65.02	48.50
12.	TCGS-1157	15.86	14.44	80.00	59.50
13.	TCGS-1157A	19.46	16.10	82.87	52.00
14.	TCGS-1173	9.97	13.93	60.56	35.00
15.	DHARANI	17.20	12.45	64.00	57.00
16.	NARAYANI	10.70	9.46	62.94	52.50
	Mean	**14.39**	**12.46**	**63.23**	**44.72**
	CD (P=0.05)	**4.250**	**2.796**	**9.292**	**5.128**
	SEm ±	**1.349**	**0.888**	**2.950**	**1.627**

Table 2. Yield and yield components of groundnut genotypes grown during early *kharif*, 2013

S.No	Genotype	Pod yield (Kg ha^{-1})	Hundred pod weight (g)	Hundred kernel weight (g)
1.	TCGS-1330	4210.44	98.01	45.56
2.	TCGS-1323	3366.65	61.45	27.26
3.	TCGS-1342	3785.43	114.11	45.91
4.	TCGS-1343	3333.98	104.70	39.96
5.	TCGS-1346	3899.65	68.35	28.09
6.	TCGS-1349	3844.71	58.00	27.73
7.	TCGS-1350	3620.24	59.61	26.69
8.	TCGS-1374	2959.32	115.99	39.77
9.	TCGS-1375	3961.53	101.45	45.39
10.	TCGS-1360	2339.13	72.03	31.81
11.	TCGS-1073	3535.48	91.24	41.29
12.	TCGS-1157	3300.09	94.47	42.37
13.	TCGS-1157A	3414.32	105.15	41.89
14.	TCGS-1173	2938.26	84.20	40.45
15.	DHARANI	3799.64	94.68	39.75
16.	NARAYANI	2432.56	82.54	33.76
	MEAN	**3421.34**	**87.87**	**37.36**
	CD (P=0.05)	**365.672**	**17.22**	**3.843**
	SEm±	**127.717**	**6.01**	**1.342**

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GROWTH, YIELD ATTRIBUTES, YIELD AND ECONOMICS OF SESAME (*Sesamum indicum* L.) AS INFLUENCED BY SYSTEM OF CROP INTENSIFICATION (SCI) PRACTICES

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ABSTRACT

A field experiment was conducted during the early summer season at Tamil Nadu Agricultural University, Coimbatore, to evaluate the System of Crop Intensification (SCI) practices in sesame. The experiment was laid out in Randomized Complete Block Design, comprised of ten treatments and replicated thrice. The results revealed that closer square planting of sesame at 30×30 cm with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_2) showed its superiority in recording the higher plant height, number of branches m^{-2}, LAI and drymatter production, number of capsules m^{-2}, seeds capsules^{-1}, test weight and in producing greater seed yield, stalk yield, harvest index and economic profit than the control and any other treatments tested in the study.

KEY WORDS: SCI, sesame, growth characters, yield attributes, yield and economics

INTRODUCTION

Edible oils are next to food grains in Indian diet. With burgeoning population, the demand of edible oils will remain at its peak. To meet this demand, it becomes essential to identify new technological options to increase the productivity of oilseed crops. In India, sesame or gingelly is an important oilseed crop next to groundnut and rapeseed-mustard. Sesame has the highest oil content of 46-64 per cent with 25 per cent protein (Goel and Kumar, 1994). There is a wide gap between the potential and actual yield of sesame obtained by the farmers.

The probable reason for the low yield is the lack of appropriate production technology for increasing and sustaining its productivity. To narrow down this yield gap and to enhance the productivity, a new investigation in line with System of Rice Intensification (SRI) has been initiated. SRI is a new innovation in rice cultivation. SRI increases the rice yield than the conventional method of rice cultivation. A similar approach has been tried with other crops with some variations to specific crop is termed as system of crop intensification (SCI) (ISD, 2009). So, the present experiment was carried out to study the influence of SCI practices on growth characters, yield attributes and yield of sesame.

MATERIAL AND METHODS

A field experiment was conducted during the early summer season (January to May, 2013) at Wetland farms of Tamil Nadu Agricultural University, Coimbatore, to evaluate the System of Crop Intensification (SCI) practices in sesame. The soil of the experimental field was clay loam in texture belonging to *Typic Haplustalf* with pH of 8.35, EC 0.4 dSm^{-1}, organic carbon 0.33 % and available nitrogen (N), phosphorus (P) and potassium (K) were 236, 15.08 and 506 kg ha^{-1}, respectively. The experiment was laid out in Randomized Complete Block design, comprised of ten treatments were replicated thrice *viz.*, T_1 - 30×30 cm spacing + No nipping + HW at 35 DAS (Control), T_2 - 30×30 cm spacing + TIBA @ 50 ppm at 30 DAS + HW, T_3 - 40×40 cm spacing + Nipping at 35 DAS + HW, T_4 - 40×40 cm spacing + Nipping at 35 DAS + MW, T_5 - 40×40 cm spacing + TIBA @ 50 ppm at 30 DAS + HW, T_6 - 40×40 cm spacing + TIBA @ 50 ppm at 30 DAS + MW, T_7 - 50×50 cm spacing + Nipping at 35 DAS + HW, T_8 - 50×50 cm spacing + Nipping at 35 DAS + MW, T_9 - 50×50 cm spacing + TIBA @ 50 ppm at 30 DAS + HW and T_{10} - 50×50 cm spacing + TIBA @ 50 ppm at 30 DAS + MW. The sesame variety, VRI (SV) 2 was used as test cultivar sown on 28.01.2013 at 30×30 cm, 40×40 cm

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and 50 × 50 cm. Full dose of N, P and K (35:23:23) was applied basal at the time of sowing. All other recommended package of practices for growing of sesame were followed as per the recommendations of Crop Production Guide (CPG, 2012). TIBA was sprayed @ 50 ppm at 30 days of crop growth. Nipping was done by terminal clipping of first pair of leaves and mechanical weeding was done using self-propelled power weeder at 35 days of after sowing. In the net plot area, five plants were selected at random, tagged and used for taking biometrical data at 30 days interval starting from 30 DAS to at harvest stage. The data were subjected to statistical analysis as prescribed by Gomez and Gomez (2010).

RESULTS AND DISCUSSION

Growth characters

The treatments imposed had no significant influence on plant height of sesame barring at harvest stage. At harvest, the taller plants were recorded under closer square planting of 30 × 30 cm without nipping and hand weeding at 35 DAS (T_1) (Table 1), whereas, it was statistically on par with wider square planting of 50 × 50 cm with TIBA application @ 50 ppm at 30 DAS and mechanical weeding at 35 DAS (T_{10}) or hand weeding at 35 DAS (T_9) and wider square planting of 40 × 40 cm with TIBA application @ 50 ppm at 30 DAS and mechanical weeding at 35 DAS (T_6) or hand weeding at 35 DAS (T_5). This was perhaps due to the competition between the inter and intra plants for sun light under closer spacing encouraged self-thinning of branches and enhanced vertical growth rather than horizontal growth. The action of auxins present at apical part of stem increased the rate of cell elongation and cell division which might have lead to increased plant height in case of non-nipped plants or non-spraying of TIBA. Similar findings were reported by Kokilavani *et al.* (2007) in sesame.

The SCI practices exerted significant influence on the number of branches m^{-2}, drymatter production and leaf area index at all the stages of sesame. Closer square planting of 30 × 30 cm with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_2) registered perceptibly higher number of branches m^{-2}, drymatter production and leaf area index compared to all other SCI practices tested. This was mainly due to more population resulting in higher number of leaves unit area^{-1} under closer geometry level and hand weeding also might had positive

influence through provision of weed free environment to the crop and all combinedly had cumulative effect in enhancing the drymatter and leaf area. Spraying of TIBA increases the number of branches plant by better translocation of natural auxins to lateral bud stimulates lateral branches to grow. These results are in conformity with Caliskan *et al.* (2004) in sesame.

Yield attributes

Closer square planting of 30 × 30 cm with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_2) gave more number of capsules m^{-2} whereas, it exhibited statistical similarity with wider square planting of 40 × 40 cm with nipping and mechanical weeding at 35 DAS (T_4). The reason for more number of capsules m^{-2} might be due to combined effect of more number of plants m^{-2} and increased number of branches plant^{-1} leads to increasing the total number of capsules plant^{-1} ultimately results in higher number of capsules unit area^{-1}. The least number of capsules m^{-2} was recorded under wider square planting of 50 × 50 cm with nipping and hand weeding at 35 DAS (T_7) (Table 1). The results were in conformity with Caliskan *et al*. (2004) in sesame.

The treatments imposed set a prominent variation on number of seeds capsule^{-1}, number of seeds locule^{-1} except test weight of sesame. Wider square planting of 50 × 50 cm with TIBA application @ 50 ppm at 30 DAS and mechanical weeding at 35 DAS (T_{10}) registered higher number of seeds locule^{-1} and capsule^{-1} (Table 1). Lower number of seeds locule^{-1} was found in closer square planting of 30 × 30 cm without nipping and hand weeding done at 35 DAS (T_1). Overall improvement in plant vigour and production of sufficient photosynthates through increased leaf area and higher dry matter production plant^{-1} with better partitioning might have increased the number of seeds locule^{-1} capsule $^{-1}$ due to the combined effect of crop geometry, TIBA application @ 50 ppm at 30 DAS and mechanical weeding at 35 DAS. These results are in agreement with Basha and Reddy (2001) in sesame.

There were no discernible variations on 1000-seed weight of sesame due to adoption of SCI practices (Table 2). However, maximum 1000-seed weight (3.6 g) was noticed under wider square planting of 50 × 50 cm with nipping and mechanical weeding at 35 DAS (T_8). The minimum test weight was with closer square planting of 30 × 30 cm without nipping and hand weeding done at 35

Table 1. Effect of system of crop intensification practices on growth and yield attributes of sesame at harvest stage

Treatments	Plant height (cm)	Number of branches m^{-2}	Drymatter (kg ha^{-1})	Leaf area index	Capsule number m^{-2}	Number seeds capsule^{-1}	Number of seeds locule^{-1}	1000 seed weight (g)
T$_1$: 30 × 30 cm + No nipping + HW at 35 DAS – Control	100.3	167.2	6504	0.40	908	59.6	14.8	3.1
T$_2$: 30 × 30 cm spacing + TIBA @ 50 ppm at 30 DAS + HW	86.0	202.4	9113	0.68	1408	63.1	15.6	3.2
T$_3$: 40 × 40 cm spacing + Nipping at 35 DAS + HW	77.8	127.2	6432	0.60	1162	65.4	16.3	3.3
T$_4$: 40 × 40 cm spacing + Nipping at 35 DAS + MW	79.0	136.2	7195	0.63	1318	66.5	16.5	3.4
T$_5$: 40 × 40 cm spacing + TIBA @ 50 ppm at 30 DAS + HW	93.0	114.6	6169	0.61	1074	61.0	15.8	3.3
T$_6$: 40 × 40 cm spacing + TIBA @ 50 ppm at 30 DAS + MW	94.8	126.6	6450	0.61	1106	61.9	15.9	3.4
T$_7$: 50 × 50 cm spacing + Nipping at 35 DAS + HW	89.4	93.2	6176	0.44	796	63.7	17.0	3.5
T$_8$: 50 × 50 cm spacing + Nipping at 35 DAS + MW	91.1	100.4	6571	0.49	948	70.1	17.7	3.6
T$_9$: 50 × 50 cm spacing + TIBA @ 50 ppm at 30 DAS + HW	96.5	79.2	4613	0.44	913	66.3	17.0	3.5
T$_{10}$: 50 × 50 cm spacing + TIBA @ 50 ppm at 30 DAS + MW	97.8	86.8	5344	0.49	991	70.9	17.9	3.6
SEd	4.5	7.4	427	0.04	65	3.5	0.7	0.2
CD (P=0.05)	9.4	15.5	897	0.08	137	7.4	1.4	NS

HW: Hand weeding; MW: Mechanical weeding; TIBA: Tri iodo benzoic acid; NS: Non significant

DAS (T_1). Similar results were also noticed by Basha and Reddy (2001) in sesame.

Yield

Effect of SCI practices brought out a significant influence on both seed and stalk yield of sesame (Table 2). Among the treatments, closer square planting of 30×30 cm with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_2) shown its superiority over other treatments in recording higher seed and stalk yield of sesame. Whereas, wider square planting of 40×40 cm with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_5) registered the lowest seed and stalk yield. This was due to more plant population unit area^{-1} and also application of TIBA under closer spacing lead to increased number of branches and drymatter production with better source-sink partition to produce more number of capsules plant^{-1} which inturn increased the seed yield. Similar findings were also reported by Tiwari and Namdeo (1997) in sesame. The SCI practices did not exert significant difference among the treatments related to harvest index of sesame due to significant biological yield which indicates that the partitioning efficiency of crop was not up to the mark owing to capsule wall. Similar results were reported by Harsha (2006) in sesame.

Economics

The highest gross return (₹ 56850 ha^{-1}) and net return (₹ 23434 ha^{-1}) were obtained with treatment composed of closer square planting (30×30 cm) with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_2). Whereas, the lowest gross return (₹ 38150 ha^{-1}) and net return (₹ 4734 ha^{-1}) were noticed under wider square planting of 40×40 cm with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_5). Similar to gross return and net return, the benefit-cost ratio was also maximum under closer square planting of 30×30 spacing cm with TIBA application @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_2). The economic efficiency and viability of crop cultivation are mainly the outcome of crops and yield with lesser management cost. Among the SCI practices, closer spacing of 30×30 cm with TIBA @ 50 ppm at 30 DAS and hand weeding at 35 DAS (T_2) gave higher gross and net returns with benefit-cost ratio. This might be due to lesser cost of cultivation in addition to increased seed yield. This result is supported by the findings of Tiwari and Namdeo (1997) in sesame.

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FACTORS AFFECTING TECHNOLOGICAL GAP OF RICE GROWERS OF KURNOOL DISTRICT IN ANDHRA PRADESH

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ABSTRACT

The study was conducted in the Kurnool district of Andhra Pradesh during the year 2014-15. The study has focused on factors affecting technological gap of rice growers in adoption of recommended rice production technology. A sample of 120 farmers of six villages was included by random sampling and their responses were analyzed with relevant statistical tools. Findings of the study revealed that independent variables viz., age, education, annual income, cosmopoliteness, social participation, extension contact, mass media exposure, innovativeness, scientific orientation, management orientation and risk orientation were found negatively and significantly correlated with technological gap of rice farmers. Farming experience was found to have positive and significant relation with technological gap where as farm size had non- significant relation with technological gap of rice farmers with overall technological gap of rice growers.

KEY WORDS: Technology gap, Adoption, Rice growers production technology

INTRODUCTION

Rice is life, for most people of Asia. Rice has shaped the cultures, diets and economies of thousands of millions of people. It is a time honored crop to the Asian way of life; deeply embedded in the cultural heritage, spirituality, traditions and norms. A Chinese proverb says that "Precious things are not pearls and jades but the five grains, of which rice is the finest". The adoption or acceptance of recommended agricultural technology is a unit that acts but a complex process is involving in the sequence and thought of action. The action of individual farmers is governed by their profile characteristics and situational factors. Some farmers adopt new agricultural technology more quickly than others because of the differences in profile characteristics. Hence, considering the importance of these characteristics and review of past research studies, an attempt has been made in this investigation to ascertain the relationship if any, between selected profile characteristics of the rice growers and their technological gap in adoption of rice production technology.

The present study was conducted to analyze the factors affecting the technological gap in adoption of recommended cultivation practices by the farmers in rice production, with an objective of studying the

technological gap in adoption of recommended cultivation practices by the rice growers.

METHODOLOGY

The study was conducted using expost- facto research design to study the factors affecting the technological gap in adoption of recommended cultivation practices by the growers in Kurnool district of Andhra Pradesh during the years 2014-15. Kurnool district was selected as the researcher hails from the same area and had the familiarity with social conditions, local language and culture of the people. Kurnool district comprises of 54 mandals out of which three mandals namely Mahanandi, Sirivella and Rudravaram were purposively selected for the study. From each of the selected mandals, two villages were selected based on random sampling procedure. Thus, a total of six villages were selected for the study. A total sample of 120 rice farmers were selected by selecting 20 farmers from each village through simple random sampling procedure. Keeping the objective of the study in view, a semi structured interview schedule was developed and pretested. This was administered to sample respondents through personal investigation. The data obtained were coded, classified and tabulated. The technological gap of rice cultivation determined and tested with help of Karl Pearson (1978) co efficient correlation test.

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RESULTS AND DISCUSSION

Considering the importance of characteristics of the respondents and review of past research studies, the relationship between selected profile characteristics of rice growers and technological gap was calculated and presented in Table 1.

Age Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = 0.4674) between age and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was a significant relationship between age and technological gap of rice farmers. Most of the respondents belonged to middle and old age categories, as the youth in the rural areas were not interested in doing agricultural because of various reasons. The youth preferred academic and business careers. Hence this trend was noticed. This finding is similar with the result of Singh (2007) and Chouhan *et al.* (2013).

Education Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.3905) between education and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was a negative and significant relationship between education and technological gap of rice farmers. It is evident that farmers with more education will reach the latest technologies by using different media. These farmers also were able to understand clearly the use of the technology and were able to practically apply to their field situation as compared to the less educated farmers, hence this relation was noticed. This finding was in line with Roy *et al.* (2013).

Farm size Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.0764) between farm size and the technological gap of respondents was less than the table value of 'r'. Hence, null hypothesis was accepted and empirical hypothesis was rejected. It could, therefore be inferred that there was non-significant relationship between farm size and technological gap of rice farmers. The different categories of farming community were

almost having similar income. The respondents were using the similar resources, cultivation practices and technology and hence this trend was noticed.

Farming experience Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = 0.3807) between farm experience and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was a significant relationship between farming experience and technological gap of rice farmers. The more experienced farmers were having the better knowledge of latest recommendations and technology. They were using minimum of the technologies were critical in the cultivation of rice crop when compared to the farmers with less experience and hence this trend was noticed.

Annual income Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.4346) between annual income and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between annual income and technological gap of rice farmers. The farmers with more income were able to sustain in the rice cultivation and they got the income because of use of latest production recommendations and hence this result was noticed.

Cosmopoliteness Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.3647) between cosmopoliteness and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between cosmopoliteness and technological gap of rice farmers. It is evident that the farmers having the trait of cosmopliteness would eventually search the different channels of information outside their community also. Usually the information about the latest technologies in the own community would be similar at different angles, but the information gained through the outside channels may sometimes prove to be new and fit well to solve an existing problem. Hence this trend might have been observed.

Table 1. Relationship between selected profile characteristics of respondents and their technological gap

S. No.	Variable No.	Independent variables	Correlation coefficients ('r' value)
1.	X_1	Age	0.4674**
2.	X_2	Education	-0.3905**
3.	X_3	Farm size	-0.0764NS
4.	X_4	Farming experience	0.3807**
5.	X_5	Annual Income	-0.4346**
6.	X_6	Cosmopoliteness	-0.3645**
7.	X_7	Social participation	-0.5274**
8.	X_8	Extension contact	-0.3253**
9.	X_9	Mass media exposure	-0.5248**
10.	X_{10}	Innovativeness	-0.3794**
11.	X_{11}	Scientific orientation	-0.3224**
12.	X_{12}	Risk orientation	-0.3294**
13	X_{13}	Management orientation	-0.5115**

* : Significant at 0.05 level of probability
** : Significant at 0.01 level of probability
NS : Non-significant

Social participation Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.5274) between social participation and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between social participation and technological gap of rice farmers. The above finding was in line with Chouhan *et al.* (2013). The respondents with more social participation as compared to others, have definitely more channels of information about the latest technologies, they are better to change their attitudes towards new technologies and adopt them soon. Hence this trend might have been noticed.

Extension contact Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.3253) between extension contact and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between extension contact and technological gap of rice farmers. Good extension contact keeps the farmers aware of the agricultural innovations, which are essential to minimize the gaps of using the latest technologies with regard to rice cultivation. Rice being the prime crop, usually a continuous series of technologies would be there. So as compared to farmers with less extension contact these farmers have fewer gaps in the use of technology. Hence this result might have been observed.

Mass media exposure Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.5248) between mass media exposure and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between mass media exposure and technological gap of rice farmers. Mass media especially at present is having a definite impact on the farmers to use the latest technologies in agriculture. As time to time the number television channels separately for agriculture, news paper columns, Information and Communication Tools are added up very frequently. Hence this trend might have been noticed.

Innovativeness Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.3793) between innovativeness and the technological gap of respondents was more than the table

value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between innovativeness and technological gap of rice farmers. An innovative farmer always try to cultivate the crop differently from others by using new methods of cultivation and he searches for new varieties which are resistant to pests and diseases and tolerant to other micro climatic factors. Hence this result was observed.

Scientific orientation Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.3224) between scientific orientation and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between scientific orientation and technological gap of rice farmers. Respondents with more scientific orientation had more belief in the latest technologies recommended by the extension personnel. They adopted more recommended technologies when compared to other rice farmers. Hence this trend might have been noticed. This finding is in similar to the results of Bhatia *et al.* (2011).

Risk orientation Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.3294) between risk orientation and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between risk orientation and technological gap of rice farmers. Farmers were knowing that there was a prevalent risk in the cultivation of rice and they were more interested to avoid the pitfalls in the cultivation of crops and use mostly the recommended technologies in comparison to other farmers, hence this trend was noticed.

Management orientation Versus Technological gap

From the Table 1 it is evident that co-efficient of correlation (r = -0.5115) between management orientation and the technological gap of respondents was more than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore be inferred that there was negative and significant relationship between management

orientation and technological gap of rice farmers. The farmers with management orientation will definitely use more accurate and latest technologies in the rice farming. They have the planning ability to foresee the difficulties in the cultivation of the crop and meet the contingencies effectively in comparison to other farmers, hence this trend might have been observed.

CONCLUSION

It is concluded from the above findings that independent variables like age, education, annual income, cosmopoliteness, social participation, extension contact, mass media exposure, innovativeness, scientific orientation, management orientation and risk orientation were found negatively and significantly correlated with technological gap of rice farmers. Farming experience was found to have positive and significant relation with technological gap where as farm size had non significant relation with technological gap of rice farmers. More efforts should be made by the extension agencies to establish in-depth extension contact with the farmers and their traits which influence the technological gap of the rice growers in terms of change in behavioural components must be reckon within training programme.

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FACTORS INFLUENCING THE KNOWLEDGE LEVEL OF THE PARTICIPANT AND NON PARTICIPANT FARMERS OF RICE FFSs ON RECOMMENDED ICM PRACTICES

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ABSTRACT

The present investigation was carried out in Nellore district of Andhra Pradesh state during 2014-15 to study the level of knowledge and factors influencing the level of knowledge of the participant and non participant FFS rice farmers. A total of 150 respondents were selected for the study out of which 75 farmers were participant farmers of rice FFS and the other 75 were non participants. The results of the study revealed that 53.33 per cent of the participant farmers were having medium level of knowledge, followed by high (34.67%) and low (12.00%) levels. Whereas in case of non participant farmers majority (65.33%) of the respondents were having medium level of knowledge, followed by low (18.67%) and high (16.00%) levels. The profile characteristics viz., education, social participation, mass media exposure, extension contact, innovativeness, scientific orientation, achievement motivation and management orientation were found to be positively significant with the level of knowledge of participant and non participants. Further, all the selected 12 independent variables put together explained about 86.10 per cent variation in the knowledge level of the participant farmers of rice FFSs and whereas in case of non participant farmers it was found 59.30 per cent.

KEY WORDS: Knowledge level, Integrated crop management, Farmer Field School

INTRODUCTION

Farmer field school (FFS) is described as a Platform and "School without walls" for improving decision making capacity of farming communities and stimulating local innovation for sustainable agriculture. It is a participatory approach to extension, whereby farmers are given opportunity to make a choice in the methods of production through discovery based approach. The continuous learning occur throughout the crop season and facilitates farmer to farmer communication. The special feature of FFS is field based learning and acts as a primary venue of learning for farmers. The Farmer Field Schools are oriented to provide basic agro ecological knowledge and skills in a participatory manner so that farmers experience is integrated in the programme. For the success of any programme, there should be a periodical appraisal and evaluation of what is being done, so that suitable changes can be made for effective functioning. So far a limited research was done on FFS programme and also the Department of Agriculture organized more number of farmer field schools on rice in Nellore district, an attempt was made to study the impact of FFS programme in terms of knowledge gained by the participant and non participant farmers of rice FFSs during the year 2014-15.

METERIAL AND METHODS

Nellore district of Andhra Pradesh was purposively selected as rice is extensively cultivated and also Farmer Field School on Integrated Crop Management (ICM) was successfully implemented in this district. Out of 46 mandals of Nellore district, 3 mandals were purposively selected based on the highest number of FFSs on rice were conducted. Two villages i.e. one FFS village and another non FFS village were selected randomly from each selected mandal thus making a total of six villages of which three were FFS and three non FFS villages. From each FFS and non FFS selected villages, 25 respondents were selected by using simple random sampling procedure, thus making a total of 150 respondents for the study of which 75 farmers were FFS rice farmers and the other 75 were non FFS rice farmers.

RESULTS AND DISCUSSION

Knowledge is an indispensable criterion for the adoption of any innovation, as it enables the farmers to

understand completely and clearly the recommended ICM practices. The rate of adoption of an innovation is directly linked with level of knowledge of the respondents. Hence, it was felt necessary to know the knowledge level of the farmers on recommended ICM practices.

Overall level of knowledge on recommended ICM practices by the participant and non participant farmers of rice FFSs

In order to assess the overall knowledge level on the recommended ICM practices by the participant and non participant rice farmers, data were collected and the respondents were categorized into three groups viz., low, medium and high by using mean and standard deviation and the results were presented in Table 1.

A glance at the Table 1 revealed that 53.33 per cent of the participant farmers were having medium level of knowledge, followed by high (34.67%) and low (12.00%) levels of knowledge. In case of non participant farmers majority (65.33%) of the respondents were having medium level of knowledge, followed by low (18.67%) and high (16.00%) levels of knowledge.

From the above results it could be revealed that majority of the participant farmers belonged to 'medium to high' levels of knowledge. Whereas in case of non participant farmers majority belonged to 'medium to low' levels of knowledge.

The probable reason for this trend might be that FFS is being conducted for one complete season with weekly intervals. The participant farmers were well trained on ICM practices during FFS sessions. Further, the personal and psychological traits of the participant farmers revealed that their education level was fairly good. In FFS, farmers trained on rice ICM practices i.e. soil sample collection, seed germination test, seed treatment, Integrated Nutrient Management (INM), Integrated Pest Management (IPM), preparation of Neem Seed Kernal Extract (NSKE) and poison baits, water management, pests and diseases identification, identification of beneficial insects, defoliation experiments, farm machinery etc. through non formal education and also by conducting short and long term experiments in their own fields. This might have helped the respondents to gain high knowledge regarding ICM practices. Hence the above trend of medium to high level of knowledge possessed by the majority of the participant farmers of rice FFS than non participant farmers. This finding was in line with Krishnamurthy (1999), Obaiah (2004) and Gopala *et al.* (2010).

Relationship between the selected profile characteristics and the level of knowledge of the participant and non participant farmers of rice FFSs

In order to study the nature of relationship between the selected profile characteristics with the level of knowledge on recommended ICM practices by the participant and non participant farmers of rice FFSs, correlation co-efficients (r) were computed and the values were presented in Table 2. The relationship between the selected profile characteristics and the level of knowledge on recommended ICM practices by the participant and non participant farmers of rice FFSs were tested by null hypothesis and empirical hypothesis.

Null Hypothesis (H₀)

There will be no significant relationship between the selected profile characteristics and the level of knowledge on recommended ICM practices by the participant and non participant farmers of rice FFSs.

Table 1. Distribution of respondents according to their overall level of Knowledge

S. No.	Category	Participant farmers (n=75)		Non participant farmers (n=75)	
		Frequency	Percentage	Frequency	Percentage
1.	Low Knowledge level	9	12.00	14	18.67
2.	Medium Knowledge level	40	53.33	49	65.33
3.	High Knowledge level	26	34.67	12	16.00
	Total	75	100.00	75	100.00
	Mean	37.87		22.80	
	SD	1.20		4.16	

Empirical hypothesis (H₁)

There will be a significant relationship between the selected profile characteristics and the level of knowledge on recommended ICM practices by the participant and non participant farmers of rice FFSs.

Age Vs level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r = 0.076, -0.209) between age and knowledge of the respondents was less than the table value of 'r' at 0.05 level of significance. Hence, null hypothesis was accepted and empirical hypothesis was rejected. Therefore, it could be inferred that there was a non significant relationship between age and knowledge of the participant farmers of rice FFSs whereas non significant relationship also existed between age and knowledge of the non participant farmers of rice FFSs.

The probable reason for the above trend might be that variation in knowledge had no influence on the age level of the respondents. The possible reason might be due to the fact that irrespective of age of the respondent, the grasping of practical information on FFS rice in the field situation was dependent on individual's personnel interest. This finding was in agreement with Naik (2009).

Education Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.623, 0.547) between education and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between education and knowledge of the participant and non participant farmers of rice FFSs.

The probable reason for this trend might be that education widens horizons of the individuals. Educated farmers with more information seeking habits had better access to farm information sources such as farm magazines, books on agriculture possess better capacity to grasp things, analyze and interpret them in proper way. Educated people have more exposure to extension agencies, scientists and research stations which also contribute to their increased knowledge. This finding was in line with the finding of Ramu (2005).

Land holding Vs Extent of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.042, -0.143) between land holding and knowledge of the respondents was less than the table value of 'r' at 0.05 level of significance. Hence, null hypothesis was accepted and empirical hypothesis was rejected. Therefore, it could be inferred that there was a non significant relationship between land holding and knowledge of the participant farmers of rice FFS whereas non significant relationship existed between land holding and knowledge of the non participant farmers of rice FFS. The finding was in tune with Naik (2009).

Farming experience Vs Extent of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.057, -0.195) between farming experience and knowledge of the respondents was less than the table value of 'r' at 0.05 level of significance. Hence, null hypothesis was accepted and empirical hypothesis was rejected. Therefore, it could be inferred that there was a non significant relationship between farming experience and knowledge of the participant farmers of rice FFS whereas non significant relationship existed between farming experience and knowledge of the non participant farmers of rice FFSs.

The probable reason might be that irrespective of the farming experience, participation in FFS might have contributed to gain more confidence and increased knowledge about new and innovative technologies involved in rice cultivation. This finding of the study was in agreement with the findings of Gattu (2001) and Naik (2009).

Social participation Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.439, 0.337) between social participation and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between social participation and knowledge of the participant and non participant farmers of rice FFSs.

The possible reason might be that increased social participation of farmers provides more chances of getting exposed to different sources and ideas related to agriculture. Further the social participation provided better

opportunity to have interpersonal interactions which will help in easy adoption of ICM practices and also develop knowledge level. This finding of the study was in agreement with the findings of Ashok (2012).

Mass media exposure Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.456, 0.452) between mass media exposure and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between mass media exposure and knowledge of the participant and non participant farmers of rice FFSs.

The result supports the general view that high mass media exposure enhances the knowledge of the farmers on several aspects of ICM practices. At present radio, television, newspaper, agricultural magazines, agricultural exhibitions, mobile technologies, internet and other mass media channels were considered to be the accelerators for diffusion of agriculture innovations. Farmers who keep in touch with mass media are likely to have better knowledge on the ICM practices. Hence, the above relationship was observed. This finding of the study was in agreement with the findings of Sreenivasulu (2011).

Extension contact Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.610, 0.570) between extension contact and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between extension contact and knowledge of the participant and non participant farmers of rice FFSs.

This might be due to the fact that extension personnel are the best and reliable sources of information. Contact with extension agencies can gain more knowledge about the ICM practices in rice cultivation. Hence the above trend was noticed. This finding of the study was in agreement with the findings of Obaiah (2004).

Innovativeness Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.801, 0.449) between innovativeness and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between innovativeness and knowledge of the participant and non participant farmers of rice FFSs.

This might be due to the fact that an individual having high innovativeness desires to seek changes in farming and introduces the same in his own field situations. FFS influences the aspiration of participant farmers to acquire more knowledge on innovations directly from agricultural experts and agricultural officers. This finding was in line with the findings of Sreenivasulu (2011).

Scientific orientation Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.759, 0.465) between scientific orientation and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between scientific orientation and knowledge of the participant and non participant farmers of rice FFSs.

This might be due to the fact that as the scientific orientation increases the knowledge gain of the farmers about ICM practices of FFS also increases. This is quite common since higher level of knowledge generally enhances scientific and analytical ability of farmers towards any issue more so with the knowledge of ICM practices of rice FFS. Hence, the above relationship was observed. This finding of the study was in agreement with the findings of Ramu (2005).

Achievement motivation Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.578, 0.322) between achievement motivation and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between achievement motivation and knowledge of the participant and non participant farmers of rice FFSs.

The probable reason for this might be that achievement motivation enables the individual to work

Table 2. Correlation coefficients between selected profile characteristics and the level of knowledge on recommended ICM practices by the participant and non participant farmers of rice FFSs

S. No.	Variables	Participant farmers (n=75) Correlation co-efficients ('r' values)	Non participant farmers (n=75) Correlation co-efficients ('r' values)
X_1	Age	0.076^{NS}	-0.209^{NS}
X_2	Education	0.623^{**}	0.547^{**}
X_3	Land holding	0.042^{NS}	-0.143^{NS}
X_4	Farming experience	0.057^{NS}	-0.195^{NS}
X_5	Social participation	0.439^{**}	0.337^{**}
X_6	Mass media exposure	0.456^{**}	0.452^{**}
X_7	Extension contact	0.610^{**}	0.570^{**}
X_8	Innovativeness	0.801^{**}	0.449^{**}
X_9	Scientific orientation	0.759^{**}	0.465^{**}
X_{10}	Achievement motivation	0.578^{**}	0.322^{**}
X_{11}	Management orientation	0.751^{**}	0.415^{**}
X_{12}	Economic orientation	0.450^{**}	0.215^{NS}

* : Significant at 0.05 level of probability
** : Significant at 0.01 level of probability
NS : Non-significant

constantly towards attaining the goal of obtaining higher yields. This forces the individuals to acquire more knowledge on ICM practices of rice FFSs. This finding was in line with the findings of Ashok (2012) and Obaiah (2004).

Management orientation Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.751, 0.415) between management orientation and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and significant relationship between management orientation and knowledge of the participant and non participant farmers of rice FFS.

Management orientation is concerned with how well the farmer can organize and utilize factors of planning, production and marketing in his farm to yield more profits. The emphasis of FFSs is on empowering farmers to implement their quality decisions in their own fields based on a more scientific understanding of the agro-ecosystem thus developing their capability to be better managers of their farming systems. So the farmers who had high management orientation will acquire more knowledge

about farm technologies. Hence the above relationship was observed. This finding was in line with the findings of Ramu (2005) Obaiah (2004).

Economic orientation Vs Level of Knowledge

From the Table 2, it is evident that co-efficient of correlation (r =0.450) between economic orientation and knowledge of the respondents was greater than the table value of 'r' at 0.01 level of significance. Hence, null hypothesis was rejected and empirical hypothesis was accepted. Therefore, it could be inferred that there was a positive and non significant relationship between economic orientation and knowledge of the participant farmers of rice FFSs. In case of non participant farmers co-efficient of correlation (r =0.215) between economic orientation and knowledge of the respondents was less than the table value of 'r' at 0.05 level of significance. Hence, null hypothesis was accepted and empirical hypothesis was rejected. Therefore, it could be inferred that there was a non significant relationship between economic orientation and knowledge of the non participant farmers of rice FFS.

Through FFS, farmers learn and investigate for themselves, the costs and benefits of alternative management practices for sustaining and enhancing farm

Table 3. Multiple Linear Regression analysis of the selected independent variables with the level of knowledge on ICM practices by the participant and non participant farmers of rice FFSs

S. No.	Variables	Participant farmers (n=75)				Non participant farmers (n=75)			
		Std. error	'b' values	't' values	'P' values	Std. error	'b' values	't' values	'P' values
X_1	Age	0.008	0.008	0.999^{NS}	0.322	0.164	-0.208	-1.268^{NS}	0.210
X_2	Education	0.058	0.030	0.507^{NS}	0.614	0.258	0.501	1.941^{*}	0.057
X_3	Land holding	0.017	-0.003	0.203^{NS}	0.840	0.202	-0.103	0.510^{NS}	0.612
X_4	Farming experience	0.008	0.001	0.106^{NS}	0.916	0.139	0.195	1.410^{NS}	0.163
X_5	Social participation	0.035	0.039	1.127^{NS}	0.264	0.246	0.173	0.704^{NS}	0.484
X_6	Mass media exposure	0.040	-0.026	0.651^{NS}	0.518	0.157	0.288	1.832^{NS}	0.072
X_7	Extension contact	0.041	0.014	0.337^{NS}	0.737	0.128	0.341	2.666^{**}	0.010
X_8	Innovativeness	0.034	0.154	4.502^{**}	0.000	0.111	0.129	1.162^{NS}	0.250
X_9	Scientific orientation	0.041	0.120	2.960^{**}	0.004	0.172	0.258	1.496^{NS}	0.140
X_{10}	Achievement motivation	0.031	-0.004	0.142^{NS}	0.887	0.100	0.021	0.208^{NS}	0.836
X_{11}	Management orientation	0.050	0.135	2.719^{**}	0.004	0.060	0.101	1.671^{NS}	0.100
X_{12}	Economic orientation	0.034	-0.007	0.212^{NS}	0.833	0.125	0.157	1.258^{NS}	0.213

$R^2 = 0.861$ $R^2 = 0.593$

* : Significant at 5% level of probability

** : Significant at 1% level of probability

NS : Non significant

productivity. The farmers who were having more economic orientation had more enthusiasm to acquire more knowledge related to rice cultivation from different sources of information. Hence the above result was observed. This finding was in line with the finding of Obaiah (2004).

Further, in order to study the combined effect of all the independent variables in explaining variation in knowledge level on recommended ICM practices by the participant and non participant farmers of rice FFS, Multiple Linear Regression (MLR) analysis was carried out. The computed co-efficient of determination (R^2) value and partial regression co-efficient (b) values with their corresponding' values were presented in Table 3. The R^2 and 'b' values were tested statistically for their significance.

The 'R^2' value of 0.861 which depicted that all the selected twelve independent variables put together explained about 86.10 per cent variation in the knowledge of participant farmers of rice FFSs.

The partial regression coefficients presented in Table 3 further revealed that the independent variables viz., innovativeness, scientific orientation and management orientation were found positively significant as evident from their significant 't' values. This implied that innovativeness, scientific orientation and management orientation have contributed to most of the variation in the knowledge level of participant farmers of rice FFSs.

The 'R^2' value of 0.593 which depicted that all the selected twelve independent variables put together explained about 59.30 per cent variation in the knowledge of the non participant farmers of rice FFSs.

The partial regression coefficients presented in Table 3 further revealed that the independent variables viz., education and extension contact were found positively significant as evident from their significant 't' values. This implied that education and extension contact have contributed to most of the variation in the knowledge level of the non participant farmers of rice FFSs.

CONCLUSION

The results of the study showed that there is significant difference in the knowledge levels of FFS participant farmers and non participant farmers with respect to ICM practices in rice. The farmer field school being a non formal education and learner centered educational process has technically empowered the rice

growers in increasing their knowledge level on improved cultivation practices. It is therefore concluded that the farmer field school extension approach could be used as a means for disseminating agricultural technologies.

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RESPONSE OF PRE-RELEASED EARLY MATURING SUGARCANE VARIETIES TO DIFFERENT LEVELS OF NITROGEN FERTILIZER

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ABSTRACT

Field trials were conducted at Agricultural Research Station, Perumallapalle, during 2012-13 and 2013-14 to evaluate the response of promising early maturing sugarcane varieties to different levels of nitrogen. Six early maturing varieties, *viz.,* 2003V46, 2006T3, 2006T36, 2006T19, 2006T23 and 2006T8 were tested at five nitrogen levels, i.e. 0, 75, 100, 125 and 150 per cent of recommended dose of nitrogen (RDN: 224 kg ha^{-1}). Application of nitrogen at 125 per cent RDN produced significantly greater number of millable canes, stalk yield and sucrose per cent. However, the effect of nitrogen levels on juice sucrose per cent was not significant. Hence, application of nitrogen at 280 kg ha^{-1} (125% RDN) is the most economical and viable nitrogen level for the plant cane in sandy loam soils of Southern agro climatic zone of Andhra Pradesh. Among the six early varieties, 2006T36 followed by 2006T19 responded well to the applied nitrogen and recorded higher cane yield.

KEY WORDS: Sugarcane early varieties, Nitrogen levels, Cane yield, Juice quality

INTRODUCTION

Sugarcane is an important commercial crop in Andhra Pradesh. Most of the soils in the Southern agro climatic zone of Andhra Pradesh, where sugarcane is grown low in available nitrogen. This was coupled with long term monocropping and more number of ratoons. The nitrogen fertilizer is costly and its indiscriminate management such as inappropriate rate, time and method may lead to poor crop performance and yield besides, it may results in loss of nitrogen due to leaching, denitrification and ammonium volatilization with serious environmental pollution. Nitrogen has been considered as the most limiting nutrient in sugarcane farming. Different sugarcane varieties have different yield potentials and other specific attributes (Stevenson *et al.* 1992). The new varieties developed have improved cane and sugar yields, resistance to pests and diseases, good milling qualities and adaptability to local growing conditions. These varieties are expected to yield as per the potential when cultivated in the recommended agro ecological zones with appropriate agronomic practices. Variation in the varietal response to nitrogen was reported by Rama Krishna Rao *et al.* (1989) and Srinivas *et al.*

(2003). One of the causes of declining sugarcane yield is speculated to be declining soil fertility as a result of depletion of the essential plant nutrients, *viz.* N, P and K (Bell *et al.*, 2001; Gerside and Bell, 2003) with low rates of replenishment. These macronutrients play a major role in sugarcane physiology, growth and development Malavolta, 1994 and Rice *et al.,* 2002). Nitrogen is essential for photosynthesis, sugar production and growth. This study was undertaken to determine the optimum nitrogen fertilizer rate for increased and sustained cane yields for promising sugarcane varieties

MATERIAL AND METHODS

The field experiments were conducted at Agricultural Research Station, Perumallapalle, Andhra Pradesh, during 2012-13 and 2013-14. The soil of the experimental field is sandy loam in texture, neutral in pH, normal in EC, low in available nitrogen (190 kg ha^{-1}) medium in available phosphorus (14 kg ha^{-1}) and high in available potassium (279 kg ha^{-1}). The experiment was designed in a split plot with three replications. Six promising early maturity varieties, *viz.* 2003V46, 2006T3, 2006T36, 2006T19, 2006T23 and 2006T8 were included in the study

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with five levels of nitrogen viz. 0, 75, 100, 125 and 150 recommended dose of nitrogen (RDN: 224 kg ha^{-1}). Nitrogen was applied in the form of urea in two equal splits at 45 and 90 days after planting. Phosphorus and potassium were applied @ 112 kg ha^{-1} in the form of Single Super Phosphate and Muriate of Potash, respectively as basal. Furrows were made at a spacing of 80 cm and three budded setts @ 40,000 ha^{-1} were planted in the first fortnight of January. Atrazine 2 @ kg a.i ha^{-1} was sprayed as pre-emergence herbicide on the 3rd day after planting of setts. Irrigations were provided as and when necessary. All other agronomic practices like hand weeding, earthing up, trash twist propping *etc.* were carried out according to the recommendations. Yield attributing parameters like number of millable canes, cane length, cane diameter were recorded at the time of harvest. Cane yield was recorded after stripping of the leaves and detopping. Juice quality parameters *viz.* Brix, Sucrose per cent were recorded at harvest by following standard procedures (Spencer and Meade, 1963). Brix was recorded by using hydrometer and sucrose was estimated by pol per cent with polarimeter.

RESULTS AND DISCUSSION

Results pertaining to yield attributes, yield and juice quality parameters are presented and discussed below.

Number of millable cane ha^{-1} (NMC)

Among the varieties, 2006T36 produced the highest NMC followed by 2006T19 due to higher conversion efficiency of tillers into millable canes. A variation in varieties for their response to nitrogen was also reported by Srinivas *et al*. (2003), Shukla (2007). The number of millable canes is a major constituent of cane yield. Tillering which provides the plant with the optimum number of stalks needed for a good yield is known to be affected by the availability of various nutrients. The highest number of millable canes at harvest was recorded with 125% RDN *i.e.* 280 kg N ha^{-1}.

Cane length and diameter

Plant height is also a major parameter of growth and yield. Although length, thickness and shape of the internodes are varietal characteristics, the rate of elongation and length of internodes are influenced by the nutrient availability. Varieties did not differ among them with regard to cane length and diameter. The lengthier canes were recorded when nitrogen is applied @ 150% RDN.

The results are in accordance with Naga Madhuri *et al.* (2011) for promising early maturing sugarcane varieties.

Cane yield

The highest cane yield was recorded by the variety 2006T36 followed by 2006T19. Highest shoot population coupled with efficient conversion of tillers into millable canes at harvest in these varieties could have contributed to higher cane yield. Same results have been reported by Srinivas *et al*. (2003). Cane yield was significantly enhanced with increasing levels of nitrogen application from 75 per cent to 150 per cent of RDN (Table 1). Application of nitrogen @ 150% RDN (336 kg N ha^{-1}) resulted in highest cane yield which was on par with 125% RDN and both were significantly higher than 100% and 75% RDN.

Sucrose (%)

For sugarcane, the quality of the crop is assessed by the sugar produced per tonne of cane, Nitrogen has the greatest influence on cane growth, ripening and juice quality (Hussain *et al* 1990). The quality parameter which include sucrose % is not affected by increasing nitrogen application. This could be due to the early application of nitrogen (90 days after planting). Thus the detrimental effect of higher nitrogen on juice quality was minimized before the maturity age of the cane (Gana *et al.,* 2007). Higher quantity of nitrogen fertilizer generally results in luxurious growth and increases percentage of reducing sugars. But as the crop ages and matures, it is expected that nitrogen content will be reduced and there is an increasing conversion of the reducing sugars to sucrose (Hussain *et al.,* 1990).

CONCLUSION

The study revealed that among the varieties, 2006 T36 followed by 2006T19 responded well to the applied nitrogen and recorded the higher cane yield. Application of nitrogen @ 125% RDN *i.e* 280 kg N ha^{-1} is optimum for obtaining higher cane yield in sandy loam soils of Southern agro climatic zone of Andhra Pradesh

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Table 1. Response of sugarcane pre-releasing early varieties to varied levels of nitrogen

Treatment	Number of millable canes ha^{-1}	Millable cane length (m)	Millable cane diameter (cm)	Cane yield t ha^{-1}	Sucrose (%)
Varieties					
2006T8	68749	2.28	2.56	91.43	17.18
2006T3	69756	2.33	2.14	89.32	17.70
2006T36	84062	2.45	2.56	114.5	17.89
2003V46	75964	2.48	2.49	104.6	17.94
2006T19	82490	2.62	2.56	106.3	17.82
2006T23	74630	2.53	2.46	98.65	17.14
SEm+/-	5327	0.06	0.04	3.34	0.26
CD @ 5%	NS	NS	NS	10.5	NS
Nitrogen levels					
Control (No nitrogen)	63959	2.03	2.38	62.67	78.17
75% RDN	74843	2.43	2.59	85.92	17.69
100% RDN	80520	2.54	2.81	99.98	17.66
125% RDN	81072	2.68	2.82	106.94	17.42
150% RDN	78489	2.79	2.67	108.64	17.66
SEm±	2060	0.03	0.06	3.34	0.14
CD @ 5%	5327	0.10	0.2	1.73	0.42
V × N	NS	NS	NS	7.32	NS

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JOB SATISFACTION OF AGRICULTURAL GRADUATES WORKING IN SELECTED AVENUES OF EMPLOYMENT

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ABSTRACT

The study was conducted on job satisfaction of agricultural graduates working in selected avenues of employment in Chittoor district of Andhra Pradesh. Majority of agricultural graduates working in both Department of Agriculture (57.33%) and ANGRAU institutions (74.67%) had high job satisfaction. A positive and significant relationship was noticed with respect to experience, training received, level of aspiration, job involvement, organizational climate and achievement motivation for job satisfaction. The partial regression analysis further indicated that 12 selected independent variables put together about 58.34 per cent variation in job satisfaction. Experience, level of aspiration, job involvement and organizational climate were fond positively significant and contributed to the most of the variation in job satisfaction of agricultural graduates.

KEY WORDS: Agricultural Graduates, Achievement Motivation, Job Satisfaction

INTRODUCTION

Job satisfaction is a complex of several attitudes possessed by the employees. For Hoppock (1935), the proponent of the term 'Job Satisfaction', it is the force that makes the work pressure and vigour bearable. Blum (1956) defined job satisfaction as a general attitude which a worker has as consequences of several specific attitudes in the following three areas, specific job factor, individual adjustment and group relationships outside the job. Prestonjee (1973) noted that job satisfaction can be taken as a summation of employees feeling in four important areas. Likert (1961) considered job satisfaction derived by members of organization as one of the criteria proposed for evaluating the effectiveness in the functioning of any organization. Job satisfaction of the employees is another criterion for evaluating the effectiveness of an organization, as greater satisfaction leads in a simple or direct way to achieve results. Keeping these aspects in view, the present study was conducted on "Study on job satisfaction of agricultural graduates working in selected avenues in Chittoor district of Andhra Pradesh" with the following objectives.

1. To study the job satisfaction of agricultural graduates working under selected avenues of employment.

2. To study the relationship of personal, socio-psychological and situational factors with job satisfaction.

MATERIAL AND METHODS

Using Ex-post facto research design, the study was conducted in Chittoor district of Andhra Pradesh in the year 2002. All the available agricultural graduates working in Department of Agriculture and ANGRAU institutions in Chittoor district were selected for the study. Out of 78 agricultural graduates working in the State Department of Agriculture, 75 available respondents were taken for the study. In case of ANGRAU institutions, out of 80 agricultural scientists, 75 available agricultural scientists were selected for the study. Total number of respondents taken for the study was 150.

Job satisfaction ladder originally devised by Cantril (1985) was used with slight modifications in this study. A 32 items ladder was used for scoring as per the procedure given by Cantril *i.e.,* -5 to +5 was used. Total score on 32 items were the total job satisfaction score of a respondent. Categories to which the agricultural graduates in selected avenues belonged were decided based on mean score. Mean and scores above mean were high job satisfaction

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scores and below mean were taken as low job satisfaction scores (Table 1). Also, an attempt has been made to find out whether or not there was any significant difference between independent variables and job satisfaction by finding correlation coefficient 'r' and tested for significance. In order to determine the combined effect of all the selected independent variables in explaining variation in job satisfaction of respondents, Multiple Linear Regression analysis was carried out.

RESULTS AND DISCUSSION

Job satisfaction of agricultural graduates: It was observed from Table 1 that 57.33 per cent of respondents had high job satisfaction followed by low (42.67%) job satisfaction in the Department of Agriculture, whereas, 74.67 per cent of respondents had high job satisfaction followed by low (25.33%) job satisfaction in ANGRAU institutions. The probable reason for the high job satisfaction might be due to good organizational climate, praise and recognition for good work, cooperation from superiors, peers and subordinates and clerical assistance provided in their jobs. As the satisfaction of the employees in their job is high, simultaneously the job performance will also increase. Hence, the organization should try to provide incentives to improve their job satisfaction as far as possible which will increase the out turn of employees.

Relationship between independent variables and job satisfaction: Experience, training received, level of aspiration, job involvement, organizational climate and achievement motivation had positively significant relationship, where as, age, sex, educational qualification, rural urban background and economic orientation had no significant relationship, while work load had negatively non-significant relationship with job satisfaction of agricultural graduates. The probable reasons were the experience facilitates better job perception and job performance. These will inturn yield high job satisfaction

simultaneously. Training received by agricultural graduates increases their knowledge, skills and inturn yields job satisfaction. As recognition and rewards increase job satisfaction which will lead to increase in the level of aspiration. This indicates that efforts to ensure better job performance of agricultural graduates should be made. It can be stated that one should set realistic and moderate level of aspiration in professional life. When a job is done with greater interest and enthusiasm, then the chances of better performance will be there leading to higher job satisfaction. Organizations components like supervisor-subordinates relations, guidance, supervision, cooperation, coordination which were strong points in the present organization climate were felt by the respondents (Table 2).

Multiple regression of independent variables with job performance: Table 3 indicated that ('R^2' value of 0.5834) all the selected 12 independent variables put together explained about 58.34 per cent variation in job satisfaction of agricultural graduates. The partial regression coefficient in Table 3 further indicated that independent variables i.e., experience, level of aspiration, job involvement and organizational climate were found positively significant as evident from their 't' values. This implied that, experience, level of aspiration, job involvement and organizational climate were positively and significantly contributed to most of the variation in job satisfaction of agricultural graduates. The probable reasons for this trend was due to that experience leads to better job perception and performance and thus will results with higher satisfaction in their jobs. Level of aspiration is associated with the individual's ambition to learn more, acquire more, participate more and achieve more. The possession of this particular trait predisposes the individuals to perform better in his job and tries to satisfy him self. More job involvement will results in yielding satisfactory results in their jobs. A better organizational climate will promote better understanding between the

Table 1. Distribution of respondents depending upon their job satisfaction

S. No.	Job satisfaction	Department of agriculture		ANGRAU Institutions		Total	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Low	32	42.67	19	25.33	51	34.00
2	High	43	57.33	56	74.67	99	66.00
	Total	75	100	75	100	150	100

Table 2. Relationship between the job satisfaction and personal, socio-psychological and situational characteristics of the agricultural graduates

S. No.	Variable No.	Independent Variable	Coefficient of Correlation 'r' Values
1.	X_1	Age	0.0946^{NS}
2.	X_2	Sex	0.0591^{NS}
3.	X_3	Experience	0.2992^{**}
4.	X_4	Education qualification	0.1285^{NS}
5.	X_5	Training received	0.2984^{**}
6.	X_6	Rural urban background	0.1543^{NS}
7.	X_7	Level of aspiration	0.3455^{**}
8.	X_8	Job involvement	0.2268^{*}
9.	X_9	Organizational climate	0.4144^{**}
10.	X_{10}	Achievement motivation	0.3568^{**}
11.	X_{11}	Work load	-0.1248^{NS}
12.	X_{12}	Economic orientation	0.1555^{NS}

Table 3. Multiple Linear Regression analysis of the selected independent variables on the job satisfaction of agricultural graduates

S. No.	Variable No.	Independent Variable	Partial regression coefficient 'b' Values	Computed 't' Values
1	X_1	Age	0.28011	0.3213^{NS}
2	X_2	Sex	0.6396	1.0920^{NS}
3	X_3	Experience	0.0864	2.1061^{*}
4	X_4	Educational qualification	0.4982	0.1244^{NS}
5	X_5	Training received	0.0884	1.2254^{NS}
6	X_6	Rural urban background	-0.4478	0.9093^{NS}
7	X_7	Level of aspiration	0.2914	2.4979^{*}
8	X_8	Job involvement	0.2214	2.3864^{*}
9	X_9	Organizational climate	0.09041	3.4304^{**}
10	X_{10}	Achievement motivation	0.2395	0.3923^{NS}
11	X_{11}	Work load	-0.8545	0.9395^{NS}
12	X_{12}	Economic orientation	-0.8486	0.6010^{NS}

$R^2 = 0.5834$,

* Significant at 0.05 level of probability

** Significant at 0.01 level of probability

NS Non-significant

employees and increase their cooperativeness to deal with difficult situations. This leads to better job satisfaction in the agricultural graduates.

The results of the investigations show that the job satisfaction working in both Department of agriculture and ANGRAU institutions was high. This shows that the organizational climate is congenial for agricultural graduates to work and deliver the results. Further, high job satisfaction of the employees is always good sign for the organization to reach new heights of development and to provide better services to the farming community. The results of the study will be helpful for the organizational management and other policy makers to undertake some of the reforms in human resources management which results in sustaining the employee's higher level of job satisfaction.

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ENTREPRENEURIAL BEHAVIOUR OF COTTON GROWERS IN KURNOOL DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The study was conducted in Kurnool district of Andhra Pradesh during the year 2014-15 to know the level of entrepreneurial behaviour of cotton growers. A sample of 120 respondents was selected for present study. Majority of the respondents possessed medium level of entrepreneurial behaviour followed by low and high levels of entrepreneurial behaviour. Entrepreneurial behaviour was positively and significantly related with education, farm size, annual income, social participation, training undergone, sources of micro finance, scientific orientation and marketing facilities of cotton growers.

KEY WORDS: Entrepreneurial behaviour, Cotton growers, Correlation

INTRODUCTION

Cotton, the 'White gold' or the "King of Fibres", is one of the oldest fibers cultivated all over the world. Cotton production and trade is widely spread across the world with more than 80 nations cultivating the crop. The origin of cotton is India. The world's four largest cotton-producing countries are China, India, USA and Pakistan. They account for nearly 79 per cent of the world's production. In a development context, cotton is crucially important for income and employment providing by its production and processing. The area under cotton cultivation in the world is 36.01 million ha. The world cotton production in 2013-14 is 26.25 Million Metric Tonnes (International Cotton Advisory Committee report 17th November 2014).

Cotton cultivation is a very important part of the Indian agrarian landscape and provides sustainable livelihood to a sizeable population in India. Cotton has been grown in India for more than 6,000 years since the pre- Harappan period, and it is later referred to in the Rig- Veda, composed in 3000 BC. Cotton is cultivated in about 10.31 million hectares in the country, which accounts for 30 per cent of the global cotton area and con-tributes to 22 per cent of the global cotton produce. India is the third largest producer of cotton in world after USA and China. The cotton production of India is 398 lakh bales in 2013-14. (Cotton Advisory Board dated 13th October 2014).

The cotton productivity of India is 552 kg/ha in 2013-14 (Cotton Advisory Board). It is estimated that more than 5.8 million farmers cultivate cotton in India and about 40-50 million people are employed directly or indirectly by the cotton industry. The states of Gujarat, Maharashtra and Andhra Pradesh are the major producers of cotton, accounting for about 75% of the total production.

Andhra Pradesh ranks third in terms of area and production in India. Cotton crop is the most cultivated commercial crop in Andhra Pradesh. The area under cotton production in Andhra Pradesh is 22.69 lakh hectares in 2013-14 (Cotton Advisory Board dated 13th October 2014). The cotton production of Andhra Pradesh is 78 lakh bales in the year 2013-14. (Cotton Advisory Board dated 13th October 2014). The cotton productivity of Andhra Pradesh is 571 kg ha^{-1} in 2013-14 (Cotton Advisory Board). Kurnool district ranks first in area and production in Rayalaseema region. The area under cotton cultivation in Kurnool district is 6.77 lakh ha in 2013-14. The cotton production of Kurnool district is 19.44 lakh tonnes. The cotton productivity of Kurnool district is 489 lakh kg^{-1}. (Department of Agriculture, Andhra Pradesh) Kurnool district has regulated cotton markets in Adoni and Nandyal areas.

The entrepreneurs are key persons of any country for promoting economic growth and technological change. The development of entrepreneurship is directly related to the socio-economic development of the society. Eighty

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per cent of the population resides in the rural areas and seventy per cent of the work force depends on agriculture for their livelihood. Therefore role of farmers is very important in agricultural and socio-economic development of the nation. Farmers should develop the entrepreneurial qualities for betterment of their farming and livelihood. In this context, it was felt necessary to determine the level of entrepreneurial behaviour among the farmers. Entrepreneurial behaviour of farmers is operationally defined as cumulative outcome of several components namely decision making ability, innovativeness, risk bearing ability, achievement motivation, information seeking behaviour, knowledge of the enterprise, managerial assistance, cosmopoliteness and leadership. (Nandapurkar 1980). Keeping this in view of the above scenario, the present study was conducted with the following objectives:

i. To study the entrepreneurial behaviour of cotton growers.

ii. To find out the relationship between different personal-psychological and socio-economic characteristics of cotton growers and their entrepreneurial behavior.

MATERIAL AND METHODS

The present study was conducted during the year 2014-15 by following Ex-Post-Facto research design. Kurnool district of Andhra Pradesh was purposively selected as it stands first in area and production of cotton in Rayalaseema region. Out of 54 mandals of the district, three mandals namely Kosigi, Adoni and Mantalayam were purposively selected based on highest area and production of cotton. From each of the selected mandals, four villages were selected by following simple random sampling procedure. Thus, a total of twelve villages were selected for the study. A total sample of 120 cotton farmers were selected by selecting 10 farmers from each village through simple random sampling procedure. Scale developed by Venkataramaiah (1991) was used to study entrepreneurial behaviour for this study. Keeping the objectives of the study in view, a semi structured interview schedule was developed and pretested. This was administered to sample respondents through personal investigation. The data obtained were coded, classified and tabulated. The statistical tools such as mean, standard deviation, correlation and regression were used for the analysis of the data.

RESULTS AND DISCUSSION

It is evident from the Table 1 that majority (70.00%) of the cotton growers had medium level of entrepreneurial behaviour followed by low (17.50%) and high (12.50%) levels.

Table 1. Distribution of respondents according to their level of entrepreneurial behaviour

(n=120)

S. No.	Category	Frequency	Percentage
1.	Low	21	17.50
2.	Medium	84	70.00
3.	High	15	12.50
	Total	120	100.00

Seeking innovative ideas, spotting the opportunities and taking risk for adoption requires the presence of important psychological traits like decision making ability, self confidence, achievement motivation, which will influence the entrepreneurial behaviour of the farmers. Due to increased commercialization in cotton, more and more technologies were being introduced from time to time and were contributing towards increased productivity and profitability. Farmers were been exposed to all such new innovations by the different input agencies to adopt such technologies. This approach might have developed the entrepreneurial behaviour among cotton growers. On the other side the farmers with illiteracy, poor management practices might have experienced low yields inspite of adoption of innovations. Hence they might have not developed good entrepreneurial qualities. These findings are in conformity with the results of Vidhyadhari (2007), Kiran *et al.* (2012), Lawrence and Ganguli (2012).

The data furnished in the Table 2 revealed that education, farm size, annual income, social participation, training undergone, scientific orientation, sources of micro finance and marketing facilities had positive and significant relationship at 0.01 per cent level of significance, whereas age and farming experience had non-significant relationship with the entrepreneurial behaviour of Cotton growers. These finding is in line with the results of Suresh (2004) and Subramanyeshwari *et al.* (2007).

The possible reason for non-significant relationship with age and farming experience might be that, irrespective of age farmer might be influenced by latest

Table 2. Relationship between selected profile characteristics of respondents and their entrepreneurial behaviour

<div align="right">(n=120)</div>

S. No.	Variable No.	Independent variables	Correlation coefficient ('r' value)
1.	X_1	Age	-0.1249^{NS}
2.	X_2	Education	0.6049**
3.	X_3	Farming experience	-0.0815^{NS}
4.	X_4	Farm size	0.4085**
5.	X_5	Annual income	0.3389**
6.	X_6	Social participation	0.4815**
7.	X_7	Training undergone	0.4285**
8.	X_8	Sources of microfinance	0.5214**
9.	X_9	Scientific orientation	0.4368**
10.	X_{10}	Market facilities	0.6086**

* : Significant at 0.05 level of probability

** : Significant at 0.01 level of probability

NS : Non-significant

technologies to get high income from their farm and more gaining of farming experience by following traditional methods of farming never act as source of entrepreneurial behaviour. One must have the quality of inclination towards seeking innovations in farm and ready to take risk which will enhance the entrepreneurial behaviour of farmers.

The possible reason for the existence of positive significant relationship between education and the entrepreneurial behavior might be due to the fact that education brings about behavioural changes in an individual, contributes to his self development, change his knowledge about the 'unknown so far' areas and motivates him to try the untried ideas, which is essentially contributing to the entrepreneurial behaviour.

Greater the farm size more will be the opportunities for taking risk and implementing innovations. A farmer with high land holding might have chance of implementing innovations on limited reach on his farm and keeping in view of the results of innovations he can adopt innovations on his farm. Being the opportunity of having trialability in his farm the farmer with high land holding will develop more of entrepreneurial behaviour than the farmer with low land holding.

Higher the annual income greater the scope of entrepreneurial behaviour. A farmer with high annual income might be ready to take risks and adopting innovations in his farm without any hesitation. Such behaviour might have motivated him to seek innovations regularly. Being a high income farmer, he might have perceived such expenditure as very low investment.

The possible reason behind positive relationship between social participation and entrepreneurial behaviour might be due to the fact that it enables the entrepreneur to have more social contact which in turn gives him an opportunity to share and gain enormous experiences and valuable information.

Training imparts variety of technical skills which are necessary to run an enterprise and enhances the entrepreneur's confidence. Because they are aware about the practical aspects of an enterprise, they may able to run the enterprise smoothly and efficiently. Ultimately it will contribute to the profitability of the enterprise.

Capital is the primary means for any entrepreneurial activity. By having enormous source of finance a farmer can explore the ways and means of enhancing profitability of his farm. During the course of time, a farmer experience and exercise his entrepreneurial qualities to achieve the desired goals.

A sound knowledge base coupled with logical thinking will strengthen the scientific orientation of a farmer. Hence a farmer with high scientific orientation

might be always taking edge of getting desired results without much orientation. This condition might have developed his entrepreneurial behaviour.

The positive and significant relationship with the market facility and entrepreneurial behaviour can be due to the fact that better facilities to sell their products will enhance the entrepreneur's confidence and willingness to carry out sustained production. Assured markets will always reduce the risk factor associated with an enterprise and will enhance the profitability. The valuable market information will also help to regulate the output according to the market demands.

Hence it is imperative to focus on enhancing the entrepreneurial behaviour of cotton growers by designing the strategies with the involvement of significant variables so as to achieve the targeted goals of farming.

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