ISSN 0970-0226

THE JOURNAL OF RESEARCH ANGRAU

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
Rajendranagar, Hyderabad - 500 030.

J. Res. ANGRAU Vol. XXXIX No.4 pp 1-134, October -December, 2011

Commonwealth Agricultural Bureaux International (CABI)
www.cabi.org and www.angrau.net

The Journal of Research ANGRAU

(Published quarterly in March, June, September and December)

SUBSCRIPTION TARIF

Annual : Individual : Rs. 250/- author
Institution : Rs. 1000/-

Life : Individual : Rs. 1000/-
(till Retirement)

Reprints (25 Nos.) Charges : Rs. 50/-

DDs may be sent to The Managing Editor, Journal of Research ANGRAU, Agricultural Information & Communication Centre and ANGRAU Press - Agricultural Research Institute, Rajendranagar - Hyderabad - 500 030

Happy New Year - 2012

The original research articles are invited from all over the globe

The Global users can now retrieve the articles from Journal on the repository of Commonwealth Agricultural Bureaux International(CABI) on

www.cabi.org

and

our website

www.angrau.net

CONTENTS

PART I : PLANT SCIENCE

PART II : SOCIAL SCIENCE

PART III : RESEARCH NOTES

Abstracts

J.Res. ANGRAU 39(4)1-5, 2011

HETEROSIS AND GENE EFFECTS FOR GRAIN YIELD AND PHYSIOLOGICAL TRAITS IN RICE (*Oryza Sativa* L.)

VANISREE S, RAJU CH S, REDDY P N, SREEDHAR M and KRISHNA L
Rice Section, Agricultural Research Station
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030

ABSTRACT

Genetic basis of expression of metric traits *viz.,* yield components (panicle and grain characters) and physiological parameters (Harvest index, total biomass) was studied through estimation of heterosis on mid and better parents, SCA and GCA effects. High amount of heterosis was noticed for grain yield, total biomass and ear bearing tillers, whereas the estimates were low for panicle density and grains per panicle. The higher estimates were attributed to over dominance of hybrids on their respective better parents and the crosses, Sumati/ JGL-1798 and MTU-4870/ HMT-Sona were recommended for hybrid breeding through utilization of male sterility systems. Among other promising crosses, MTU-1010/ HMT-Sona and MTU 1001/ Kavya with high heterosis, *per se* performance and SCA effects were identified for pedigree breeding, as their parents possessed high x high GCA effects.

Rice is the preferred staple food for more than one-half of the world population. India has largest area under rice (44.6 m. ha) and ranks second only to China in production (93 m.tonnes). However, the productivity of India is 2086 kg/ha (CMIE March, 2008). Andhra Pradesh is the "granary of south" contributing to national rice production about 12.2 per cent annually. The four mega varieties *viz.,* Sambamahsuri, MTU 1001, MTU-1010 and Swarna released from Andhra Pradesh nearly occupy 25 percent (11.1 m.ha) of national rice area. Although, high yielding varieties with wider adaptability are being developed and released from time to time, there is no substantial progress in the productivity of rice in the state since a long time.

The present study was undertaken by selecting highly divergent parents with resistance to BPH, gall midge, blast and grain quality including aroma mainly to estimate the magnitude of heterosis and identify better combiners for further use.

MATERIALS AND METHODS

Nine cultures with distinct differences in morphological traits (Table 1), with at least one specific feature like biotic resistance or quality or scent were crossed in line x tester (4 x 5) design and the resultant 20 hybrids were grown along with their parents in a randomized block design during dry season (*rabi* 2006-'07*)*. Each entry was raised in 2 rows of 3.75 m long for each replication adopting a spacing of 15 x 15 cm and 3 replications were maintained. The improved management practices were followed as recommended by ANGRAU. Observations were recorded on 10 randomly selected plants and means were estimated for days to 50% flowering, panicle length (cm), grains per panicle, ear bearing tillers per plant, total biomass per plant (g), grain yield per plant (g). Panicle density was estimated dividing number of grains per panicle by panicle length. Harvest index was calculated as ratio of grain yield to total biomass and expressed in percentage. Heterosis was estimated as percent increase or decrease of F_1s over mid parent (average heterosis) and better parent (heterobeltiosis) and the general combining ability (GCA) and specific combining ability (SCA) effects were computed according to Kempthorne (1957).

RESULTS AND DISCUSSIONS

Estimates of heterosis over their respective mid and better parents along with range are presented in Table 2. Out of 20 crosses, 11 crosses exhibited significant negative heterosis over the better parent for days to 50% flowering and range for this character was from -14.71 to 5.49. Highest negative values were observed in crosses, MTU-4870/ JGL 3855 and MTU 1001/ Kavya. Among the yield components, number of grains/m^2 is considered as very important and to realize it, plants with more number of grains per panicle with increased panicle length will be selected. Excess sterility is often associated with the short and compact panicles in which more spikelets are accommodated very closely. In the present study, only 4 crosses for panicle length and

Email : vanisree_dhar@yahoo.com

Table 1. Salient features of the parents involved in crossing programs

S.No.	Line/ tester	Parentage	Description
1	Vijetha(MTU-1001)	MTU-5249/ MTU-7014	Medium duration, medium grain (fine), resistant to BPH.
2	Sumati (RNR-18833)	Chandan/ Pak. Basmati	Medium duration, extra long slender grain, strongly scented
3	Cottondora Sannalu (MTU-1010)	MTU-2077/ IR-64	Short duration, long slender (fine), tolerant to WBPH and blast
4	Deepti (MTU-4870)	Sowbhagya / ARC-6650	Medium duration, medium grain (fine), resistant to BPH
5	Karimnagar Samba (JGL-3855)	Sambamahsuri / ARC-5984//Kavya	Medium duration, slender grain (super fine), resistant to gall midge (biotype-3)
6	Jagtial Sannalu (JGL-1798)	Sambamahsuri/ Kavya	Short duration, slender grain (super fine), resistant to gall midge (biotype-3)
7	Nellore mahsuri (NLR-34449)	IR-72/ Sambamahsuri	Short duration, slender grain (super fine), resistant to blast
8	PKV-Sona (HMT-Sona)	-NA-	Medium duration, slender grain (super fine), good cooking quality
9	Kavya (WGL-48684)	WGL-27120/(WGL-17672/Mahsuri//Surekha	Medium duration, long slender grain (fine), resistant to gallmidge (biotype-1).

2 each for panicle density and grains per panicle showed significant superiority over their respective better parents, which indicated the prevalence of partial dominance relationships in expression of heterosis for these characters. The crosses, Sumati/ HMT-sona (panicle length and grains per panicle) and MTU-4870/HMT-sona (panicle density and grains per panicle) were identified as better crosses for panicle characters. The spectrum of variation for heterobeltiosis ranged from 9.54 to 25.85, -55.11 to 23.99 and -58.32 to 28.85 for panicle length, panicle density and grains per panicle, respectively. Significant positive heterosis for these traits were also reported by Akarsh and Pathak, (2008).

Grain yield in rice could be increased by enhancing total dry matter or harvest index or both, as it is a function of total dry matter and harvest index (Virk *et al*, 2004*)*. Heterosis for grain yield over mid and better parent were observed in 11 and 9 crosses respectively and the range for heterobeltiosis was from very low (-66.98) to very high (104.19). High amount of heterosis for grain yield was mainly attributed to corresponding superiority in productive tillers per plant and total biomass production, because a limited number of crosses exhibited heterosis for panicle traits and harvest index. Increased yield was associated with enhanced biomass rather than with harvest index in the present study as discussed earlier. Among the heterotic hybrids, Sumati/ JGL-1798 (104.19) and MTU-4870/ HMT-sona (85.44) were highly promising for grain yield. Interestingly, heterosis for yield was associated with heterosis for other component traits especially with ear bearing tillers, panicle length and grains per panicle. Most promising heterotic crosses for grain yield were accompanied by heterosis for two or three component traits *viz.,* Sumati/JGL-1798 for total biomass and panicle length; MTU-4870/ HMT-sona for harvest index, total biomass, panicle density, grains per panicle and ear bearing tillers, and MTU-1010/ NLR 34449 for total biomass, grains per panicle and panicle density. Almost all promising hybrids exhibited heterobeltiosis for total biomass. This indicated that heterosis manifestation for grain yield is due to cumulative effect of highly significant and desirable heterosis for yield attributing traits

*(*Krishnaveni *et al*., 2005, Akarsh and Pathak, 2008 and Roy *et al.,* 2009*)*. The genetic basis for such higher manifestation of heterosis over better parent is mainly attributed to dominance (*h*) and epistatic gene actions of dominance x dominance (*l*) of complimentary nature (both '*h'* and '*l'* on plus sides). Li *et al.* (1997) suggested epistasis might be an important genetic basis of heterosis in rice. For 1000 grain weight, though, the estimates of heterosis over better parents were significant, they were low in comparison to those of other traits. Mid parental heterosis was predominant for this trait, which indicated that it was mostly under genetic effects of partial dominance (Raju *et al,* 2005).

The hybrid combinations with high mean performance, desirable SCA estimates and involving at least one of the parents with high GCA are likely to enhance the concentration of favorable alleles (Kenga *et al,* 2004). Hence, good specific combiners (hybrids) have been adjudged on the combined analysis of *per se*, SCA effects and heterosis estimates. The crosses, Sumati/ JGL-1798, MTU-4870/HMT-Sona MTU-1010/ JGL 3855, which exhibited significant heterosis for grain yield and component characters over their respective better parents are recommended for development of hybrid combinations by using male sterility systems. Fortunately the parents of these hybrids have specific features like resistance to BPH (MTU-4870), gall midge (JGL-3844, JGL-1798) and grain quality (HMT-Sona). In case of the remaining hybrid combinations with high *per se* and SCA effects, alternate strategies like pedigree method or population improvement is suggested depending on mode of gene action. The best specific crosses with high SCA and *per se* performance and with high x high GCA parents *viz.,* MTU-1010/ HMT-Sona (ear bearing tillers), MTU-4870/ JGL-1798 (Panicle density), MTU 1001/ Kavya (1000 grain weight) were chiefly governed by additive type of genetic effects ('*d*' and '*i*' type), which are fixable in nature (Singh *et al,* 1971). For these traits, further improvement is expected by adopting progeny selection. A perusal of results in respect of other crosses indicated that good performance of hybrids with high x low or low x low GCA parents is attributed to additive x dominance and dominance x dominance type of interactions, for which simple pedigree breeding would not be sufficient, instead population improvement through mass selection with recurrent random mating in early segregating generations (Redden and Jensen*,* 1974) could be a prospective breeding for yield improvement in rice. Through the present investigation, finally, two crosses each *viz.,* Sumati/ JGL-1798, MTU-4870/ HMT-Sona for hybrids development, and MTU-1010/ HMT-Sona, MTU-1001/ Kavya for progeny selection were identified.

REFERENCES

Akarsh Parihar and Pathak, A.R. 2008. Heterosis for various quantitative traits in rice. Oryza. Vol. 45 (3): 181-187.

Center for Monitoring Indian Economy , March, 2008 Kempthorne, 1957. An Introduction to Genetic Statistics, John Wiley and sons, Inc, London

Kemthorne, O. 1957. An introduction to genetic statistics. John wiley and sons Inc. Newyork.

Kenga. R., Albani, S. O and Gupta, S. C. 2004. Combining ability studies in tropical sorghum (*Sorghum bicolor L.*). Field Crop Research.: 88 (251-260).

Krishnaveni, B., Shobha Rani, N and Prasad, A.S.R. 2005. Heterosis and inbreeding depression for yield and yield components in rice. Oryza. 42 (4): 256-259.

Li ZK., Pinson, S.R.M., Peterson, A.H., Stansel, J.W. 1997. Epistatis for three grain yield components in rice (*Oryza sativa L*). Genetics, 145: 453-465.

Redden, R. J and Jensen, N.E. 1974: Mass selection and mating system in cereals. Crop Science 14: 345-350.

Roy, S.K., Senapati, B. K., Sinhamahapatra, S. P and Sarkar , K. K. 2009. Heterosis for yield and quality traits in rice. Oryza. 46 (2): 87-93.

Raju, Ch. S., Rao, M.V.B and Sudarshanam, A. 2005 Heterosis and genetic studies on yield and associated physiological traits in rice (*Oryza sativa L.*). Oryza 3 (4) : 264-273.

Singh, T. H., Gupta, S.P., Phul, P.S 1971. Line x Tester analysis of combining ability in cotton Indian Journal of Genetics. 31: 316-321.

Virk, P. S., Khush, G. S and Peng, S. 2004. Breeding to enhance yield potential of rice at IRRI: the ideotype approach, International Rice Research Notes. 29 (1).

Table 2. Promising crosses with estimates of heterosis, GCA and SCA effect for yield components.

S.No	Character	No. of crosses showing heterosis		Range		Top five crosses (H_1)		Top five crosses (H_2)		GCA of parents of heterotic crosses (H_2)	SCA of heterotic crosses (H_2)	Mean of cross
		H_1	H_2	H_1	H_2	Cross	H_1	Cross	H_2			
1	Days to 50% flowering	9	11	-10.27 to 7.12	-14.71 to 5.49	P4 x P5	-10.27**	P4 x P5	-14.71**	**H x L**	**L**	106.3
						P1 x P9	-9.79**	P1 x P9	-12.40**	**M x M**	**L**	106.0
						P1 x P6	-7.42**	P3 x P7	-8.36**	**L x L**	**L**	106.0
						P3 x P9	-6.22**	P1 x P6	-10.74**	**M x M**	**L**	108.0
						P3 x P7	-5.78**	P4 x P7	-7.75**	**H x L**	**M**	106.0
2	Ear bearing tillers	8	7	-31.93 to 78.43	-40.0 to 68.52	P3 x P8	78.43**	P3 x P8	68.52**	**H x H**	**H**	30.3
						P4 x P8	64.58**	P4 x P8	46.3**	**L x H**	**H**	26.3
						P4 x P6	38.46**	P4 x P6	28.57**	**L x L**	**H**	18.0
						P3 x P5	33.33**	P3 x P5	20.83**	**H x L**	**H**	20.8
						P2 x P6	28.57**	P2 x P9	18.75*	**L x L**	**H**	19.0
3	Panicle length	8	4	-8.81to 29.77	-9.54 to 25.85	P2 x P8	29.77**	P2 x P8	25.85**	**H x L**	**L**	22.2
						P2 x P6	26.70**	P2 x P7	12.26**	**H x L**	**L**	23.2
						P2 x P7	24.51**	P2 x P6	9.88**	**H x L**	**H**	24.8
						P2 x P9	24.20**	P2 x P9	6.79**	**H x M**	**L**	24.6
						P2 x P5	21.10**	-	6.79*	**H x H**	**L**	24.3
4	Panicle density	5	2	-44.34 to 32.4	-55.11 to 23.99	P4 x P8	32.64**	P4 x P8	23.99**	**H x M**	**L**	9.3
						P3 x P7	23.55**	P3 x P7	15.58*	**L x L**	**H**	7.6
						P1 x P8	19.39**	-	-	**L x L**	**L**	7.4
						P1 x P7	16.42*	-	-	**L x L**	**L**	6.8
						P4 x P6	11.98*	-	-	**H x H**	**H**	10.1

Contd…1st page

5	Grains per panicle	8	2	-49.43 to 52.87	-58.32 to 28.85	P4 x P8 P2 x P8 P3 x P7 P1 x P8 P1 x P7	52.87** 22.99** 21.30** 21.20** 15.05**	P4 x P8 P2 x P8 - - -	28.85** 21.04* - - -	**H x L** **H x L** **L x L** **L x L** **L x L**	**H** **L** **H** **L** **L**	217.3 140.0 162.3 148.6 142.6
6	1000- grain weight	20	4	-3.84 to 30.79	-19.97 to 7.01	P1 x P9 P1 x P6 P1 x P8 P1 x P5 P2 x P9	30.79** 30.40** 27.11** 26.76** 20.76	P1 x P8 P1 x P9 P1 x P6 P1 x P5 -	7.01** 6.82** 7.01** 2.27** -	**H x H** **H x H** **H x M** **H x L** **L x H**	**H** **L** **H** **L** **H**	18.8 18.8 18.8 18.0 18.0
7	Total biomass per plant	12	8	-56.60 to 115.06	-60.47 to 60.99	P4 x P8 P2 x P6 P3 x P5 P3 x P8 P3 x P7	115.06** 80.71** 74.22** 71.06** 51.66**	P4 x P8 P2 x P6 P3 x P5 P3 x P8 P3 x P7	69.99** 61.69** 52.39** 34.90** 32.86**	**L x H** **L x H** **M x L** **M x H** **M x L**	**H** **H** **H** **L** **H**	90.8 80.9 81.9 72.5 71.4
8	Harvest index	7	4	-14.91 to 21.44	-17.08 to 13.95	P2 x P9 P2 x P8 P4 x P8 P2 x P6 P3 x P8	21.44** 17.05** 15.00** 14.52** 13.29**	P2 x P8 P2 x P9 P4 x P8 P4 x P8 P3 x P7	13.95** 13.42** 9.15* 8.78* -	**L x H** **L x L** **L x H** **L x L** **L x H**	**L** **H** **L** **H** **L**	49.0 53.2 52.2 52.9 51.9
9	Grain yield per plant	11	9	-63.69 to 122.46	-66.98 to 104.19	P4 x P8 P2 x P6 P3 x P5 P3 x P8 P3 x P7	122.46** 105.52** 79.35** 74.13** 65.12**	P2 x P6 P4 x P8 P3 x P5 P3 x P7 P3 x P8	104.19** 85.44** 58.02** 44.53** 43.89**	**L x H** **L x H** **L x L** **L x L** **L x H**	**H** **H** **H** **H** **L**	42.2 47.5 41.4 37.8 37.7

J.Res. ANGRAU 39(4)6-10, 2011

CHARACTERISATION AND CLASSIFACATION OF SOILS OF MARPAKA WATERSHED OF NALGONDA DISTRICT

V. SANTHOSHI, G. JAYASREE, M.V.R. SESHA SAI and V. PADMA
Department of Soil Science and Agricultural chemistry
College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad -500 030.

ABSTRACT

The digital data from Linear Imaging Self Scanner (LISS) – IV sensor on board IRS-P6 satellite along with Survey of India, toposheets of the study area were used in the study of natural resources of the watershed. Sample strips were selected for ground truth. Pedons were examined and morphological characteristics, physical and chemical properties were described and soil map was prepared on 1:10,000 scale. Soil map was super imposed on physiographic map under GIS environment. The soils are classified under six taxonomic units *viz.,* Typic Haplustepts, Typic Haplustalfs, Vertic Haplustepts, Typic Ustorthents, Lithic Ustorthents, Lithic Haplustepts. The study showed close relationship between Physiography and taxonomic units.

Timely and reliable information on soils with respect to their nature, extent, spatial distribution, potentials and limitations is very crucial for optimal utilization of natural resources on a sustainable basis. Soil surveys provide such information. Remote sensing enables faster and accurate land-use mapping and has proved to be the most efficient and reliable technique to prepare a comprehensive inventory of soil resources and land-use pattern of an area (Bandhyopadhayay *et al.,* 2009 and Roy *et al.,* 2010). The present study was carried out to characterize and classify the soils of Marpaka watershed, Nalgonda using Geo Spatial Approach.

MATERIAL AND METHODS

The study area lies between 16^0 54' 30" to 16^0 56' 45" N latitude and 79^0 19' 20" to 79^0 21' 15" E longitude with an average elevation of 185 m from the mean sea level (MSL) and covers 868.61 ha in Nidamanur and Kanagal mandals of Nalgonda district. The mean annual rainfall is 681.6 mm. The mean maximum and minimum temperatures are 34 ^{0}C and 22.6 ^{0}C, respectively. The soil temperature regime is '*hyperthermic'* and moisture regime is '*ustic'.*

The digital data from Linear Imaging Self Scanner (LISS) – IV sensor on board IRS-P6 satellite were along with Survey of India, toposheets of the study area used in the study of natural resources of the watershed. Sample strips were selected for ground truth. Pedons were examined and morphological characteristics were described as represented in Table 1. Horizon-wise soil samples were collected, processed and analyzed for various physical and chemical properties (Jackson 1973; Piper 1966). The soils were classified as per US Soil Taxonomy (Soil Survey Staff 1996).

RESULTS AND DISCUSSION

Valleys are broad in nature with gentle to very gentle slopes with good ground water potential. In pediplain the ground water potential is moderate.

The solum depth (Table 1) varied from shallow to deep. The soils on the valley were deeper compared to the soils of pediplain middle, upper and linear ridges and dolerite dykes. The color of the pedons varied from 2.5 YR to 10 YR.

Soil structure varies from weak to strong and granular to massive. Pedon 7 had weak structure in the surface layer only (Thangasamy *et al.,* 2005). All the pedons showed well developed structure in the subsurface indicating moderate to high degree of soil development. Surface cracks were observed in pedon 4.

Gravel and sand contents were higher in the soils of pediplain upper and linear ridges and dolerite dykes, where as silt and clay contents were higher in valley and pediplain lower. Soils of pediplain upper were sandy clay loam in texture and valley were clay loam with high percentage of clay content.

The soils are moderately acidic to moderately alkaline in reaction and this wide variation is attributed

Email id: Santhu.vuppala@gmail.com

Table 1. Morphological, physical and chemical properties of soils of Marpaka watershed

Horizon	Depth (cm)	Colour	Tex-tural Class	Structure	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	pH	EC dSm-1	OC (%)	CaCO3 (%)	CEC cmol (+) kg-1	Exchangeable cations				BSP	ESP
														Ca	Mg	Na	K		
Pedon 1																			
Ap	0-18	10 YR 3/2	cl	2f gr sbk	4	48.8	15.4	35.8	7.85	0.32	0.61	1.59	17.78	7.60	4.30	0.62	0.62	77.29	3.64
B1	18-30	10 YR 3/2	cl	2f gr sbk	5.2	44.6	18.2	37.2	7.80	0.40	0.64	1.72	17.00	6.50	3.60	0.92	0.58	65.24	5.17
B2	30-60	10 YR 2/2	scl	3f sbk	6.4	65.1	12.5	22.4	8.10	0.60	0.59	2.80	16.40	5.80	2.90	1.12	0.45	62.62	6.80
BC	60+	10 YR 5/3	sl	3f sbk	9.5	75.7	9.2	15.1	8.2	0.83	0.41	3.5	15.5	7.30	1.50	1.33	0.31	67.35	8.06
Padon 2																			
Ap	0-20	10 YR 3/2	scl	2 m gr	5	51	16.4	32.6	7.5	0.41	0.62	2.72	24.8	17.90	4.30	0.62	0.78	95.16	2.50
Bw1	20-45	10 YR 3/2	scl	2 f sbk	7	52.6	14	33.4	7.40	0.51	0.58	3.18	23.60	16.60	3.40	0.94	0.52	90.93	3.98
Bw2	45-80	10 YR 4/4	scl	2 f sbk	7	56.6	13	30.4	7.48	0.56	0.50	4.00	22.20	15.20	2.90	1.16	0.44	88.73	5.22
B2	80-100	10 YR 4/4	scl	2 f sbk	8	68.6	9	22.4	7.12	0.64	0.41	5.90	21.50	14.80	2.30	1.02	0.38	86.04	4.74
BC	100+	10 YR 5/6	sl	massive	20	74.4	11	14.6	7.40	0.83	0.38	6.66	18.80	12.50	1.40	1.80	0.30	85.10	9.57
Pedon 3																			
Ap	0-12	7.5 YR 3/3	sl	2 f gr	11	66	12	22	7.80	0.64	0.75	2.20	18.00	13.30	6.20	0.71	0.69	94.60	3.94
Bt1	12--30	7.5 YR 3/4	scl	2 f gr	15.5	62.2	10	27.8	7.84	0.73	0.69	2.6	17.5	15.80	8.30	1.24	0.52	85.70	7.08
Bt2	30-60+	7.5 YR 3/4	scl	2 f gr	15	58.4	11	30.6	7.81	0.88	0.42	3.9	16.5	16.90	7.40	1.36	0.43	78.90	9.06
Padon 4																			
Ap	0-15	10 YR 2/2	cl	2 f gr	5	51.43	13.87	34.7	8.20	0.81	0.72	2.80	20.20	9.10	2.40	1.28	0.98	68.11	6.33
B1	15-45	10 YR 2/2	cl	2 f sbk	7	52.33	11.87	35.8	8.44	0.85	0.68	3.30	18.40	14.80	5.10	1.18	0.72	84.70	6.41
B2	45-80	10 YR 3/2	cl	2 f sbk	8.5	55.69	8.71	32.6	8.14	0.96	0.49	3.80	17.60	12.80	4.90	1.20	0.66	64.84	6.81
BC	80+	10 YR 5/3	sl	2 f sbk	15	63.3	7.84	28.86	8.6	1.05	0.45	4	15.5	11.50	4.20	1.19	0.59	77.42	7.67
Pedon 5																			
Ap	0-14	10 YR 3/2	sc	2 f sbk	19	49.4	12.3	38.3	7.7	0.41	0.58	2.8	19.6	14.80	3.20	0.48	0.58	97.24	2.44
B1	14-35	10 YR 3/2	scl	3 f sbk	22	65.4	9.8	24.8	7.80	0.52	0.52	3.60	18.40	15.60	2.60	1.56	0.47	94.57	8.47
B2	35-45	10 YR 4/4	scl	3 f sbk	45	67.4	10	22.6	8.20	0.83	0.35	4.90	15.80	13.80	1.40	1.90	0.41	82.28	12.02

Contd.…1st page

Pedon 6																			
Ap	0-18	10 YR 3/2	sc	2 f sbk	19	49.4	12	38.6	7.8	0.48	0.69	2.2	19.8	8.90	2.60	1.36	0.92	70.00	6.86
B1	18-40	10 YR 3/2	sc	2 f sbk	24	48.6	10	41.4	7.9	0.66	0.65	2.6	17.6	5.20	1.39	0.66	0.66	45.00	3.75
B2	40-60	10 YR 4/3	scl	3 f sbk	34	56.4	10	33.6	8.4	0.71	0.52	3.9	15.5	4.60	1.12	0.50	0.55	44.00	3.22
BC	60+	10 YR 5/3	scl	3 f sbk	52	58.4	9	32.5	8.6	0.88	0.48	4.6	14.2	3.80	0.98	0.88	0.48	43.00	6.19
Pedon 7																			
Ap	0-14	2.5 YR 3/6	scl	1 f gr	25.8	61	8	31	5.44	0.13	0.43	2.80	20.10	9.30	2.40	1.28	0.96	69.00	6.36
B1	14-50	2.5 YR 3/6	scl	2 f gr	41	60	6	34	5.94	0.03	0.38	3.60	16.30	14.20	5.10	1.18	0.72	53.00	7.23
B2	50-65	2.5 YR 2/6	scl	0 f gr	58.6	64	11	25	6.12	0.01	0.33	4.50	15.80	12.80	4.90	1.20	0.56	42.30	7.59
Pedon 8																			
Ap	0-15	5 YR 3/4	scl	1 f gr	29	58.6	11.4	30	7.38	0.51	0.76	4.2	20	9.30	2.60	1.30	0.98	71.00	6.50
B1	15-27	5 YR 3/3	scl	2 f gr sbk	54	66.2	9.4	24	7.88	0.63	0.5	6.4	18.1	14.20	6.20	1.32	0.72	62.40	7.29
Pedon 9																			
Ap	0-17	5 YR 3/4	scl	1 f gr sbk	20	59.6	11	29.4	7.30	0.30	0.48	2.80	16.00	7.70	4.90	1.25	0.76	91.00	7.81
B1	17-30	5 YR 3/2	scl	1 f gr sbk	24.6	60	9.8	29.6	7.26	0.48	0.41	3.10	14.00	6.90	3.50	1.26	0.69	88.00	9.00
B2	30-45	5 YR 4/3	scl	massive	60	64.6	8.8	26.6	7.45	0.56	0.31	4.90	13.00	5.20	2.50	1.31	0.56	74.00	10.07

Table 2. The classification of pedons in Marpaka watershed

Pedon	Order	Sub-Order	Great group	Family Series
1	Inceptisol	Ustepts	Haplustepts	Fine loamy, mixed, hyperthermic, Typic Haplustepts
2	Inceptisol	Ustepts	Haplustepts	Fine loamy, mixed, hyperthermic, Typic Haplustepts
3	Alfisol	Ustalfs	Haplustalfs	Fine loamy, mixed, hyperthermic, Typic Haplustalfs
4	Inceptisol	Ustepts	Haplustepts	Fine, mixed, hyperthermic, Vertic Haplustepts
5	Inceptisol	Ustepts	Haplustepts	Loamy, mixed, hyperthermic, Lithic Haplustepts
6	Inceptisol	Ustepts	Haplustepts	Clayey, mixed, hyperthermic, Typic Haplustepts
7	Entisol	Orthents	Ustorthents	Loamy skeletal, mixed, hyperthermic, Typic Ustorthents
8	Entisol	Orthents	Ustorthents	Loamy skeletal, mixed, hyperthermic, Lithic Ustorthents
9	Entisol	Orthents	Ustorthents	Loamy skeletal, mixed, hyperthermic, Typic Ustorthents

to the nature of parent material, leaching, presence of calcium carbonate and exchangeable sodium. Electrical conductivity was less than 1.0 dS m^{-1}.

The free calcium carbonate content varied from 1.5 to 6.6 percent. The organic carbon content was low to medium in all the pedons.

Cation exchange capacity and extractable bases varied considerably among the soils. The cation exchange capacity varied from 13 to 24.8 cmol (p+) kg^{-1}. In all the soils, calcium was the predominant cation followed by magnesium and potassium.

Based on the properties, the soils are grouped under the orders *viz. Entisol*, *Inceptisol* and *Alfisol.* The pedons 7, 8 and 9 were placed under *Entisol* as they did not exhibit any diagnostic horizon and characterized as Orthents. They were placed under Ustorthents subgroup due to '*ustic'* soil moisture regime. The pedons 1, 2, 4, 5 and 6 were placed under *Inceptisol* . The pedon 3 was placed under *Alfisol.* Similar study was carried out by Arunkumar *et al.* (2002).

The soils were classified under six families *viz.,* Typic Haplustepts, Typic Haplustalfs, Vertic Haplustepts, Typic Ustorthents, Lithic Ustorthents, Lithic Haplustepts (Table 2).

The study showed close relationship between physiography and taxonomic units of the study area, according to the soil map prepared with remote sensing and ancillary data as depicted in Figure 1.

Among the six taxonomic units Typic Haplustepts and Vertic Haplustepts occurred in valley. Typic Haplustepts and Typic Haplustalfs in pediplain lower; Typic Haplustepts in the pediplain middle; Lithic Haplustepts, Typic Ustorthents and Lithic Ustorthents in the pediplain upper; Typic Ustorthents in the linear ridges and dolerite dykes.

Most of the soils under this watershed are coming under valley having Typic Haplustepts and Vertic Haplustepts. The soil map prepared may be utilized by policy makers and agricultural planners for various needs for integrated watershed development.

REFERENCES

Arun Kumar, V., Natarajan, S and Sivasamy, R. 2002. Characterization and classification of soils of lower Palar-Manimuthar watershed of Tamil Nadu. *Agropedology* 12: 97-103.

Bandyopadhyay, R.K., Jaiswal, R.K., Hedge, V.S and Jayaraman, V. 2009. Assessment of land suitability potentials for agriculture using a remote sensing and GIS based approach. *International Journal of Remote Sensing.* 30 (4): 879 – 895.

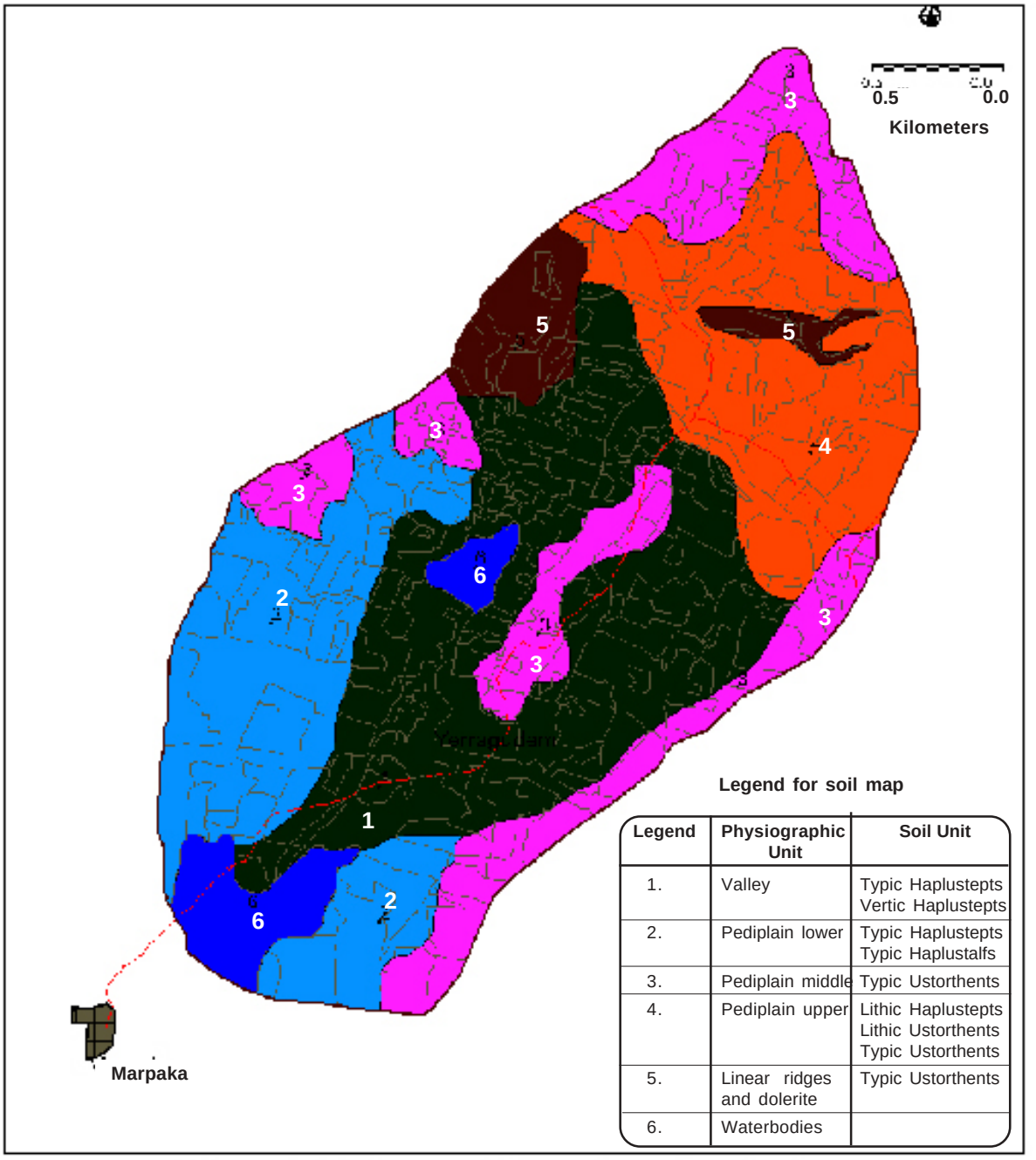
Jackson, M. L. (1973). '*Soil Chemical Analysis'.* Prentice Hall of India Pvt. Ltd: New Delhi

Piper, C. S. (1966). '*Soil and Plant Analysis'*. Interscience Publication: New York.

Roy, P. S., Dwivedi, R. S and Vijayan, D. 2010. *Remote sensing Applications*. NRSC Publication, Balanagar, Hyderabad. 100 – 150.

Soil Survey Staff. (1996). ' *Keys to Soil Taxonomy'.* Eighth edition (USDA: Washington, D.C.)

Thangasamy, A., Naidu, M. V. S., Ramavatharam, N and Raghava Reddy, C. 2005. Characterization, classification and evaluation of soil resources in Sivagiri micro-watershed of Chittoor district in Andhra Pradesh for sustainable land use planning. *Journal of the Indian Society of Soil Science.* 53: 11–21.



Legend	Physiographic Unit	Soil Unit
1.	Valley	Typic Haplustepts Vertic Haplustepts
2.	Pediplain lower	Typic Haplustepts Typic Haplustalfs
3.	Pediplain middle	Typic Ustorthents
4.	Pediplain upper	Lithic Haplustepts Lithic Ustorthents Typic Ustorthents
5.	Linear ridges and dolerite	Typic Ustorthents
6.	Waterbodies	

Fig. 1. Soil map of Marpaka watershed

J.Res. ANGRAU 39(4)11- 15, 2011

SCREENING OF DIFFERENT VARIETIES OF GRAPE FOR WINE PRODUCTION UNDER HYDERABAD CONDITIONS

VEENA JOSHI, S. AMARENDER REDDY, B. SRINIVASA RAO, R. SUBHASH REDDY and D. VISHNU VARDHAN REDDY

Department of Horticulture, College of Horticulture
Dr. Y.S. R.Horticultural University, Rajendranagar, Hyderabad-500030

ABSTRACT

Thirteen grape wine varieties (8 coloured and 5 white) were evaluated for their suitability to wine making under semi- arid tropical conditions of Hyderabad. The bio- chemical properties of wine revealed that cultivar Shiraz among the coloured and Chenin Blanc among white were superior in terms of producing maximum alcohol percent in wine. The range of volatile acidity (0.011 to 0.063%) in different varieties was below than the acceptable limit (1 gL^{-1}) as per the Indian Standards for wine constituents. The wine prepared from coloured varieties showed higher content of tannins, total phenols and flavonoids when compared to the white varieties due to presence of coloured pigments in skin of berries. The organoleptic evaluation of wine samples indicated that incase of wine made from coloured varieties, Shiraz and Cabernet Sauvignon and white varieties Chenin Blanc and Sauvignon Blanc could be ranked as 'Good' whereas wine prepared from Ruby Red, Gulabi and Italia was of ordinary quality.

Wine is the fermented product known to the man kind since times immemorial. Wine is considered as a health drink and has been used as an important adjunct to the diet and has many medicinal and therapeutic values due to the presence of anti-oxidants which cure most of the human ailments especially the cardio vascular diseases (Joshi and Sharma, 2004). However, the production of wine is negligible in India, due to limited domestic consumption and non availability of standard wine varieties to produce good quality wine of international standards. In India the remarkable success has been achieved in table grape production and emphasis was not given for research on enology. As most of the commercial grapes grown in our country are table varieties, when used for wine making, result in poor quality wine. Further, biochemical properties of wine vary according to the variety and environmental conditions of the region in which the grapes are grown. Hence, it was proposed to study the biochemical properties of different wine grape varieties grown in Hyderabad region for their suitability to wine making.

MATERIALS AND METHODS

The investigation was carried out at the Department of Horticulture, College of Agriculture, Acharya N.G. Ranga Agricultural University, in collaboration with Grape Research Station, Rajendranagar, Hyderabad. Crop harvested during March- April of 2007 and 2008 was used for the above study.The experiment was laid out in Completely Randomized Design (CRD) with 13 grape wine varieities, of which 8 were coloured ones viz., Zinfandel, Cabernet Sauvignon, Gulabi, Shiraz, Bangalore Blue, Pusa Navrang, Athens and Ruby Red and five white ones viz., Thompson Seedless, Chenin Blanc, Sauvignon Blanc, Italia and Symphony as treatments with three replications. Ten varieties selected for the study were wine grape varieties introduced from traditional grape growing countries and the remaining three varieties, viz., Bangalore Blue, Pusa Navrang and Thompson Seedless were the native grape varieties, found suitable for wine making. Different biochemical components of wine viz., titrable acidity, reducing sugars (AOAC, 1965), volatile acidity (Amerine & Ough (1974), alcohol (Natu *et al*.,1986), total phenols (Sadasivam and Manickam,1996) tannins (Amerine and Joslyn (1951), flavonoids (Ough and Amerine (1988) and organoleptic evaluation based on the hedonic scale given by Joslyn and Amerine (1964) were determined.

RESULTS AND DISCUSSION

The mean data of two years on biochemical properties of wine viz., titrable acidity, volatile acidity, reducing sugars, alcohol content, total phenols, tannin content and flavonoid content of wine in different varieties of grape are presented in Table 1.

e-mail : veenahorti@ rediffmail.com

The titrable acidity of wine was maximum in the variety Chenin Blanc (0.79%) which was significantly superior to rest of the varieties and minimum content was in Ruby Red (0.34%).These finding are in conformity with the report (0.32 to 0.98%) of Revis et al. (1974). Maximum volatile acidity was observed in the wine prepared from Ruby Red (0.063 %) and minimum in Symphony (0.011 %). The range of volatile acidity in the present study was very close to the range (0.015 to 0.072%) reported by Suresh *et al.*(1985). It was also noticed that the volatile acidity of all the wines studied was below the maximum acceptable limit (0.1%) as per the Indian Standards for Wine Constituents (Bhalerao, 2001).

Significant variation was noticed among the varieties with respect to the reducing sugar content. Cultivar Symphony (3.34%) recorded significantly maximum reducing sugar content in wine and was at par with Italia (3.33%) while lowest content was noticed in Cabernet Sauvignon (1.53%) closely preceded by Chenin Blanc (1.54%) and Shiraz (1.76%). Higher amounts of sugar content in wine might be due to improper utilization of sugars by the yeast cells during fermentation. Similar line of work was reported by Patil (1994) and Pawar (2002).

Alcohol content of wines from different varieties ranged from 8.78 to 12.25 per cent (v/v). Maximum alcohol content was present in the wine of Shiraz (12.25%) followed by Chenin Blanc (12.08%) and Cabernet Sauvignon (11.48%),while the wine of Italia had minimum alcohol content. A range of 7.4 to 15.5 % alcohol content was reported by Suresh and Negi (1977) and Suresh *et al*. (1985) while Tambe *et al*.(2008) reported alcohol 8.41 to 12.15% in wines prepared from different varieties of grape.

Total phenol content was highest in Pusa Navrang (1652.83 mg/l) and was closely followed by Ruby Red (1619.5 mg/l) while minimum was noticed with Chenin Blanc (213.33 mg/l). Coloured varieties showed higher contents of total phenols than white ones due to the presence of monomeric anthocyanins and other phenols (Venkataramu *et al*., 1980). The results are in accordance with the findings of Joseph *et al*. (1963) and Salunkhe *et al*. (1990).

Tannin content of wines ranged from 0.004 to 0.060 per cent. Minimum tannin content was found in the wine of Chenin Blanc, which was at par with all the white varieties, except Italia while maximum was observed with Ruby Red. The result is in conformity with the report of Golmick *et al*. (1991).

Among the coloured varieties, significantly higher content of flavonoid was found in the variety Pusa Navrang (922.42 mg/l) followed by Ruby Red (823.33 mg/l). On the other hand, all the white varieties recorded lower content of flavonoids except Italia. The red wines had significantly higher flavonoid content probably due to higher extraction of anthocyanin from skins of crushed red grapes, which are kept with fermenting juice for a few days at the time of red wine preparation, as described by Ribereau-Gayon *et al*. (1998).

Organoleptic Evaluation of wine

The data regarding the organoleptic evaluation of wine of different varieties of grape are presented in Table 2. The wines were evaluated for their overall quality based on appearance, flavour, aroma, taste, colour and overall acceptability by a panel of judges.

The wines were categorized based on hedonic scale grade in to good, fair, ordinary, poor, bad and very bad. The highest score of 16.15 (good) for overall quality was recorded by Shiraz followed by Chenin Blanc(15.41) and was comparable with the variety Cabernet Sauvignon (15.40) while the lowest score of 10.67 (ordinary) was observed in Italia. The remaining varieties were found to range from 11.25 in Ruby Red to 14.68 in Zinfandel.

It is evident from the present investigation, that the varieties viz., Shiraz and Cabernet Sauvignon among the coloured and Chenin Blanc, Sauvignon Blanc from the white varieties were suitable for preparation of wine for commercial acceptability under the semi arid climatic conditions of Hyderabad. Hence they can be recommended as wine grape varieties for this region.

REFERENCES

Amerine, M.A and Joslyn, M.A. 1951. Testing and analyzing Table Wines, The Technology of their production in California. The Regents of the University of California 187-215.

Table 1.Bio-chemical properties of wine from different varieties of Grape

S.no	Varieties	Titrable Acidity (%)	Reducing Sugars (%)	Volatile Acidity (%)	Alcohol (%)	Total Phenols (mg/l)	Tannins (%)	Flavo-noids (mg/l)
Coloured Varieties								
1	Zinfandel	0.48	0.040	2.14	10.86	1352.49	0.036	525.30
2	Cabernet Sauvignon	0.40	0.041	1.53	11.48	1007.83	0.043	783.50
3	Gulabi	0.55	0.059	2.58	9.70	1535.16	0.053	720.83
4	Shiraz	0.53	0.027	1.76	12.25	1179.83	0.035	591.16
5	Bangalore Blue	0.69	0.053	2.24	9.68	1350.83	0.028	702.78
6	Pusa Navrang	0.55	0.043	2.34	9.36	1652.83	0.055	922.42
7	Athens	0.57	0.050	3.03	10.43	1510.83	0.045	529.55
8	Ruby Red	0.34	0.063	3.13	9.21	1619.5	0.060	823.33
White varieties								
9	Thompson Seedless	0.43	0.022	2.68	10.43	422.16	0.011	135.16
10	Chenin Blanc	0.79	0.012	1.54	12.08	213.33	0.004	122.33
11	Sauvignon Blanc	0.42	0.015	3.30	10.29	217.5	0.009	130.94
12	Italia	0.62	0.029	3.33	8.78	511.49	0.016	257.94
13	Symphony	0.43	0.011	3.34	10.03	280.44	0.010	121.34
	SEm+	0.03	0.004	0.04	0.05	7.05	0.002	10.86
	CD at 5%	0.09	0.013	0.12	0.15	20.05	0.007	32.45

Table 2. Organoleptic evaluation of wine from different varieties of grape.

Treatments	Varieties	Organoleptic evaluation						
		Appearance	Aroma	Flavour	Taste	Colour	Overall accept ability	Mean
Max. Score		**20**	**20**	**20**	**20**	**20**	**20**	**20**
Coloured								
T1	Zinfandel	15.23	15.23	14.78	15.71	13.78	13.36	14.68
T2	Cabernet Sauvignon	16.35	16.35	14.93	16.55	16.08	12.18	15.40
T3	Gulabi	11.85	11.18	11.91	11.45	12.83	11.00	11.70
T4	Shiraz	17.73	15.75	15.41	17.30	16.55	14.18	16.15
T5	Bangalore Blue	13.71	13.81	13.61	14.50	13.66	13.55	13.80
T6	Pusa Navrang	14.81	11.90	12.36	14.20	12.23	11.83	12.88
T7	Athens	15.16	14.56	13.71	14.60	14.60	12.23	14.14
T8	Ruby Red	12.70	11.91	10.43	11.61	10.23	10.66	11.25
White								
T9	Thompson Seedless	14.30	13.21	14.66	14.05	12.76	10.95	13.32
T10	Chenin Blanc	16.66	14.98	16.46	16.53	14.63	13.21	15.41
T11	Sauvignon Blanc	12.75	14.88	15.23	13.61	15.73	12.30	14.08
T12	Italia	10.66	10.96	11.26	10.11	10.55	10.50	10.67
T13	Symphony	14.38	13.81	14.88	14.50	14.50	11.23	13.88
	Mean	14.33	13.73	13.81	14.20	13.70	12.09	
	SEm±	0.06	0.08	0.10	0.07	0.08	0.05	
	CD at 5%	0.19	0.25	0.28	0.22	0.24	0.14	
Hedonic scale: 18-20 excellent, 15-17 good, 12-14 fair, 9-11 ordinary, 6-8 poor, 3-5 bad, 1-2 very bad								

Amerine, M.A and Ough 1974. Wine and Must analysis, John willey and sons, Newyork, USA.

AOAC. 1965. Official methods of analysis of the AOAC. 11th edition Washington DC. USA pp.183-187.

Bhalerao, S.B. 2001. Indian grape wine. A profitable business from grape cultivation (Trans) Drakshvritta, 27 (8): 73-78.

Golmick, F.N., Bocker, H and Grunzel, H.(eds.). 1991. Das Weinbunch, Leipzig. Fachbuch-verllag.

Joseph, R., Sreekantaiah, K.R and Johar, D.S. 1963. Studies on pectolytic enzyme production by fungi, Part V. Use of pectolytic enzyme preparation in the extraction and clarification of grape juice. Food Science,12 :364-368.

Joshi, V. K and Sharma Somesh, (2004). Contribution of Wines.Beverage and Food World. 41-44.

Joslyn, M.A and Amerine, M. A. 1964. Sensory examination of wines. Desert, Appetizer and Related flavoured wines. The technology of their production. University of California, Division of Agricultural Sciences 357-371.

Natu, R. B., Sawant, A.D and Jadhav,S.J., 1986. Spectro photometric assay of ethanol in fermented molasses and sugarcane juice. Bharatiya Sugar 11(6): 41-43.

Ough, C.S and Amerine, M.A. 1988. Methods for analysis of musts and wines (2nd Ed). New York: John Wiley and Sons.

Patil, D.S. 1994. Study on preparation of wine from commercially grown varieties of grapes (Vitis Vinifera L.) in Maharashtra. M.Sc. (Agri.) thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra.

Pawar, R.A.2002. Studies on preparatation of wine from blended juices of commercially grown grape cultivars. M.Sc. (Agri.) thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra.

Revis, B., Shukla, K.G and Joshi, P.K. 1974.Comparative performance of some varieties of grapes (Vitis vinifera L.) grown in North India for wine making. Progressive Horticulture. 6(4): 41-50.

Ribereau- Gayon, P., Dubourdier, D., Domeche, B and Lonvand 1998. The microbiology of wine and verification. In: Handbook of Enology, Vol 1. John willey and sons ltd., Newyork.

Sadasivam, S and Manickam,A. 1996. Biochmical methods. New international publishers 2nd edition 193-194.

Salunkhe, D.K., Chavan, J.K and Kadam,S.S. 1990. Dietary Tannins: Consequences and Remedies,CRC Press.Inc. Boca Raton, Florida.

Suresh, E.R., Ethiraj, S and Negi, S.S. 1985. Evaluation of new grape cultivar for preparation of wine. Journal of Food Science and Technology 22 (3): 211-212.

Suresh, E. R and Negi, S.S. 1977. Evaluation of some indigenous and exotic grape varieties for wine quality In: Viticulture in tropics. Chadha,.K.L., Randhawa, G.S. and Patil, R.B.(Eds.), Horticultural Society of India, Bangalore. pp.111-115.

Tambe, T.B., Kadu,Y.S and Patil S. P. 2008. Studies on biochemical properties of wine and must of various grape varieties. The Asian Journal of Horticulture,3(1):144-148.

Venkataramu,K., Patel,J.D and Subba Rao, M.S. 1980. Changes in the solubility of red colour of wine in solvents during storage. Indian Food Packer. 32(4): 12- 16.

J.Res. ANGRAU 39(4)16-23, 2011

COMBINING ABILITY ANALYSIS INVOLVING AROMATIC LINES FOR GRAIN QUALITY TRAITS IN RICE (*Oryza Sativa* L.)

GONYA NAYAK. P, SREEDHAR. M, SURENDER RAJU. Ch, SUMATHI. S AND VANISREE. S
Department of Genetics and Plant Breeding, College of Agriculture, Acharya N.G. Ranga Agriculture University, Rajendranagar, Hyderabad - 500 030

ABSTRACT

Sixteen crosses developed from four aromatic lines and four normal testers were evaluated for various grain quality traits to assess the combining ability of the parents and to identify best combinations. The predominance of non-additive genetic variance was noticed for most of the quality characters viz., milling and head rice recovery, kernel length and breadth after cooking, kernel elongation ratio and aroma. Kernel length, kernel breadth and L/B ratio were under the influence of additive gene action. Parents Yamini, Pusa-1121 and MTU-1010 appeared to have contributed maximum favourable genes for physical traits and cooking. These parents can be widely used in crossing programmes to improve quality of normal rice genotypes. Cross RNR-2354 x MTU-1081 was found to be good specific combiner for head rice recovery, kernel length, kernel breadth and L/B ratio. Cross RNR-2354 x BM-71 was found to be good specific combiner for kernel length after cooking, kernel elongation ratio and aroma. Pusa-1121 x BM-71 was found to be good specific combiner for kernel length and L/B ratio.

Aromatic rices constitute a small but special group which is considered as the best in quality. Popularity of such rices has been documented in the Orient and now becoming more popular in Middle East, Europe and United States. Although aromatic rices which are popular in world market are long grain types, majority of the Indian indigenous aromatic rices are small and medium grain types. With the advent of "Geographical Indications" under WTO regulations, basmati kind of aromatic rice is accepted internationally when it is produced from North-western part of India due to its location specific eating quality, thus necessitating research efforts to evolve scented rice genotypes suitable to local requirements.

Successful application of biometrical procedures to understand genetics of quantitative characters helped the breeders to systematically plan for result oriented breeding programmes.

The challenge of quality improvement also needs to be addressed by evolving cultivar genotypes that combined high yield potential with quality attributes meeting stringent national and international standards.

MATERIALS AND METHODS

The material for the present investigation comprised of eight parents and their corresponding 16 F_1 crosses obtained following Line X Tester design (Kempthorne,1957). The experiment was conducted in randomized block design with three replications at Rice Section, Agricultural Research Institute, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad during *rabi* 2010-11. All the parents and F_1 S' were planted in rows of 3 m length with 20 x 15 cm spacing. Recommended agronomic, cultural and plant protection practices were followed. Five competitive plants for each parent and F_1 per replication were randomly selected for data generation.

Ten grams of representative sample was used for estimating milling and head rice recovery with Satake huller and Kett type T2 polisher respectively. Kernel dimensions were obtained using dial micrometer and L/B ratio was computed as per Murthy and Govindaswamy (1967). Graph sheet was used to quantify cooking traits. Kernel elongation ratio was determined using standard method of Verghese (1950) as modified by Murthy (1965). Aroma was scored as per the scale given by Khush *et al.* (1988).

RESULTS AND DISCUSSION

Analysis of variance for combining ability utilizing Line x Tester design for the 9 characters studied, indicated significant mean squares due to genotypes. Further, partitioning of the genotypes into parents and crosses and comparison of parents Vs crosses showed significant differences among themselves indicating that the crosses performed well compared to parents. The differences among lines and testers and the interaction component was also significant.

Email id: pgonanayak@gmail.com

For the milling traits i.e., milling and head rice recovery, importance of non-additive gene action was noticed. Since non- additive gene action can not be fixed, recurrent selection is advocated to break the gene constellations and release the free variability. Earlier, Shivani *et al.* (2009) reported similar gene action.

The desirable effects of prepotency of parents is generally manifested as general and specific combining ability, heterotic behaviour and *per se* performance etc., General combining ability is mainly due to additive and additive x additive gene action and is fixable in nature. The results for milling recovery per cent indicated that significantly positive gca effects were exhibited in RNR-2354 and BM-71 (Table1) which were identified as good general combiners besides recording high *per se* of more than 65 per cent.

Specific combining ability is the result of non-additivity and is not fixable in the segregating generations. In the present investigation Yamini x MTU 1010 (LxL), Ranbir Basmati x MTU-1081 (LxL) were the best specific crosses for milling recovery. These crosses had milling recovery of 72 per cent and also exhibited heterosis to the tune of 5.7 per cent (Table 3). Availability of parents with acceptable head rice yields and ability to combine well with other lines to result in out standing specific combinations would pave the way for good quality rice. In the present study, Line RNR-2354 and tester Sye-632003 recorded a significant and positive gca effect and were found to be potential donors (Table 1). These parents also had maximum *per se* values of 56 per cent (Table 3). Similarly, four crosses were found to have registered positively significant sca effects for head rice recovery. Highest positive sca effect was recorded in the cross Pusa-1121 x MTU-1010 (LxL) followed by, Ranbir Basmati x BM-71 (LxL), RNR-2354 x MTU-1081 (HxL) and Yamini x MTU-1081 (LxL) (Table 2). These crosses also had high *per se* values ranging from 55 to 61 per cent (Table 3). In all these crosses except RNR-2354 x MTU-1081 (HxL), complimentary gene effect of poor x poor gca parents was involved resulting in best specific combiners.

Importance of additive variance for kernel traits viz., kernel length, breadth and L/B ratio indicated that the variability available is fixable by simple selection procedures to recover segregants with slender grain types. These results are in conformity with the findings of Sharma *et al.* (2007) and Sanjeev Kumar *et al.* (2007).

For kernel length (mm), significantly positive gca effects were observed in Pusa-1121, Yamini, BM-71 and MTU-1010 which were the best donors (Table 1) with a mean kernel length of up to 8.04 mm (Table 3). Close association between *per se* performance and gca for kernel length was earlier reported by Singh and Singh (1982). As there are more than one good general combiners, these parents may be intercrossed to produce a composite of these lines or an intermating population involving all possible crosses among them subjected to biparental progeny selection is expected to offer maximum improvement for this trait. Six crosses have registered positively significant sca effects for this trait. Highest positive sca effect was recorded in the cross Pusa-1121 x BM-1 (HxH) followed by Ranbir Basmati x MTU-1010 (LxH), RNR-2354 x Sye-632003 (LxL) and RNR-2354 x MTU-1081 (LxL). These crosses had high *per se* values up to 7.72 mm and exhibited maximum heterosis of 10.28 and standard heterosis of 79 per cent . Top two of these crosses involved at least one parent with high general combining authority suggesting that at least one parent must be a good combiner to bring about improvement in kernel length as recommended by Sonrexa (1984). These results are in conformity with the statement of Singh and Singh (1982) that selection of crosses be made based on *per se* and sca effects.

Kernel breadth and Length/Breadth ratio are negatively correlated as lower kernel breadth naturally enhances the Length/Breadth ratio. For kernel breadth RNR-2354, Sye-632003 and Ranbir Basmati contributed maximum favourable genes and had comparatively low kernel breadth values (Table 2). These findings are in accordance with the results of Singh *et al*. (1993). Best general combiners for kernel breadth viz., Ranbir Basmati and RNR-2354 also produced best specific crosses viz., Ranbir Basmati x BM-71 (HxL) and RNR-2354 x MTU-1081 (HxH) which gave significantly negative sca effects (Table 2). Singh and Singh (1982) suggested that, crosses for kernel breadth should be selected based on *per se* and sca effects. These two best specific crosses

also recorded significant negative heterosis, heterobeltiosis and standard heterosis values of up to -5.15, -7.89 and -6.75 per cent respectively. Similarly, the results for length/ breadth ratio indicated that, Pusa-1121, Yamini and tester BM-71 recorded significant and positive gca effects and contributed maximum favourable genes for the improvement of length/breadth ratio (Table 1) and possessed length/ breadth ratio of more than 3.0. These parents could be considered as potential donors for this trait. The results also indicated positively significant sca effects in five crosses (Table 3). Highest positive sca effect was recorded in the cross Ranbir Basmati x BM-71 (LxH) followed by Pusa-1121 x BM-71 (HxH) and RNR-2354 x MTU-1081 (LxL). Among these crosses, the best specific cross Ranbir Basmati x BM-71 exhibited high *per se* (3.64), and heterosis (12.84%), heteobeltiosis (7.68%) and standard heterosis (58.78%).

The perusal of results indicated that parents Yamini, Pusa-1121 and BM-71 appeared to have contributed maximum favourable genes for kernel length and L/B ratio. These parents can be widely used in crossing programmes to improve physical quality. Among the crosses, RNR-2354 x MTU-1081 was found to be highly promising due to on express not heterosis in all forms and sca effects in desirable direction for physical quality attributes.

The analysis worked out to determine the gene action for cooking quality attributes and aroma revealed preponderance of non- additive gene action. Tyagi *et al.* (2010) reported similar gene action for cooking traits. Under these circumstances it would be difficult to obtain homozygous desirable segregants. Breeding methods that would minimize the effects of restrictive recombination and release hidden variability would be of immense help in bringing about desirable improvement in these traits.

As discussed earlier, parents which were outstanding for kernel length were also found to be potential donors for kernel length after cooking. Parents Pusa-1121, BM-71, Yamini and MTU-1010 exhibited significantly positive gca effects for kernel length after cooking (Table 1) and possesed up to 18.76 mm length and contributed maximum favourable genes (Table 3). Thus parental performance was good indicator of their gca effects. Positively significant sca effects were recorded in four crosses for this trait. Cross Pusa-1121 x MTU-1081 (HxL) had highest positive sca effect and was followed by RNR-2354 x BM-71 (LxH) and Yamini x Sye-632003 (HxL) which were identified as the best specific crosses (Table 3). In all these crosses at least one parent was a good general combiner. These crosses can be used to spot good segregants from the subsequent generations. The superior performance of these crosses was due to additive x dominance effect which is not fixable in nature and careful selection in segregating generations for accumulation of desirable genes may lead to isolation of true breeding strains with higher kernel elongation.

In respect of kernel breadth after cooking significantly negative value was recorded in Sye-632003 with low *per se* of 2.08 mm (Table 3). Three crosses viz.,Yamini x MTU-1010 (LxL), Ranbir Basmati x Sye-632003 (LxH) and Pusa-1121 x MTU-1010 (LxL) were the best specific combiners for kernel breadth after cooking (Table 4). All these crosses involved one parent with low kernel breadth after cooking. Further, for kernel elongation ratio, parents Pusa-1121 and Sye-632003 were important. RNR-2354 x BM-71 (LxL), Pusa-1121 x MTU-1081 (LxL) and Yamini x Sye-632003 (LxL) were the best specific crosses (Table 4) indicating that poor x poor parental combinations performed best.

Tyagi *et al.* (2010) studied nine lines, three testers and 27 hybrids. Among the lines Taraori Basmati, Shah-Pasand and Pusa-1121 was found to be good general combiner for aroma. Cross between Basmati-370 x Heibao was found to be good specific combiner for aroma and cross P-1463 x P-44 expressed high sca effects for aroma. In the present investigation also, lines MTU-1081, Yamini, Pusa-1121 and BM-71 exhibited significantly positive gca effect for aroma and were the best donors for this trait (Table1). Out of sixteen crosses studied, six crosses recorded positively significant sca effects for aroma. Highest positive sca effects were recorded in the cross Yamini x Sye-632003(HxL), RNR-2354 x BM-71(LxH) and Ranbir Basmati x Sye-632003(LxL) (Table 2). Contribution of aromatic parental lines viz., Yamini, Pusa-1121 and non aromatic lines viz., BM-71, MTU-1081 was considered important in transferring the aroma component to the best specific crosses.

Table 1. Estimates of general combining ability effects for nine quality characters in rice

Parent	MR (%)	HRR (%)	KL (mm)	KB (mm)	L/B Ratio	KLAC (mm)	KBAC (mm)	KER	Aroma
Yamini	-0.039	-0.260	0.340**	0.056**	0.081**	0.319**	0.130**	-0.043**	0.273**
Pusa-1121	-0.587	-2.109**	0.564**	0.050**	0.204**	1.373**	-0.018	0.060	0.262**
Ranbir Basmati	-0.513	-1.617**	-0.209**	-0.031**	-0.049**	-0.414**	-0.056	0.018	0.030
RNR-2354	1.139*	3.985**	-0.696**	-0.075**	-0.236**	-1.277**	-0.056	-0.034*	-0.565**
BM-71	1.040*	-0.736	0.399**	0.025**	0.165**	0.688**	0.132**	0.006	0.177*
MTU-1010	-1.244**	-0.522	0.129**	0.040**	-0.002	0.220*	-0.001	-0.018	-0.561**
Sye-632003	-0.170	2.335**	-0.452**	-0.048**	-0.156**	-0.817**	-0.078*	0.020	-0.116
MTU-1081	0.374	-1.076*	-0.076**	-0.018	-0.007**	-0.091	-0.053	-0.008	0.501**
SE ±	0.4518	0.7317	0.0163	0.0087	0.0157	0.0926	0.0294	0.0151	0.0645

MR=milling recovery, HRR=head rice recovery, KL=kernel length, KB=kernel breadth, Length/Breadth ratio, KLAC=kernel length after cooking, KBAC=kernel breadth after cooking, KER=kernel elongation ratio.

Table 2. Estimates of specific combining ability effects for nine quality characters in rice

Hybrid	MR (%)	HRR (%)	KL (mm)	KB (mm)	L/B Ratio	KLAC (mm)	KBAC (mm)	KER	Aroma
Yamini x BM-71	-0.859	-0.535	-0.131**	-0.008	-0.058	-0.193	0.062	-0.002	-0.558**
Yamini x MTU-1010	2.775**	0.227	-0.034	-0.013	0.003	-0.225	-0.199**	-0.008	-0.633**
Yamini x Sye-632003	-2.639**	-2.333**	0.067*	0.021	0.003	1.102**	0.229**	0.124**	0.762**
Yamini x MTU-1081	0.723	2.641**	0.098**	0.001	0.051	-0.684**	-0.093	-0.114**	0.428**
Pusa-1121 x BM-71	-0.722	-1.530	0.385**	0.011	0.163**	-0.747**	-0.019	-0.195**	0.326*
Pusa 1121 x MTU-1010	1.203	4.963**	-0.232**	-0.004	-0.110**	0.387**	-0.160*	0.122**	0.191
Pusa-1121 x Sye-632003	1.322	1.163	-0.104**	-0.030	0.010	-1.089**	-0.026	-0.159**	-0.897**
Pusa 1121 x MTU-1081	-1.803	-4.596**	-0.049	0.023	-0.063	1.448**	0.206**	0.233**	0.379**
Ranbir Basmati x BM-71	1.678	4.559**	0.038	-0.082**	0.176**	-0.170	-0.022	-0.076*	-0.345**
Ranbir Basmati x MTU-1010	-3.671**	-4.252**	0.238**	0.030	0.070*	0.214	0.254**	-0.056	0.440**
Ranbir Basmati x Sye-632003	0.085	0.961	-0.120**	0.021	-0.103**	-0.025	-0.185**	0.117**	0.551**
Ranbir Basmati x MTU-1081	1.908*	-1.268	-0.156**	0.031	-0.143**	-0.019	-0.047	0.015	-0.646**
RNR-2354 x BM-71	-0.098	-2.494**	-0.292**	0.079**	-0.381**	1.110**	-0.021	0.273**	0.576**
RNR-2354 x MTU-1010	-0.307	-0.938	0.028	-0.012	0.037	-0.376	0.105	-0.058	0.001
RNR-2354 x Sye-632003	1.233	0.209	0.156**	-0.012	0.090**	0.011	-0.018	-0.082*	-0.417**
RNR-2354 x MTU-1081	-0.828	3.223**	0.107**	-0.055**	0.154**	-0.745**	-0.066	-0.133**	-0.161
SE ±	0.9037	1.4633	0.0326	0.0174	0.0757	0.1852	0.0588	0.0303	0.1334

MR=milling recovery, HRR=head rice recovery, KL=kernel length, KB=kernel breadth, Length/Breadth ratio, KLAC=kernel length after cooking, KBAC=kernel breadth after cooking, KER=kernel elongation ratio.

Table 3. Top ranking desirable gca of parents, sca of crosses along with their *per se* values and magnitude of heterosis (H_1), heterobeltiosis (H_2) and Standard heterosis (H_3)

S.No Character	Good general combiners	*Per se*	Good specific combination	*Per se*	gca effects	Hetertosis (%)		
						H_1	H_2	H_3
I Physical quality								
1. Milling recovery (%)	RNR-2354	65.91	Yamini x MTU-1010	72.48	Low x Low	5.74	-	-
	BM-71	70.72	Ranbir Basmati x MTU-1081	72.76	Low x Low		-	-
2. Head rice recovery (%)	RNR-2354	51.69	Pusa-1121 x MTU-1010	61.97	Low x Low	17.82	4.16	13.30
	Sye-632003	56.63	Ranbir Basmati x BM-71	61.84	Low x Low	6.68	-	13.07
			RNR-2354 x MTU-1081	65.77	High x Low	15.97	6.54	20.24
			Yamini x MTU-1081	60.94	Low x Low	7.89	-	11.42
3. Kernel length (mm)	Pusa-1121	8.04	Pusa-1121 x BM-71	7.72	High x High	10.28	-	79.69
	BM-71	5.97	Ranbir Basmati x MTU-1010	6.53	Low x High	4.45	-	52.02
	Yamini	7.31	RNR-2354 x Sye-632003	5.38	Low x Low	5.55	-	25.27
	MTU-1010	5.96	RNR-2354 x MTU-1081	5.71	Low x Low	2.45	-	32.87
4. Kernel breadth (mm)	RNR-2354	1.72	Ranbir Basmati x BM-71	1.81	High x Low	-5.15	-6.86	-3.55
	Sye-632003	1.63	RNR-2354 x MTU-1081	1.75	High x High	-3.49	-7.89	-6.75
	Ranbir Basmati	1.87						
5. Length/Breadth ratio	Pusa-1121	4.26	Ranbir Basmati x BM-71	3.64	Low x High	12.84	7.68	58.78
	BM-71	3.07	Pusa-1121 x BM-71	3.88	High x High	5.90	-	69.23
	Yamini	3.95	RNR-2354 x MTU-1081	3.26	Low x Low	6.06	-	42.24
			RNR-2354 x Sye-632003	3.05	Low x Low	-	-	39.95

Contd… 1st page

S.No	Character	Good general combiners	*Per se*	Good specific combination	*Per se*	gca effects	Hetertosis (%)		
							H_1	H_2	H_3
II Cooking quality									
6.	Kernel length after cooking (mm)	Pusa-1121	18.76	Pusa-1121 x MTU-1081	13.20	High x Low	-	-	46.80
		BM-71	10.36	RNR-2354 x BM-71	10.99	Low x High	13.70	6.08	22.23
		Yamini	11.76	Yamini x Sye-632003	11.08	High x Low	11.32	-	23.16
		MTU-1010	9.26	Pusa-1121 x MTU-1010	12.45	High x High	-	-	38.46
7.	Kernel breadth after cooking (mm)	Sye-632003	2.08	Pusa-1121 x MTU-1010	2.16	Low x Low	-	-	-
				Ranbir Basmati x Sye-632003	2.02	Low x High	-	-	-10.88
				Yamini x MTU-1010	2.27	Low x Low	-	-9.80	-
8.	Kernel elongation ratio	-	-	RNR-2354 x BM-71	1.89	Low x Low	14.17	9.44	-
				Pusa-1121 x MTU-1081	1.93	Low x Low	-	-	-
				Yamini x Sye-632003	1.75	Low x Low	-	-	-
				Pusa-1121 x MTU-1010	1.81	Low x Low	-	-	-
9.	Aroma	MTU-1081	4.13	Yamini x Sye-632003	5.25	High x Low	28.43	27.86	-
		Yamini	5.18	RNR-2354 x BM-71	4.66	Low x High	8.55	-	-
		Pusa-1121	4.87	Ranbir Basmati x Sye-632003	4.44	Low x Low	-	-	-
		BM-71	4.07	Yamini x MTU-1081	5.37	High x High	35.21	34.67	10.08

Considering the cooking quality attributes, parent Yamini and Pusa-1121 contributed maximum favourable genes in desirable manner. Among the crosses RNR-2354 x BM-71 can be exploited to isolate desirable segregants with good cooking quality attributes like kernel length after cooking, volume expansion ratio, kernel elongation ratio along with aroma.

The perusal of results indicated that parents Yamini, Pusa-1121 and MTU-1010 appeared to have contributed maximum favourable genes for physical and cooking traits. These parents can be widely used in crossing programmes to improve quality.

REFERENCES

Kempthorne, O. 1957. An introduction to genetics statistics. *John wiley and Sons Inc New York.*

Khush, G.S., Kumar, I and Virmani, S.S. 1988. International rice research institute Manilla, Philippines. *Hand book of hybrid rice*. 210-211.

Murthy, P.S.N and Govindaswamy, S. 1967. Inheritance of grain size and its correlation with the hulling and cooking qualities. *Oryza.* 4(1): 12-21.

Murthy, P.S.N. 1965. Genetic studies in rice with special reference to certain quality features. M.sc. (Botany). *Thesis submitted to Orissa University of Agriculture and Technology, Bhubaneshwar*.

Sanjeev Kumar., Singh, H.B and Sharma, J.K. 2007. Combining ability analysis for grain yield and other associated traits in rice. *Oryza.* 44 (2): 108- 114.

Sharma, M. K., Sharma, A. K., Agarwal, R.K and Richharia, A.K. 2007. Combining ability and gene action for yield and quality characters in Ahu rices of Assam. *Indian Journal of Genetics*. 67(3): 278-280.

Shivani, D., Viraktamath, B.C and Shobha Rani. 2009. Heterosis for quality traits in indica/indica hybrids of rice. *Oryza.* 46 (3): 250-253.

Singh, N.B and Singh, H.G. 1982. Gene action for quality components in rice. *Indian Journal of Agricultural Sciences.* 52(8):485-488.

Singh, N.K., Singh, N.B., Jha, P.B and Sharma, V.K. 1993. Combining ability and heterosis for some quality traits in rice. *Oryza*. 30: 159-161.

Sonrexa, K.P. 1984. Genetic evaluation of some cultivars for quality traits in rice. *Cereal Research Communications.* 12(12): 89-96.

Tyagi, J.P. Tejbir Singh and Singh, V.P. 2010. Genetic analysis of combining ability for quality characters in Basmati rice. *Oryza.* 47 (2):96-99.

Verghese, E.J. 1950. A standard process for cooking of rice for experimental purpose. *Madras Agricultural Journal.* 37: 217- 221.

J.Res. ANGRAU 39(4)24-29, 2011

INFLUENCE OF TEMPERATURE AND CARRIER MATERIAL ON SHELF LIFE OF MASS CULTURED *TRICHODERMA* SPP.

BHEEMARAYA, M B PATIL, RAMESH, S T YENJEERAPPA and KALYAN RAO[1]
Department of Plant Pathology, University of Agricultural Sciences, Raichur - 584102 &
Division of Seed Science and Technology, IARI, New Delhi.

ABSTRACT

A laboratory experiment was carried out during 2009-11 at the Department of Plant Pathology, College of Agriculture, Raichur, University of Agricultural Sciences, Raichur, Karnataka to study the influence of temperature and carrier material on shelf life of mass cultured *Trichoderma* spp. Effect of formulation on shelf life (cfu g^{-1}) of three native *Trichoderma* isolates *viz.,* Tv-3, Th-2 and Tp in talc and vermicompost as carrier materials was tested at room temperature (28±1° C) and refrigerator condition (4±1° C). Th-2 has recorded highest number of propagules in vermicompost followed by talc at different storage temperatures which is significantly superior over other *Trichoderma* spp. In all the carriers, highest cfu was noticed at 30 days after storage which is significantly superior over others. There was a gradual decline in cfu of *Trichoderma* from 30, 60, 90, 120, 150 days upto 180 days. The products can be stored upto 180 days at room temperature. The population of bioagent in the produce is an important factor for the farmers in deciding the quantity and quality of product necessary to apply in the field. The present study helped to know that the viable propagule of bioagent can be observed even after 180 days of storage in both vermicompost and talc.

Biological control of soil borne plant diseases is regarded as an important component of integrated disease management (IDM) system, and it acts as an alternative to various chemical pesticides due to its self sustaining action. *Trichoderma* spp. are most widely used biocontrol agents since they have antifungal and antienduring activities (Zaidi and Singh, 2004). Failure of antagonist to survive due to shorter shelf life is major hindrance to consistent field performance. Formulation of biological control agents depends upon biomass production and maintaining viability at the end of the process (Adekunle et al., 2001). Viability of bioagent in talc based formulation reduced during storage, which ultimately influences the effectivity (Jeyarajan *et al*., 1994). The present investigation was therefore aimed to test the viability and shelf life of talc and vermicompost formulation of *Trichoderma* spp. at different storage temperatures.

Materials and Methods

The culture of native *Trichoderma viride* Pers. ex Gray, *T. harzianum* Rifai*, T. piluliferum* Webster & Rifai was collected from Department of Plant pathology, College of Agriculture, Raichur. Talc powder and vermicompost were used as organic substrates for mass multiplication of above *Trichoderma* spp. The substrates were first tyndalised and then air dried and passed through 350 mesh sieves to obtain fine powders. Mass culture of above *Trichoderma* spp. was prepared by transferring aseptically their 72 hour old growth in PDA to 1000 ml PDB and incubated at 28° C for 10 days. From this 400 ml of broth (10^8cfu ml^{-1}) was added to 1kg of substrate. Then the inoculated substrates were mixed properly and sealed in polypropylene bags and stored at different temperatures.

Determination of the population dynamics of *Trichoderma* spp*.* in different bio-formulations was done after different days of storage in room temperature (28±1° C) and refrigerator temperature (4±1° C). Experiment was designed using three treatment combinations following CRD with three replications. The viable population of *Trichoderma* spp*.* in the substrates following different period of storage was determined at 30 days interval by serial dilution technique and was expressed in terms of cfug^{-1} of substrate. The enumeration was continued up to 180 days.

Experimental results

Trichoderma viride (Tv-3)

In talc formulation, the highest mean population of *T. viride* (73.83 x 10^6 cfu g^{-1}) was recorded when stored at room temperature and it was

E-mail I.D : hawaldarbb2807@gmail.com

reduced to 65.28 x 10^6 cfu g^{-1} when stored at refrigerated condition. The propagules of *T. viride* at different days of storage were found to decrease significantly from 135.50 x 10^6 cfu g^{-1} at 30 days to 18.50 x 10^6 cfu g^{-1} at 180 days after storage (Table 1).

In vermicompost also highest propagules of *T. viride* was recorded at room temperature (110.56 x 10^6 cfu g^{-1}) compared to refrigerated condition (59.83 x 10^6 cfu g^{-1}). With regard to storage time, highest cfu was recorded at 30 days after storage (160.67 x 10^6 cfu g^{-1}). There was significant decrease of cfu from 30 days to 180 days of storage (14.17 x 10^6 cfu g^{-1}).

Mean effect showed maximum cfu at 30 days after storage (148.08 x 10^6 cfu g^{-1}), which was significantly superior over other storage days. Among different carriers used, highest cfu was recorded in vermicompost (85.19 x 10^6 cfu g^{-1}) and talc recorded 69.56 x 10^6 cfu g^{-1}

Among the different fungal bioagents tested for shelf life in different formulations at room temperature of 28±1° C and refrigerator condition (4±1° C), *T. viride* (Tv-3) recorded good number of propogules in vermicompost followed by talc and with respect to different days of storage, highest cfu was noticed at 30 days after storage (148.08 x 10^6 cfu g^{-1}) which is found significantly superior over others. There was a gradual decline of cfu from 30, 60, 90, 120, 150 and 180 days (148.08, 112.92, 92.83, 61.42, 32.67, and 16.33 x 10^6 cfu g^{-1}, respectively). Room temperature recorded highest cfu compared to refrigerated condition.

***Trichoderma harzianum* (Th-2)**

The population of *T. harzianum* in talc recorded highest cfu of 82.77 x 10^6 cfu g^{-1} when stored at room temperature, compared to refrigerator condition (71 x 10^6 cfu g^{-1}). The length of storage revealed that, highest cfu was recorded after 30 days of storage (137.67 x 10^6 cfu g^{-1}) of formulated product (Table 2).

In vermicompost, highest cfu was recorded at room temperature (118 x 10^6 cfu g^{-1}), which was significantly superior over refrigerator condition (66.17 x 10^6 cfu g^{-1}). With respect to different days of storage, highest cfu was recorded at 30 days after storage (166.50 x 10^6 cfu g^{-1}).

As per mean effect, the highest cfu was recorded at 30 days after storage 152.02 x 10^6 cfu g^{-1} which was significantly superior over rest of the storage days and lowest recorded was 23.25 x 10^6 cfu g^{-1} after 180 days of storage period. There was a gradual decrease in cfu from 30 to 180 days of storage period. The highest cfu was recorded in vermicompost (92.08 x 10^6 cfu g^{-1}) followed by talc (76.86 x 10^6 cfu g^{-1}).

T. harzianum (Th-2) has recorded highest number of propagules in vermicompost (92.08 x 10^6 cfu g^{-1}) followed by talc (76.86 x 10^6 cfu g^{-1}) when stored at different storage temperatures which is significantly superior to other *Trichoderma* spp. With respect to different days of storage, highest cfu was recorded at 30 days after storage (152.08 x 10^6 cfu g^{-1}) which was significantly superior over rest of storage days, there was gradual decline in cfu up to 180 days.

***Trichoderma piluliferum* (Tp)**

In talc powder formulation the population of *T. piluliferum* was maximum (76.33 x 10^6 cfu g^{-1}) when stored at room temperature and it was reduced to 66 x 10^6 cfu g^{-1} when stored in refrigerated condition. The population of *T. piluliferum* at different days of storage was found to decrease significantly from 30 days onwards. Maximum number of cfu was obtained at 30 days of storage 131.83 x 10^6 cfu g^{-1} and was reduced to 21.17 x 10^6 cfu g^{-1} after storage period of 180 days (Table 3).

In vermicompost, also highest population of *T. piluliferum* was recorded at room temperature (112.44 x 10^6 cfu g^{-1}) compared to refrigerator condition (62.11 x 10^6 cfu g^{-1}). With respect to length of storage life, highest cfu was obtained at 30 days of storage (161.17 x 10^6 cfu g^{-1}) and it was gradually reduced to 15.83 x 10^6 cfu g^{-1} after 180 days of storage period.

Mean effect showed a maximum number cfu at 30 days after storage (146.50 x10^6 cfu g^{-1}) which was significantly superior over other storage days. With respect to different carriers, highest cfu was recorded in vermicompost (87.28 x 10^6 cfu g^{-1}) followed by talc (71.17 x 10^6 cfu g^{-1}).

T. pililuferum (Tp) also recorded good number of propogules in both the carriers when stored at

Table 1. Effect of different carrier material on shelf life (x cfu g^{-1}) of *Trichoderma viride* (Tv-3) at different temperatures

Storage days	Talc			Vermicompost			Mean
	Room temperature	Refrigerator temperature	Mean	Room temperature	Refrigerator temperature	Mean	
30	136.00	135.00	135.50	181.33	140.00	160.67	148.08
60	104.00	82.67	93.33	182.00	83.00	132.50	112.92
90	87.67	70.00	78.83	142.67	71.00	106.83	92.83
120	58.00	57.00	57.50	98.33	32.33	65.33	61.42
150	37.00	30.33	33.67	42.33	21.00	31.67	32.67
180	20.33	16.67	18.50	16.67	11.67	14.17	16.33
Mean	**73.83**	**65.28**	**69.56**	**110.56**	**59.83**	**85.19**	**77.38**

Comparing of Means	S. Em±	C.D. at 1%
Carrier (A)	0.167	0.632
Temperature (B)	0.167	0.632
Storage days (C)	0.289	1.095
A x B	0.236	0.894
A x C	0.408	1.549
B x C	0.408	1.549
A x B x C	0.58	2.19

* Room temperature = 28±1^{o} C Refrigerator temperature = 4±1^{o} C

Table 2. Effect of different carrier material on shelf life (x 10^8 cfu g^{-1}) of *Trichoderma harzianum* (Th-2) at different temperatures

Storage days	Talc			Vermicompost			Mean
	Room temperature	Refrigerator temperature	Mean	Room temperature	Refrigerator temperature	Mean	
30	143.33	132.00	137.67	186.00	147.00	166.50	152.08
60	113.00	89.00	101.00	187.00	89.00	138.00	119.50
90	98.00	77.00	87.50	152.00	76.33	114.17	100.83
120	68.00	64.00	66.00	108.00	41.33	74.67	70.33
150	46.00	39.00	42.50	51.00	27.33	39.17	40.83
180	28.00	25.00	26.50	24.00	16.00	20.00	23.25
Mean	**82.72**	**71.00**	**76.86**	**118.00**	**66.17**	**92.08**	**84.47**

Comparing of Means	S. Em±	C.D. at 1%
Carrier (A)	0.529	2.005
Temperature (B)	0.529	2.005
Storage days (C)	0.915	3.472
A x B	0.747	2.835
A x C	1.295	4.911
B x C	1.295	4.911
A x B x C	1.831	6.945

* Room temperature = 28±1° C Refrigerator temperature = 4±1° C

Table 3. Effect of different carrier material on shelf life (x cfu g^{-1}) of *Trichoderma piluliferum* (Tp) at different temperatures

Storage days	Talc			Vermicompost			Mean
	Room temperature	Refrigerator temperature	Mean	Room temperature	Refrigerator temperature	Mean	
30	138.00	125.67	131.83	181.00	141.33	161.17	146.50
60	106.00	84.67	95.33	182.67	85.00	133.83	114.58
90	91.00	72.67	81.83	144.67	74.00	109.33	95.58
120	61.67	58.67	60.17	102.00	36.00	69.00	64.58
150	39.67	33.67	36.67	46.00	23.00	34.50	35.58
180	21.67	20.67	21.17	18.33	13.33	15.83	18.50
Mean	**76.33**	**66.00**	**71.17**	**112.44**	**62.11**	**87.28**	**79.22**

Comparing of Means	S. Em±	C.D. at 1%
Carrier (A)	0.191	0.726
Temperature (B)	0.191	0.726
Storage days (C)	0.332	1.258
A x B	0.271	1.027
A x C	0.469	1.778
B x C	0.469	1.778
A x B x C	0.663	2.515

* Room temperature = 28±1° C Refrigerator temperature = 4±1° C

different temperatures. Highest cfu was recorded in room temperature with both vermicompost and talc powder (118 x 10^6 cfu g^{-1} and 82.72 x 10^6 cfu g^{-1}, respectively) and lower cfu was observed under refrigerated condition in both the substrates (66.17 x 10^6 cfu g^{-1} in vermicompost and 71.00 x 10^6 cfu g^{-1} in talc). Higher cfu was recorded in vermicompost followed by talc powder with respect to different days of storage. Highest cfu was recorded at 30 days after storage.

The population of bioagent in the produce is an important factor for the farmers in deciding the quantity and quality of product necessary to apply in the field. Hence, the experiment indicates that the bioagent can be stored in vermicompost and talc powder upto 180 days without loss of viability.

Thus, the present investigation showed superiority of storage temperature and formulations of *Trichoderma* spp. which is in agreement with those of previous workers (Sivakumar *et al.,* 2000; Hunjan *et al.,* 2004; Zaid and Singh, 2004; Mandhare and Suryawanshi, 2005). The antagonist propagules survived up to 180 days in both carriers. In vermicompost, the bioagent colonized compost not only provides better protection of crops but also improves crop growth due to organic carbon present as compared to talc.

Prasad *et al.* (2002) also reported that formulation in talc based carrier retained optimum amounts of viable propagules (>10^6 cfu/g) even after 180 days of storage at room temperature. The results of the present findings are also comparable with that of Das *et al.* (2006), who reported that talc based formulation exhibited a gradual declining trend in multiplication and sporulation of *T. harzianum* 30 days onwards. Talc was also found to be good carrier to retain maximum numbers of viable propagules at 180 days after storage.

REFERENCES

Adekunle, A.T., Cardwell, K.F., Florini, D.A and Ikotun, T. 2001. Seed treatment with *Trichoderma* species for control of damping-off of cowpea caused by *Macrophomina phaseolina*. *Biocontrol Science Technology,* **11:** 449–457.

Das, B.C., Das, B.K., Dutta, P.B and Sarmah, D.K. 2006. Bioformulation of *T.harzianum* for management of soybean stem rot caused by *R. solani*. *Journal of Biological Control,* **2**: 57-64.

Hunjan, M.S., Rama Singh, Munshigo and Rewal, H.S. 2004. Shelf life of mutant and parent strains of *Trichoderma viride* in wet and dry formulations. *Journal of Research.,* Punjab Agricultural University, **41**(3): 356-359.

Jeyarajan, R., G. Ramakrishnan, D. Dinakaran and R. Sridhar. 1994. Development of products of *Trichoderma viride* and *Bacillus subtilis* for biocontrol of root rot disease. In: Dwivedi (ed.) *Biotechnology in India.* Bioved Research Society, Allahabad, pp.25-36.

Mandhare, V.K and Suryawanshi, A.V. 2005. Standardization of storage conditions to increase the shelf life of *Trichoderma* formulations. *Agricultural Science. Digest,* **25**(1): 71-73.

Prasad, R.D., Rangeswaram, R., Anuroop, C.P and Phanikumar, P.R. 2002. Bioefficacy and shelf life of conidial and chlamydospore formulations of *T. harzianum* Riffai.*Journal of Biological Control,* **16**: 145-148.

Sivakumar, G., Sharma, R.C and Rai, S.N. 2000. Biocontrol of banded leaf and sheath blight of maize by peat based *Pseudomonas fluorescens* formulation. *Indian Phyto-pathology.,* **53**(2): 190-192.

Zaidi, N., W and Singh, U.S. 2004. Mass multiplication of *Trichoderma harzianum* on cowdung. *Indian Phytopathology.,* **57**(2): 189-192.

J.Res. ANGRAU 39(4)30-34, 2011

COMPARISION OF BT-COTTON HYBRIDS WITH THEIR NON-BT COUNTER PARTS FOR YIELD TRAITS, FIBRE AND OIL QUALITY

A. BREZNEV, J. SURESH, M. V. BRAHMESWARA RAO, A.GEETHA and P. SAIDAIAH
Department of Genetics and Plant Breeding, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030

ABSTRACT

Ten commercially grown Bt cotton hybrids were compared with their Non Bt counter parts for quantitative, fibre and oil characters during *Kharif*, 2008 at College of Agriculture, ANGRAU, Hyderabad, Andhra Pradesh. The results suggested that the Bt cottons significantly outperformed their Non Bt counterparts in three quantitative characters viz. days to 50% flowering, number of bolls per plant and seed cotton yield per plant. The transgenic Bts showed several statistically significant but minor differences in four important fibre quality traits *viz*., 2.5% span length, uniformity ratio, micronaire and tenacity. The variations observed in these traits were trivial and the performances of Bts with respect to fibre properties were similar with that of their non Bt counter parts. Some cottons varied significantly in fatty acid profile of oil quality measured but they were of minor magnitude only. The analysis demonstrated that the seed from Bt cottons is compositionally equivalent and as nutritious as seed from their Non Bt counter parts.

Bt cotton has been cultivated in India since 2002 and there has been considerable debate and conflicting views regarding its agronomic performance and whether Bt cotton seeds have nutritional safety to be used for human food and animal feed. There have been reports of goats and sheep taking ill and dying after grazing on these fields. Because of the existence of the Bt gene and selectable marker gene in the transgenic cotton seed, general concerns of whether this transgenic cotton seed can be used as safely as the conventional counterpart in food and feed stuff have arisen (Jia, 1997; Lack 2002; Kok and Kuiper, 2003). Reports from India regarding the economic performance of Bt cotton have been mixed with some claiming benefits for Bt growers while others claim that they are actually worse off compared with growers of Non Bt cotton (Shiva and Jafri, 2003). And also these transgenic Bt cotton may show genetic variability beyond that of the parental cultivar through somaclonal variation (Altman *et al.,* 1991) or through pleiotropic effects of the foreign genes that were inserted into the genome. In view of the above field tests were conducted to study the fibre properties of these transgenic cotton varieties along with their non Bt counterparts. The objective of this study was to determine whether the insertion of transgenes affects the quantitative characters, fibre quality and qualitative Characteristics of Bt cotton varieties.

MATERIALS AND METHODS

An experiment was conducted at College Research Farm, College of Agriculture, ANGRAU, Rajendranagar, Hyderabad during *Kharif*, 2008. The experimental material consisted of 10 commercially cultivated Bt cotton hybrids *viz.,* RCH 138, RCH 20, RCH 2, Bunny, Mallika, Brahma, Viswanath, JK Durga, Ankur 651 and Nathbaba and their respective non Bt counterparts obtained from various private seed companies in India. The experimental material was sown in R B D with three replications. Each plot consisted of five rows of 4 m length with a spacing of 120 cm in between the rows and 80 cm within the row. Normal agronomic practices and prophylactic measures recommended to the region were adopted for raising the crop. Five representative plants from each plot in each replication were chosen at random and labelled for recording the observations for quantitative traits viz., days to 50% flowering, number of bolls per plant, seed index and seed cotton yield per plant. The seed cotton samples from each replication were ginned and the seeds were acid delinted. The consolidated seed cotton samples were collected for ginning. The ginned cotton samples from each replication were subjected to fibre quality analysis in high volume instrument (ICC mode) and data were recorded for the four fibre quality traits *viz*., 2.5% span length, uniformity ratio, micronaire and tenacity. The delinted seed samples were subjected

Email: breznev@gmail.com

to oil quality analysis using Nuclear Magnetic Resonance method for oil content and gas chromatography (thermofocus model) / using capillary column, DB 225) for estimating fatty acid profiles viz. palmitic acid, stearic acid, oleic acid and linoleic acid. Comparison of means of Bt cotton and their non Bt counterparts for quantitative, qualitative and oil traits were performed by paired-t-test (Student, 1908).

RESULTS AND DISCUSSION

Seven Bt hybrids viz., RCH 2, Bunny, Mallika, Brahma, Viswanath, Ankur 651 and Nathbaba, were early to reach 50% flowering compared to Non-Bts. In case of Bunny Mallika and Nathbaba significant increase in no. of bolls per plant was noticed because of the introduction on Bt. Four hybrids viz., RCH – 138, RCH 2, Bunny and Mallika were statistically significant compared to their Non Bt counterparts for the trait seed cotton yield per plant.

Seed index was significantly lowered in Bt hybrids - RCH 138, RCH 20, RCH 2, Mallika and J.K Durga relative to their counterparts of Non-Bts. In case of other hybrids, Bt and non Bt had comparable performance for seed index.

Six Bt hybrids studied *viz.,* RCH 20, Bunny, Brahma, JK Durga, Ankur 651 and Nathbaba registered significantly when compared with their non Bt counterparts increased staple length. However, there was no change in the category based on staple length in case of these hybrids. Those under medium category remained in the same group. In case of Brahma JK Durga and Nathbaba the staple length decreased in such a way that the Bts have moved to medium category while the non-Bts had longer staple length. Similar results were earlier reported by Douglas Wilson *et al.* (1994), Liyan (1999) and Kerby *et al* (2000).

The changes in uniformity ration were peculiar. Becuase of the conversion to Bt, it decreased in certain hybrids, while increase was noticed in certain other hybrids. The non-Bts of Mallika and Brahma belonged to the category – very good (>47% uniformity ration), but they moved down to 'Good' category to the above, the non-bts of RCH-20 and Bunny, which were under 'Average' category (43-4.5%), moved to 'Good' category (45-47%) because of the introduction of Bt.

The results with micro naire were also interesting. RCH-2 and JK Durga were to be classified as "average" (40-49), but because of conversion to Bt they cause under the group "fine" (3.0-3.9). In some of the other hybrids the micro naire either decreased or increased significantly, but the cottons remained in the same group i.e "average", except for RCH-138, which remaind in the "fine" category.

Seven Bt hybrids viz. RCH 138, RCH 2, Bunny, Mallika, Brahma, Viswanath and JK Durga were significantly different from their Non Bt counterparts for the trait. But these differences were not important as all the hybrids studied fall under 'very low' category (<34.5 g / tex) based on their mean values for this trait.

The paired-t-test was applied to the mean data of all Non Bt and Bt hybrids studied. The results showed that the differences among them for all the four fibre traits measured were not significant indicating that the performance of Bt hybrids was comparable with that of their non Bt counterparts for the fibre quality traits.

The oil content of any of the hybrids tested, was not altered because of the conversion to Bt, aspect RCH-138 which showed marginal but significant increase with Bt a per t-test. However the oil content level of that hybrid was within the reported values in literature (13-28%) and showed that there was no difference between Bt and Non Bts for this trait. Significant differences were noticed in three Bts viz. RCH 138, Mallika and Viswanath in case of pamitic acid whereas five Bts showed statistical significant differences for stearic acid compared to respective non-Bts. However, the mean values were within the literature range for the respective fatty acids. Hence they were not considered to be meaningful differences in nutritional value of the seed. Also, the mean values for palmitic acid were low in eight of the ten Bts studied, when compared with their Non Bt counterparts, and it gave a clear picture that the Bt hybrids offered better oil quality with respect to this trait as nutritionists believe that palmitic acid raises blood cholesterol level considerably. A team of researchers has modified

Table 1. Quantitative characters of Bt and Non-Bt hybrids

	Days to 50% flowering		No. of bolls/plant		Seed cotton yield/plant (g)		Seed Index (g)	
	Non Bt	Bt	Non Bt	Bt	Non Bt	Bt	Non Bt	Bt
RCH 138	54.7	52.3	20.3	24.3	77.7	91.0*	7.13	6.60
RCH 20	55.3	55.3	36.3	34.0	89.0	94.0	11.7	9.3*
RCH 2	55.7	52.3*	16.3	18.7	74.3	77.7*	8.2	7.3*
Bunny	55.7	51.3*	35.7	39.3*	104.0	118.7*	8.1	8.1
Mallika	60.0	55.3*	31.7	37.0*	92.3	114.7*	8.4	8.6*
Brahma	60.3	55.3*	22.7	22.3	81.7	83.3	7.7	7.4
Viswanath	56.7	53.3*	37.3	38.0	106.0	115.3	7.7	7.7
J K Durga	54.3	52.3	24.0	26.3	83.0	84.8	8.2	6.2*
Ankur 651	55.3	50.3*	20.0	23.0	75.0	83.7	7.4	7.5
Nathbaba	56.7	52.3*	21.7	26.7*	81.7	87.7	7.5	7.9
Mean	56.5	53.0*	26.6	30.0*	86.5	98.0*	8.24	7.7

* Significant at 5% level

** Value reported is the mean obtained from three replications

Table 2. Fibre quality parameters of Bt and Non-Bt cotton hybrids

Name of the Variety	2.5% span length		Uniformity ratio		Micronaire (10^{-6})		Tenacity (g/tex)	
	Non Bt	Bt	Non Bt	Bt	Non Bt	Bt	Non Bt	Bt
RCH 138	25.24	26.23	48.15	47.00	3.70	3.90*	19.54	17.50*
RCH 20	31.45	30.26*	44.19	46.09*	4.61	4.20*	20.13	20.38
RCH 2	28.38	28.60	46.46	44.02	4.04	3.60*	19.01	20.73*
Bunny	30.48	31.60*	43.97	45.03	4.20	4.30*	19.98	21.22*
Mallika	29.52	29.62	47.13	45.73*	4.10	4.37*	21.64	20.38*
Brahma	30.09	28.61*	47.16	44.59	4.41	4.06*	22.47	21.09*
Vishwanath	29.07	28.64	47.12	47.06	4.11	4.20	21.36	20.13*
J K Durga	31.21	27.66*	46.01	45.94	4.10	3.89*	21.13	20.37*
Ankur 651	27.17	26.58*	46.19	46.83	4.41	4.48	18.65	18.62
Nathbaba	29.48	28.11*	44.98	42.17*	4.30	3.41	20.31	20.28
Over all Mean	29.21	28.59	46.13	45.45	4.20	4.04	20.42	20.07

* Significantly different as 5% level.

Table 3. Individual comparison between Non Bt varieties and their Bt counterparts for oil quality parameters

	Oil content (%)		Palmitic acid (%)		Stearic acid (%)		Oleic acid (%)		Linoleic acid (%)	
	Non Bt	Bt	Non Bt	Bt	Non Bt	Bt	Non Bt	Bt	Non Bt	Bt
RCH 138	17.5	17.7*	23.3*	21.41*	3.0	2.1*	15.6	13.2*	55.9	48.3*
RCH 20	18.8	19.0	26.3	25.7	2.0	2.7*	19.2	16.1*	53.5	54.0
RCH 2	17.7	17.8	22.5	22.5	2.4	2.8	17.4	16.7*	55.5	56.0
Bunny	19.0	19.1	26.3	26.0	3.0	3.1	14.5	16.9*	52.2	51.3*
Mallika	18.6	18.7	25.3	21.4*	1.4	2.1*	19.7	12.5*	53.4	42.2*
Brahma	18.8	18.6	23.3	23.2	3.6	1.8	18.5	14.3*	52.6	56.4*
Viswanath	18.4	18.6	24.3	28.1*	3.1	2.3*	17.6	15.5*	52.1	51.3*
J K Durga	18.2	15.7	24.4	24.2	2.8	3.1	14.3	14.9	56.0	54.5*
Ankur 651	18.3	18.1	23.3	23.0	2.9	2.6	16.3	17.5*	55.9	55.4
Nathbaba	19.0	18.3	25.3	24.3	2.8	1.9*	17.1	13.5*	52.3	45.2*
Literature range	13 - 28[b]		17 - 29[b]		1 - 4[b]		13 - 44[b]		33 - 58[b]	
Mean	18.5	18.2	24.5	24.0	2.7	2.5	17.0	15.1	54.0	51.5

*Significantly different at 5% level.

b = FAO/WHO codex Alimentarius committee on fats and oils (Cotton seed oil, 1993)

the cotton seed so that it produced stearate instead of palmitate, making it healthier product for margaraine (Liu et al., 2002). Improving quality of oil involves reduction of saturated fatty acid contents (Palmitic and Stearic) and therefore it is evident that both non Bt and Bts performed equally for this trait.

Interestingly nine Bt hybrids (all except JK Durga) showed significant differences for oleic acid and seven Bts - [RCH 138, Bunny, Mallika, Brahma, Viswanath, JK Durga and Nathbaba] were statistically different from their Non Bt counterparts for linoleic acid, but none of the mean values of these hybrids exceeded the reported literature ranges for these two fatty acids. Therefore, the differences can be regarded as biologically insignificant. Since the oleic and Linoleic acids come under unsaturated fatty acids, the higher level of these fatty acids in cotton seed renders better oil quality (Singh, 2003). Seven out of ten Non Bts had higher of mean values oleic acid and Linoleic acid than their Bt counterparts. The results of overall comparison between Non Bt and Bts revealed no statistical significance for any of the oil traits measured. Nida *et al* (1996), Berberich *et al* (1996) and Bertrand *et al* (2005) also reported compositional equivalence in oil quality traits of Bt cotton with their parental cultivars. Thus it can be inferred that the seed from the insect protected Bt cotton hybrids is compositionally equivalent to that of their Non Bt counterparts.

REFERENCES

Altman, D. A., Stelly, D. M. and Milten, D.M. 1991. Qualitative trait variation in phenotypically normal regenerants of cotton. In vitro cell development biology **27** : 132-138.

Berberich, S. A., Ream, J. E., Jackson, T. L., Wood, R., Stipanovic, R., Harvey, P., Patzer, S. and Fuchs, R. L. 1996. The composition of insect protected cotton seed is equivalent to that of conventiaonal cotton seed. Journal of Agriculture and Food Chemistry **44**: 365-71.

Bertrand, J. A., Sudduth, T. Q., Codon, A., Jenkins. T, C. and Calhoun, M. C. 2005. Nutrient content of whole cotton seed. Journal of Dairy Science **88**: 1470-1477.

Douglas Wilson, F., Flint, H. M., Deaton, W. R. and Buehler, R. E. 1994. Yield components and fibre properties of insect resistant cotton lines containing a *Bacillus thuringiensis* toxin gene. Crop Science **34** (1): 38-41.

Jia, S. R. 1997. Safety evaluation of marker genes in transgenic food plants. Scientia Agriculturae Sinica **30**(2): 1-15.

Kerby, T., Hugie, B., Howard, K., Bater, M., Burgers, J. and Mahaffey, J. 2000. Fibre quality comparison among varieties for conventional, Bollgard Reg. and Roundup ready Reg. versions. Proceedings Beltwide cotton conferences, San Antonio, USA **1**: 484-488.

Kok, E. J., Kuiper, H. A. 2003. Comparitive safety assessment for biotech crop. Trends in Biotechnology **21** (10): 439-44.

Lack, G. 2002. Clinical risk assessment of GM food. Toxic / Lett **127**: 337-40.

Liu, Q., Singh. S. P., Green, A. G. 2002. High stearic and high oleic cotton seed oil produced by hairpin RNA mediated post transcription gene silencing. Plant Physiology **129**: 1732-43.

Liyan, E. and Chenzhixian, 1999. A brief introduction to transgenic Jinmian 26. China cottons **26** (10) : 25

Morse, S., Bennet, R. and Ismael, Y. 2005. Bt cotton boosts the gross margin of small scale cotton producers in South Africa. International Journal of Biotechnology **7**(1/2/3): 72-83.

Nida, D. L., Patzer, S., Harvey, R., Stipanovic, R., Wood, R. and Fuchs, R. L. 1996. Glyphosate tolerant cotton. Journal of Agriculture and Food Chemistry **44**: 1967-74.

Shiva, V. and Jaffri, A. 2003. Failure of GMOs in India. Synthesis / Regeneration.*Pp.* 33.

Singh, B. D. 2003. Breeding for oil quality. Plant Breeding. Kalyani Publishers, New Delhi Pp. 574-597.

Student, 1908. The probable error of a mean. Biometrika **6** (1): 1-25.

J.Res. ANGRAU 39(4)35-40, 2011

COMBINING ABILITY ANALYSIS FOR GRAIN YIELD AND OTHER QUANTITATIVE TRAITS IN MAIZE (*Zea mays* L.)

B. RAGHU, J. SURESH, P. SAIDAIAH and S. SUDHEER KUMAR
Department of Genetics and Plant Breeding, College of Agriculture, Acharya NG Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030

ABSTRACT

Combining ability studies were conducted using 10 parents and their 45 hybrids obtained from a half diallel mating for grain yield and yield components. The studies revealed significant *gca* and *sca* effects for all the traits studied. The parents SK-1, SK-2 and SRRL-65 were found to be good general combiners for grain yield PER plant, height and ear height . The cross combinations CM-211 X ACROSS, SK-1 X SK-3, SRRL-79 X SK-1 and SRRL-65 X MH-12 showed high SCA effects for grain yield and other prime components.

Maize is one of the important crops of Andhra Pradesh occupying more than 7 lakh hactares under commercial hybrids. Andhra Pradesh is the largest producer of maize in India contributing 21% of annual maize production with an average productivity of 4.8 t/ha.

Maize is a very important cereal crop in India. India ranks fifth in maize acreage after US, China, Brazil and Mexico. In per acre productivity, India is low with8 lakh quintals/acre, where as world average is about 20 quintals/acre. India needs to double its maize production in next ten years to meet the growing domestic demand from the feed and starch sectors. Inspite of availability of numerous hybrids currently for commercial cultivation, development of new ones secure sustainable cultivation of maize hybrids.

Combining ability analysis is exclusively used to study the nature and magnitude of gene action. This also facilitate correct choice of parents in a hybrid breeding programme. The analysis of genetic variance was also an equally important objective to gain knowledge regarding the nature and magnitude of gene action, which has importance in the choice of most appropriate and efficient breeding procedure for enhance performance of hybrids. Exploitation of additive genetic variance is stable for the development of composites and non-additive genetic variance is suitable for exploitation of heterosis through various selection methods. Keeping the above in the view, newly developed inbred lines were used to study their combining abilities.

MATERIALS AND METHODS

The experimental material for the present investigation comprised of ten promising early elite genotypes *viz.,* CM-211, SRRL-79, SRRL-65, SK-1, BML-7, DMR-103, SK-2, ACROSS, SK-3 and MH-12. These were crossed in a half diallel fashion at Maize Research Centre, Rajendranagar, Hyderabad during *kharif,* 2008 to generate experimental hybrids for this study. The 45 F_1s along with their parental lines and two standard checks BH 1576, BH 40625 were grown in Randomized Block Design with three replications during *rabi*, 2008-09 at College Form, College of Agriculture, Acharya N.G. Ranga Agricultural University, Hyderabad. Data were recorded for days to 50 % tasselling, days to 50 % silking, days to maturity, plant height (cm), ear height (cm), ear length (cm), number of kernel rows per ear, number of kernels per ear, 100 grain weight (g) and grain yield per plant (g). Average values of five randomly selected plants were recorded for all the characters. The combining ability analysis was worked out according to method-II, model-1 (fixed effects model) given by Griffing (1956).

RESULTS AND DISCUSSION

The combining ability analysis of variance (Table 1) revealed significant differences among parents and crosses for all the characters. The estimates of components of variance, GCA and SCA (Table 2) indicated that for all the characters SCA variance was greater than GCA variance in magnitude indicating the preponderance of non-additive gene action for the characters studied. Similar reports were made by Manmohan (1984).

Email: raghu.plantbreeder@gmail.com

Study of *gca* effects of the parental inbreds for grain yield per plant (Table 2) revealed highest magnitude for SK-2, SK-1 and SRRL-65 in the positive direction. The inbreds had also resulted in the production of best single crosses viz.,SK-1 X SK-3, SRRL-79 X SK-1, CM-211 x ACROSS, SK-1 x SK-2, SRRL-65 x BML-7 and SK-2 x SK-3 with high SCA. Further they exhibited significant and desirable *sca* effects for various yield component characters and were considered to be high general combiners with good potential in hybrid breeding programme. The possibility of production of superior crosses with high SCA from high yielding; high *gca* inbreds was also reported earlier in maize (Kumari *et al.* 2006) and Gowar Ali *et al.,* (2007). The superiority of SK-1, SK-2, ACROSS and SRRL-65 inbreds was also reflected in terms of their production of greater number of heterotic crosses. In contrast, the inbreds ACROSS and SK-3 were found to be poor general combiners.

Specific combining ability effects (Table 3) revealed significant and desirable effects for grain yield in 10 crosses *viz.,* CM-211 x ACROSS, SK-1 x SK-3, SRRL-79 x SK-1 SRRL-65 x BML-7, CM-211 x SRRL-79, SRRL-79 x SK-3, SK-2 x SK-3, SRRL-79 x SRRL-65, SK-1 x SK-2 and SK-1 x BML-7. The highest *sca* values (70.21 and 60.72) for yield were reported in crosses CM-211 x ACROSS and SK-1 x SK-3 involving one good and one poor general combiners. While most of other high *sca* crosses also showed the same behaviour (high X low) indicating the possibility of obtaining superior crosses with high X low combination of parents. The findings are in consonance with earlier worker (Nawar *et al.*1979). Such crosses could be utilized in the production of high performing hybrids on a commercial scale.

Crosses with desirable *sca* effects for various traits along with mean performance and *gca* effects of parents involved in the crosses are listed in the Table 3. The crosses SRRL -79 x SRRL -65 and SRRL -79 x SK -1 for days to 50% tasselling, SRRL -79 X SK -1 for days to 50% silking and days to maturity expressed significant *sca* effects as well as high *per se* performance for grain yield and related traits. These desirable cross combinations involved high x high type of general combiners. Salgotra *et al.* (2009) also reported about interaction between positive and positive alleles in crosses involving high x high combiners which can be fixed in subsequent generations if no repulsion phase linkages are involved.

The desirable performance of combinations like high x low may be ascribed to the interaction between dominant alleles from good combiners and recessive alleles from poor combiners (Dubey, 1975). Such combinations were observed in the hybrids viz., CM -211 x SRRL -79, SK -1 x SK -2, SRRL -79 x SK -3 for days to 50% tasselling, CM -211 x SRRL -79, SRRL -79 x SRRL -65 for days to 50% silking, SRRL-79 x SK -1, SRRL -65 x BML -7, CM -211 x ACROSS for days to maturity, SK -2 x SK -3, CM -211 x ACROSS, SRRL-79 x SK -3 for plant height (cm), CM -211 x ACROSS, SK-1 x BML-7 for ear height (cm) and ear length(cm), SK -1 x SK -2, CM -211 x ACROSS for ear girth (cm), SK -1 x SK -2 for no of kernel rows/ ear and 100 grain weight (g), SK -1 x SK -3, SRRL -79 x SK -1, SRRL -65 x BML -7 for grain yield/ plant (g). Peng and Virmani (1990) also reported the possibility of interaction between positive alleles from good combiner and negative alleles from poor combiner in high x low cross combination and suggested for the exploitation of hybrid vigour, as their high yielding potential would be unfixable in succeeding generation.

Involvement of both parents which are poor combiners also produced superior specific combining hybrids as evidenced from the combinations such as CM -211 x ACROSS for days to 50% tasselling, SRRL -65 x BML-7, SK-1 x SK-2 for plant height (cm), SRRL-79 x SK -3, CM-211 x SRRL-79, SK-1 x SK -3 for ear height (cm), SRRL-79 x SK-1, SK-1 x SK-3, CM-211 x SRRL-79, CM-211 x ACROSS for ear length (cm), SRRL-79 x SK-1, SRRL-79 x SRRL-65, SRRL -65 x BML-7 for ear girth (cm), SK-1 x SK-3, SK-1 x BML-7, SRRL-79 x SK-1, SRRL-65 x BML-7 for no of kernel rows/ ear, SK-1 x SK-3, CM -211 x ACROSS, SRRL-79 x SK -3, SRRL-79 x SK-1, SK-1 x BML-7 for no of kernels per row, CM-211 x ACROSS, SRRL-79 x SK-3, CM-211 X SRRL-79, SRRL-79 x SK -1 for 100 for grain weight (g) and CM-211 x ACROSS, CM-211 x SRRL-79 for grain yield/ plant (g)).

Involvement of both the combiners with low *gca* and producing superior hybrids has been attributed to over dominance and epistasis interaction, which has been suggested by Dalvi and Patel (2009). In majority of the crosses, high *sca* was mainly either

Table 1. Analysis of variance for combining ability for grain yield and yield components

Source of variation	d.f	Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	No of kernel rows/ ear	No of kernels/ row	100 grain weight (g)	Grain yield/ plant (g)
gca	9	16.3 **	8.68 **	20.75 **	979.6 **	380.23 **	3.06 **	1.51**	3.90**	19.62 **	9.49 **	1167.42**
sca	45	3.07 **	2.59 **	6.82 **	726.58 **	248.39 **	4.87 **	1.87**	1.35**	23.67 **	8.84 **	1255.61**
Error	108	0.38	0.38	0.23	27.70	9.01	0.59	0.23	0.29	3.34	0.86	33.76
s_2 *gca*		1.32	0.69	1.70	79.32	30.93	0.20	0.10	0.30	1.35	0.71	94.47
s_2 *sca*		2.69	2.20	6.58	698.87	239.38	4.28	1.64	1.05	20.33	7.98	12.21
s_2 *gca* / s_2 *sca*		0.49	0.31	0.25	0.11	0.12	0.04	0.07	0.28	0.06	0.08	0.07

.

Table 2. Estimates of general combining ability effects of parents for grain yield and yield components

Parents	Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	No of kernel rows/ ear	No of kernels/ row	100 grain weight (g)	Grain yield/ plant(g)
CM -211	0.87**	0.53**	-0.31*	-17.74**	-5.90**	-0.98**	-0.32*	0.70**	-0.85	-1.00**	-8.18**
SRRL -79	-1.49**	-1.00**	-1.53**	-2.00	-7.86**	-0.27	0.20	-0.34*	-1.42**	0.31	1.02
SRRL -65	-0.72**	-0.03	-2.48**	5.29**	4.72**	-0.07	0.19	0.15	0.64	0.47	6.99**
SK -1	-0.97**	-0.81**	0.16	0.82	-3.31**	-0.20	0.01	-0.66**	0.55	0.08	9.06**
BML -7	1.34**	0.36*	2.05**	17.12**	6.57**	0.45*	0.21	-0.43**	0.10	0.71**	0.88
DMR -103	-1.66**	-1.31**	-0.26	-0.88	-3.81**	0.69**	0.06	0.70**	1.78**	-0.89**	0.18
SK -2	0.28	0.06	0.41**	6.67**	8.38**	0.47*	0.42**	0.55**	1.00*	1.12**	14.58**
ACROSS	0.03	0.03	-0.01	-0.23	4.44**	0.22	0.27*	-0.03	0.69	0.36	-1.88
SK -3	0.67**	0.64**	0.44**	-6.49**	-2.74**	-0.49*	-0.29*	0.28	0.06	-1.69**	-1.26
MH -12	1.64**	1.53**	1.52**	-2.57	-0.49	0.18	-0.75**	-0.90**	-2.57**	0.52*	-21.40**
$S.E_{(gi)}$	0.16	0.17	0.13	1.44	0.82	0.21	0.13	0.14	0.50	0.25	1.59
$S.E_{(gi - gj)}$	0.25	0.25	0.19	2.14	1.22	0.31	0.19	0.22	0.74	0.37	2.37

Table 3. Estimates of specific combining ability effects of the crosses for grain yield and yield components

Crosses	Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	No of kernel rows/ ear	No of kernels/ row	100 grain weight (g)	Grain yield/ plant (g)
CM -211 X ACROSS	0.591	-0.616	0.280	8.767	12.885 **	2.322 **	1.340 **	-1.051 *	6.261 **	4.922 **	70.215 **
SK -1 X SK -3	0.119	-0.561	3.030 **	28.425 **	11.582 **	2.763 **	1.026 **	1.932 **	7.155 **	1.125	60.726 **
SRRL -79 X SK -1	-1.048 *	-0.588	-3.330 **	21.506 **	3.268	2.799 **	2.216 **	1.021 *	4.775 **	2.049 *	52.308 **
SRRL -65 X BML -7	-0.131	-0.394	-0.610 *	0.778	4.438	0.772	1.610 **	0.827	-0.900	-0.180	39.366 **
CM -211 X SRRL -79	-1.881 **	-1.425	-1.53 **	27.770 **	11.820 **	2.250 **	0.669	-0.473	2.175	3.082 **	36.908 **
SRRL -79 X SK -3	-0.354	1.301 *	1.058 *	9.987 *	12.463 **	0.366	0.11	-0.190	5.530 **	3.125 **	34.270 **
SK -2 X SK -3	0.869	1.912 **	2.780 **	-0.691	-2.120	1.549 *	0.663	-0.145	2.239	0.533	31.379 **
SRRL -79 X SRRL -65	-1.631 **	-1.366 *	-1.030 *	11.539 *	4.499	0.131	1.964 **	-0.057	-0.980	-0.680	28.682 **
SK -1 X SK -2	-0.159	-0.977	3.391 **	7.595	6.693 *	1.782 *	1.590 **	0.132	3.417 *	2.627 **	25.971 **
SK -1 X BML -7	1.452 *	1.384 *	0.086	14.612 **	10.874 **	2.214 **	0.789 *	1.238 *	3.983 *	1.183	20.968 **
SE (Sij)	0.565	0.569	0.445	4.487	2.765	0.707	0.400	0.499	1.683	0.854	2.372
SE (Sij - Sik)	0.830	0.837	0.655	7.126	4.064	1.039	0.647	0.733	2.474	1.225	7.867

due to high x low or low x low combining parents, which further substantiate the operation of non-additive gene action (additive x dominance and dominance x dominance epistatic interaction

Cross SRRL-79 x SRRL-65 showed significant highest negative effect for days to 50 per cent tasselling and days to 50 per cent silking, whereas the cross CM-211 x ACROSS combination showed highest *sca* effects for plant height and 100 grain weight in addition to grain yield per plant. While cross SK-1 x BML-7 high for ear length and ear girth and also revealed high sca effects. SK-1 x SK-3 for number of kernel rows per ear and number of kernels per row.

Two crosses viz., SRRL-79 x SK-1 and SRRL-79 x SRRL-65 were identified as most promising for yield based on *sca* effects , better *per se* and with both or one of the parents with high *gca* for yield per plant also. These hybrid combinations could be exploited profitably for yield realization in maize after multilocational evaluation.

REFERENCES

Dalvi, V.V and Patel, D.V. 2009. Combining ability anlysis for yield in hybrid rice. Oryza, 46 (2): 97-102.

Griffing, B. 1956. Concept of general and specific combing ability in relation to diallel crossing systems. Australian Jornal of Biological Sciences. 9: 463-493.

Gowar Ali, Ishfaq, A., Rather, A.G., Wani, S.A., Gul Zaffar and Malchdoomi, M.I. 2007. Heterosis and combining ability for grain yield and its components in high altitude maize inbreds (Zea mays L.). Indian Journal of Genetics and Plant Breeding. 67(1): 81-82.

Kumari, Jyoti, Gadag, R.N and Jha, G.K. 2006. Identification of potential early maturing single cross maize (Zea mays L.). Indian Journal of Agricultural Science. 76: 383-385.

Manmohan, E. 1984. Evaluation of combining ability and association characters in inbred lines of maize. M.Sc (Ag) Thesis submitted to Acharya N.G. Ranga Agricultural University, Hyderabad.

Nawar, A.A., Gomma, M.E and Reddy, M.S. 1979. Heterosis and combining ability in maize. Egyptian Journal of Genetics. 13: 227-237.

Peng, J.Y and Virmani, S.S. 1990. Combining ability for yield and yield related traits in relation to breeding in rice. Oryza. 27: 1-10.

Salgotra, R.K., Gupta, B.B and Praveen Singh, 2009. Combining ability studies for yield and yield components in basmati rice. Oryza. 46 (1): 12-16.

J.Res. ANGRAU 39(4)41-43, 2011

STUDIES ON RICE (*Oryza sativa* L.) CULTIVARS DURING DRY SEASON UNDER TERAI AGRO-CLIMATIC SITUATION OF WEST BENGAL

M. Ghosh and B. De
Department of Agronomy, Uttar Banga Krishi Viswavidyalaya
Pundibari, Cooch Behar, West Bengal -736165

ABSTRACT

The field experiment was carried out at the institutional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during the winter season of 2009-10 and 2010-11 to replace the existing rice cultivars having lower yield with improved cultivars. Experiment was laid out in a Randomized Block Design with twelve treatments (cultivars). Results obtained from the experiment showed that the increase in final yield of IET-4555 corresponded to the higher stomatal conductance; higher photosynthetic rate and higher crop growth rate. This was followed by KRM-3. The above results indicated that the cultivar IET-4555 was highly suitable under dry condition of winter season in *Terai* agro-climatic situation.

Rice is cultivated in 18 districts of West Bengal. Out of which 4 districts are under high productivity group, 9 districts are under medium productivity group, 3 districts are under medium-low productivity group and 2 districts are under low productivity group.

The experiment was carried out to study the effect of Net Photosynthesis Rate, Stomatal Conductance Rate on growth and yield of rice cultivars during Dry season, to evaluate the growth and yield of rice cultivars in Terai Agroclimatic Region of West Bengal.

MATERIALS AND METHODS

The field experiments were carried out at farm of Uttar Banga Krishi Viswavidyalaya at Pundibari, Cooch Behar, West Bengal, India during the winter season of 2009-'10 and 2010-'11. The farm is situated at $26^0$19'86"N latitude and $89^0$23'53" E longitude at an elevation of 43 meters above mean sea level. The climate of *terai* zone is subtropical in nature with distinctive characteristics of high rainfall, high humidity and prolonged winter. The average rainfall of this zone varies between 2100 to 3300 mm. The maximum rainfall, *i.e.*, about 80% of the total, is received from south-west monsoon during the rainy months of June to September. The temperature range of this area varies from minimum of 7.1-8^0C to maximum of 24.8-32.2^0C. The area as a whole is humid and warm except having a short winter spell during December to February. This varied climatic situation makes the agro-ecological condition more complex and dynamic. Composite soil samples from all the experimental plots in both the years were collected and analyzed before starting the experiment. The experimental soil's pH was 5.5, organic carbon was 0.639%, cation exchange capacity was 14.54 me/100 g, available nitrogen was 107.59 kg ha^{-1}, available phosphorus was 15.36 kg ha^{-1} and available potassium was 71.68 kg ha^{-1}. Experiment was laid out in Randomized Block Design with twelve treatments (cultivars). The treatments were replicated thrice. The Stomatal Conductance rate and Net Photosynthesis Rate (Pn) (micro mol m^{-2} s^{-1}) were measured by Hand-Held Portable Photosynthesis System (Model no CI-340, CID, Inc., Camas, WA).

RESULTS AND DISCUSSION

The pooled data revealed that there were significant differences in stomatal conductance rate (mili mol m^{-2} s^{-1}) for different rice cultivars. The maximum stomatal conductance rate was recorded in IET-4555 and the lowest stomatal conductance rate was recorded in IET-6223. The stomata of rice plants close noticeably in response to a reduction in leaf water potential causing marked reduction in photosynthetic rate (Hirasawa *et al*., 1999). There was a decreasing trend of stomatal conductance rate as the plant got matured. Photosynthesis has two major components; the stomatal and the non stomatal. Nonstomatal components include activities of the photosynthetic enzymes and light reactions. Water stress affects both the stomatal and non

E-mail: mayukh_agronomy@yahoo.co.in

Table 1. Interaction of year, sampling date and cultivar on Stomatal Conductance, Net Photosynthesis Rate, Leaf Area Index, Crop Growth Rate, Final yield

Observations Treatments	Stomatal conductance rate ($mmol \cdot m^{-2} \cdot s^{-1}$)	Net Photosynthesis Rate ($micro\ mol\ m^{-2}\ s^{-1}$)	Leaf Area Index	Crop Growth Rate ($g \cdot m^{-2} \cdot day^{-1}$)	Final yield ($kg\ ha^{-1}$)
Year					
Y1	174.42	34.59	3.014	23.781	5185
Y2	176.68	35.74	3.011	25.305	5190
SEm (±)	0.2228	0.3668	0.0045	0.1688	128
LSD (0.05)	0.6284	1.0343	0.0126	0.4803	N.S.
Sampling date					
S1	225.57	45.20	3.444	15.356	N.A.
S2	169.34	30.73	3.250	33.730	N.A.
S3	131.73	29.56	2.342	N.A.	
SEm (±)	0.2729	0.4492	0.0055	0.1688	N.A.
LSD (0.05)	0.7696	1.2667	0.0154	0.4803	N.A.
Cultivars					
V1	209.84	39.67	3.465	24.749	5438
V2	130.93	28.79	3.166	23.788	4900
V3	211.83	36.07	2.748	25.107	5810
V4	123.43	25.28	2.450	23.718	4520
V5	246.97	54.23	3.028	28.834	6020
V6	190.22	36.29	2.474	24.580	5157
V7	233.56	41.04	3.303	25.370	5890
V8	149.83	32.40	3.069	24.268	4957
V9	139.59	33.24	3.174	24.060	4900
V10	119.31	27.93	3.049	21.224	4460
V11	180.68	33.56	3.370	24.508	5108
V12	170.36	33.49	2.896	24.314	5088
SEm (±)	0.5459	0.8984	0.0109	0.4135	128
LSD (0.05)	1.5392	2.5334	0.0309	1.1764	375
Cultivars X Sampling date					
SEm (±)	0.9455	1.5561	0.0190	0.5848	N.A.
LSD (0.05)	2.6661	4.3880	0.0535	1.6637	N.A.
Cultivars X Year					
SEm (±)	0.7720	1.2706	0.0155	0.5848	N.A.
LSD (0.05)	2.1768	3.5828	0.0437	1.6637	N.A.
Sampling date X Year					
SEm (±)	0.3860	0.6353	0.0077	0.2387	N.A.
LSD (0.05)	1.0884	1.7914	0.0218	0.6792	N.A.
Cultivars X Sampling date X Year					
SEm (±)	1.3371	2.2007	0.0268	0.8270	N.A.
LSD (0.05)	Significant	Significant	Significant	Significant	N.A.

V_1= IET-9219; V_2= IET-723; V_3= IET-13439; V_4= Hil Bao; V_5= IET-4555; V_6= IET-9671; V_7= KRM-3; V_8= IET-21287; V_9= MTU-1010; V_{10}= IET-6223; V_{11}= IET-4786; V_{12}= IET-2684.

S1=40 DAT, S2=60 DAT, S3=80 DAT

Y1=2009-10, Y2=2010-11

stomatal components of photosynthesis (Sinha *et al*., 1982).

Higher stomatal conductance gave the opportunity to perform better and store more photosynthate to the sink at the dry period. The maximum net photosynthetic rate was recorded in IET-4555 and the lowest net photosynthetic rate was recorded in IET-6223. Photosynthesis is the primary source of biomass and grain yield in rice (Teng *et al*., 2004). According to Jiang and YinFa (1995) photosynthetic rates decreased during senescence of rice leaves.

There was an increase in the crop growth rate as the plant grew older and more photosynthates stored from source to the sink. The pooled data revealed that there was significant difference in crop growth rate among the cultivars where IET-4555 showed highest value and IET-6223 showed the lowest value.

There was variation in the leaf area index due to the genetical variation among the cultivars and response to the environment. In the last stage of vegetative stage (at 60 DAT) the highest LAI was observed in IET-4555 which was significantly different from the other cultivars. But the LAI decreased later when the plants ran toward maturity.

Among the cultivars, IET-4555 gave the highest grain yield followed by KRM-3 and the lowest yield was from IET-6223. For increase in grain yield, growth parameters like crop growth rate, stomatal conductance and photosynthetic rate proved decisive factors.

REFERENCES

Hirasawa, T., Ito, O and Hardy, B. 1999. Physiological characterization of the rice plant for tolerance of water deficit. Genetic Improvement Rice for Water Limited Environment. IRRI, Philippines. Pp. 89-98.

Sinha, S.K., Khanna, T., Chopra, Aggarwal, P. K., Chaturvedi, G.S and Koundal, K.R. 1982. Effect of drought on shoot growth: Significance of metabolism to growth and yield. Drought Resistance in Crops with Emphasis on Rice. IRRI, Philippines. Pp. 153-169.

Teng, S., Qian, Q., Zeng, D., Kunihiro, Y.,Fujimoto, K., Huang, D. and Zhu, L.; 2004. QTL analysis of leaf photosynthetic rate and related traits in rice (*Oryza sativa* L.). Euphytica. **135**: 1-7.

Jiang De' and YinFa Xu 1995. Internal dominant factors for decline of photosynthesis during rice leaf senescence. Journal of Zhejiang Agricultural University. **21**(5): 533-538.

CID, Inc. Hand Held Portable Photosynthesis System Instruction Manual, CI-340. 4845 NW Camas Meadows Drive, Camas, WA 98607, USA.

J.Res. ANGRAU 39(4)44-50, 2011

OCCURRENCE AND DISTRIBUTION OF COCOA (*Theobroma cocoa* L.) DISEASES IN INDIA

PRABHA K. PETER and R. CHANDRAMOHANAN
Central Plantation Crops Research Institute,
Kasaragod, Kerala-671124

ABSTRACT

A random survey of cocoa gardens in 4 southern cocoa growing states of India revealed that Phytophthora diseases such as black pod, stem canker and seedling blight are the major problems leading to heavy economic loss to the growers. Stem canker caused by *Phytophthora palmivora* and zinc deficiency were observed as major problems in Andhra Pradesh compared to other states. Colletotrichum disease, stem canker and zinc deficiency were observed in all the cocoa gardens surveyed in Andhra Pradesh. Though *Colletotrichum* pod rot was reported long back from India, it has recently emerged as a serious problem in several gardens in India. Vascular streak die back was noticed only in Kerala state. Therefore, it is important to follow strict quarantine measures to prevent the entry of this disease to other cocoa growing states. Other major diseases like swollen shoot (virus diseases) witches broom and monilia pod rot are not observed in India. All agencies importing planting materials from other countries should take special care in not introducing these diseases to India.

Cocoa (*Theobromae cocoa* L.) is extensively cultivated in the four southern states of India, viz., Kerala, Karnataka, Tamil Nadu and Andhra Pradesh, getting both South – West (heavy rainfall) and North – East monsoonal rainfall. Coconut (*Cocos nucifera* L.) and arecanut (*Areca catechu* L.) are the principal plantation crops in the southern states of India. Cocoa being a shade loving crop has been found to be a suitable and highly profitable mixed crop in existing coconut and arecanut gardens. Commercial cocoa cultivation was started during 1970s in India. At present, cocoa occupies an area of 31,885 ha with an annual production of 10,560 metric tonnes. Andhra Pradesh and Tamil Nadu which are new entrants in commercial cocoa cultivation have an area of 12734 ha and 1421 ha respectively under cocoa cultivation in 2007-2008. During 2001-02 Kerala state had the largest area of 8949 ha whereas at the same time the area under cultivation of cocoa in Andhra Pradesh and Tamil Nadu was only 2744 ha and 92 ha respectively. Now the largest area under cocoa cultivation is in Andhra Pradesh. The area expansion of cocoa cultivation is progressing fast. Though several major diseases of cocoa were recorded from other cocoa growing countries (Thorold, 1975), only a few have been noticed so far in India. Among the Phytophthora diseases, black pod (Ramakrishnan and Thankappan, 1965), stem canker (ChandraMohanan, 1978), Chupon blight and twig dieback (ChandraMohanan *et al.*, 1979) and seedling dieback (ChandraMohanan, 1979) have been recorded in India. Of these, black pod disease has been found to be of greater economic importance owing to the heavy loss it causes year after year during the raining season. With the recent expansion in cocoa cultivation and with increasing age of the existing plantations the incidences of diseases are also on the increase. Hence, the present studies were undertaken to find out the incidence and overall distribution of the diseases in the cocoa growing states of India.

MATERIAL AND METHODS

A random survey was undertaken from July to November in 2009 and 2010 in the cocoa growing areas in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. A total of 490 gardens were covered in the present study. In Kerala all districts viz., Thiruvanathapuram, Kollam, Pathanamthitta, Alappuzha, Kottayam, Idukki, Ernakulam, Thrissur, Palakkad, Malappuram, Wayanad, Kozhikode, Kannur and Kasaragod were included in the random survey. Here, a total of 292 gardens were surveyed. Occurrence and intensity of diseases (Percentage of the gardens with disease incidence) were recorded from 5-49 gardens per district depending on the area under cultivation and intensity of diseases. In Karnataka it is mainly grown in Dakshina Kannada, Coorg, Uduppi, Uttara Kannada, Chikkamagalooru, Shimoga and Mysore districts. Of the 105 gardens

Email: rcmcpcri@yahoo.co.in

surveyed in this state, thirty were from Dakshina Kannada, the major cocoa growing district in Karnataka. In Tamil Nadu, cocoa cultivation with yielding plants is mainly found in Coimbatore district, and 23 gardens were covered in this district. Observations were recorded from 8 gardens in Kanyakumari district. Since majority of cocoa plantings in Andhra Pradesh are restricted to West Godavari and East Godavari districts, the present study was concentrated in these two districts, where a total of 62 gardens were covered.

RESULTS AND DISCUSSION

Observations on cocoa diseases occurring in the southern states of India revealed the occurrence of the following fungal diseases and zinc deficiency in cocoa plantations and in nurseries.

I. Pod rot

a. Black pod dissae (*Phytophthora palmivora* Bult.)

b. Charcol Pod rot (*Lasiodipoldia theobromae* Pat.)

c. Chrelle rot (*Colletotrichum gloeosporioides* Penz.)

II. Trunk and branch diseases

a. Stem canker (*P.palmivora*)

b. Vascular streak dieback (*Oncobasidum theobromae* Talbot & Keane)

c. Chupon blight and twig dieback (*P.palmivora*)

d. Foliar infection caused by *C. gloeosporioides*

III. Nursery diseases

a. Seedling dieback (*P.palmivora*)

b. Leaf blight and shot hole (*C. gloeosporioides*)

c. Stem canker of grafted seedlings (*P.palmivora*)

IV. Nutritional disorder

a. Zinc deficiency

Among the diseases occurring in India, Phytophthora diseases were found to be very important owing to the intensity and economic loss. Of these, black pod disease caused by *P.palmivora* was found to be the most important disease in all the four southern states of India and found occurring in 84.3 % of the gardens surveyed (Table 1). Among the gardens surveyed in Kerala, black pod incidence was noticed in 90.75% of the gardens. In India, black pod disease was reported as early as in 1965 (Ramakrishnan and Thankappan, 1965). A preliminary study conducted in Dakhina Kannada District revealed the incidence of black pod disease in 22.1 % of the total pods observed in five gardens. (ChandraMohanan, 1985).

Stem canker caused by *P.pamivora* infection was found to be a serious problem in India especially in the cocoa gardens in Andhra Pradesh . Anthracnose or rotting of young pods referred as cherelle rot caused by *C. gloeosporioides* during pre and post monsoon season was also found to be a major problem in some of the cocoa plantations in the four states. The highest incidence of Stem canker (100 %) based on the gardens survyed was observed in Andhra Pradesh followed by Tamil Nadu (82.1%). It was observed in 57.87 % of the gardens in Kerala (Table 1). Though cherelle rot causal by *C. gloeosporioides* was observed in all the gardens surveyed in Andhra Pradesh it was not a serious problem in all the gardens. But colletotrichum pod rot observed in all the four states indicated that this disease has recently emerged as a serious problem in many locations and warrants control measures in gardens with high incidence, especially in Andhra Pradesh and some parts of Kerala and Karnataka.

Vascular streak dieback was noticed mainly in Kerala State. But it was not observed in the gardens surveyed in the other three states. The incidence of vascular streak dieback was high in Kozhikode, Kottayam, Idukki and Pathanamthitta districts (Table 2). It was observed in 17.8 % of the gardens surveyed in Kerala. During 1981 vascular streak dieback was found occurring only in Kottayam and Thrissur districts of Kerala (ChandraMohanan and Kaveriappa, 1981). It is important to follow strict quarantine measures to prevent the entry of this disease to other cocoa growing areas in India.

Though foliar infection caused by *C. gloeosporioides* and charcoal pod rot were observed in most of the gardens (Table 2), they were

not considered as serious problems as the intensities were very low. Other fungal diseases such as chupon blight and twig dieback, white thread blight, horse hair blight and pink disease were observed as minor problems. Cephaleuros leaf spot and knob gall were very rarely observed. But chupon blight and twig dieback/leaf infection caused by *Phytophthora* should not be neglected as they contribute to a great extent to the *Phytopthora* inoculum build up in the garden which may lead to higher incidence of black pod and canker diseases. Therefore, frequent removal of chupons, proper pruning of cocoa plants, removal and destruction of Phytophthora infected pods and proper spacing of cocoa plants are very important factors in the integrated management of black pod and canker diseases. Similarly, though foliar infection caused by *C. gloeosporioides* was observed in almost all gardens, it was not found directly causing much damage or loss in adult / yielding plants. But this phase of *C. gloeosporioides* infection will definitely contribute to the inoculum build up in the plantations which in turn may cause severe pod infection leading to direct loss in yield. The incidence of Colletotrichum foliar infection was reported throughout the year with peak intensity during September - November (ChandraMohanan et al., 1989).

P.palmivora infection of seedlings causing high mortality in the nurseries during rainy season was the major problem in all the nurseries especially in nurseries with very young seedlings. Seedling infection was observed initiating from tip of the seedling (dieback), leaf, cotyledonary region or collar region and ultimately leading to death of seedling (Thorold, 1975, Gregory, 1974). Phytophthora infection of cocoa seedlings was observed to be very high when seedlings were raised during rainy season without proper shade and hygienic conditions. *P.palmivora* infection on the stem (canker) of grafted seedlings was also observed in the nurseries in Dakshina Kannada district. In such cases the infection was mostly initiated from the grafted region. Foliar infection of seedling caused by *C. gloeosporioides* caused stunted growth with blighted or malformed leaves (with shot hole). Shot hole symptom caused by C. gloeosporioides was mostly observed in seedlings kept under open conditions without proper shade and in the nurseries raised inside coconut gardens.

Zinc deficiency was observed as a major problem in the cocoa gardens of Andhra Pradesh and Tamil Nadu. It was observed in all the gardens surveyed in Andhra Pradesh in varying intensities. Chlorosis of leaves was the initial symptom of zinc deficiency in cocoa. As the symptoms progressed, green portion was found only along the sides of the veins giving a vein banding appearance to the leaves. Affected leaves also showed mottling and crinkling with wavy margin and sickle shape. By observing the leaf symptom many cocoa growers suspected it as a virus disease. Twig symptoms included rosette, defoliation and dieback. Severe defoliation and dieback caused gradual death of young plants. Inadequate shade, high pH and poor aeration of the soil were attributed as some of the probable causes of zinc deficiency (Jurrinak and Thorne, 1955: Schroo, 1959).

The present study clearly indicated that Phytophthora diseases especially black pod and stem canker are the major problems causing economic loss to the cocoa gardens in South India. Vascular streak dieback was noticed only in Kerala state. Adequate care should be taken to prevent the entry of this disease into other cocoa growing states where area expansion of cocoa cultivation is fast increasing. Seedlings and cocoa grafts raised in Kerala state should not be transported to other cocoa growing states. Swollen shoot disease, one of the most economically important plant diseases in the world (Thresh, 1958) which is wide spread in Ghana, Ivory Coast, Nigeria, Sri Lanka, Colombia, Trinidad, Venezula, Indonesia, Sabah etc. has not been observed in the present study in any of the cocoa growing areas in India. Special care has to be taken to prevent the introduction of such major diseases to India.

REFERENCES

ChandraMohanan, R. 1979. Cocoa seedling dieback. *Indian Cocoa, Arecanut & Spices Journal.***3**: 5-6.

Chandra Mohanan, R. 1985. Incidence of cocoa black pod disease in Dakshina Kannada District (Karnataka) - a major cocoa growing area in India. *Indian Cocoa, Arecanut & Spices Journal* **8**: 91-92.

Table 1. Percentage of gardens with incidence of cocoa diseases out of total garden surveyed in four southern states of India

Disease	Kerala	Karnataka	Tamil Nadu	Andhra Pradesh	Mean of 4 states
Black pod	90.75	94.3	77.42	45.16	84.3
Charcol pod rot	81.5	80.95	82.1	45.16	76.3
Canker	57.87	32.38	82.1	100	58.8
Colletotrichum cherelle rot	45.89	57.14	67.85	100	56.12
Colletotrichum foliar infection	92.12	100	100	100	95.3
Vascular streak dieback	17.80	-	-	-	10.6
Chupon blight	42.12	74.3	19.4	14.51	44.1
White thread blight	18.8	9.5	7.14	-	13.67
Zinc deficiency	19.18	13.3	71.42	100	31.02
Horse hair blight	5.8	6.6	3.57	-	5.1
Pink diseas	2.4	12.4	-	-	4.08
Knob gall	1.02	2.8	-	4.8	1.8

- Not observed

ChandraMohanan, R and Kaveriappa, K.M. 1981 Occurrence and distribution of cocoa diseases in South India. Proc. *8th International Cocoa Research Conf.* 18-23, Oct., 1981. Cartagena, Columbia.pp.445-49.

ChandraMohanan, R., Anandaraj, M and Joshi, Y. 1979. Studies on *Phytophthora* diseases of cocoa occurring in India. Proceedings of Plantation Crops Symposium (PLACROSYM II). pp 335-342.

Chandramohanan, R., Kaveriappa, K.M and Nmabiar, K.K.N. 1989. Epidemiological studies of *Colletotrichum gloeosporioides* disease of cocoa. *Annals of applied Biology.,* **114**: 15-22.

ChandraMohanan, R.1978. Cacao canker caused by *Phytophthora palmivora. Plant Diseases. Reptr.* **62**:1080- 1082.

Greogory, P.H. (Ed.). 1974 .*Phytophthora diseases of cocoa*. Longman Group Ltd., London. 348p.

Jurinak, J.J and Thorne, D.W. 1955. Zinc solubility under alkaline conditions in a zinc-bentonite system. Proceedings *of Soil Science Society America*.**, 19**:446-448.

Ramakrishnan, K and Thankappan, M. 1965. First report of black pod disease of cacao in India. *South Indian Horticulture*.**13**:33-4.

Schroo, H.1959. Acute zinc deficiency observed in cacao on certain soil types in Netherlands, New Guinea.*Neth.Journal of Agril. Sciences*.**, 7** : 309-316

Thorold, C.A. 1975. *Disease of cocoa*. Clarendon Press, Oxford 432p.

Thresh, J.M.1958. Virus research .Nigerian isolate of cacao virus. *Annual Report of West African cocoa Research Institute.* 1956-57.pp 71-73.

Table 2. District wise occurrence of cocoa diseases in south India

State/District	Total No. of gardens surveyed	Number of gardens with disease incidence									
		Black pod	Charcoal pod rot	Stem canker	Colletotrichum disease		Vascular streak dieback	Chupon blight / twig dieback	White thread blight	Zinc deficiency	Horse hair blight
					Cherelle rot	Foliar infection					
Kerla state											
Thiruvananthapuram	10	4	8	-	2	10	2	-	-	-	-
Kollam	5	-	2	-	5	5	1	-	-	-	-
Pathanamthitta	21	21	21	9	10	21	7	16	3	2	1
Alappuzha	16	14	15	7	9	16	1	7	8	5	2
Kottayam	47	46	40	38	25	24	9	31	19	7	3
Idukki	44	44	36	37	19	44	7	30	11	7	2
Ernakulam	49	47	37	33	14	49	2	9	2	3	1
Thrissur	12	12	12	9	6	12	4	-	-	-	-
Palakkad	10	8	7	3	5	10	1	3	-	5	-
Malappuram	14	10	8	5	7	14	2	2	-	4	-
Wayanad	5	5	4	3	2	5	3	1	1	2	1
Kozhikode	34	34	31	21	19	34	11	23	11	19	7
Kannur	14	12	11	1	7	14	2	-	-	-	-
Kasaragod	11	8	6	3	4	11	-	1	-	2	-
Total	**292**	**265**	**238**	**169**	**134**	**269**	**52**	**123**	**55**	**56**	**17**

Table 2 Contd...

State/District	Total No. of gardens surveyed	Number of gardens with disease incidence									
		Black pod	Charcoal pod rot	Stem canker	Colletotrichum disease		Vascular streak dieback	Chupon blight / twig dieback	White thread blight	Zinc deficiency	Horse hair blight
					Cherelle rot	Foliar infection					
Karnataka											
Dakshina Kannada	30	30	30	23	21	30	-	30	7	8	5
Coorg	11	8	5	1	6	11	-	5	2	1	-
Uduppi	11	11	11	4	7	11	-	8	1	3	-
Uttara Kannada	17	16	10	1	13	17	-	14	-	2	1
Chikkamagalooru	17	15	13	2	7	17	-	13	-	-	-
Shimoga	9	9	7	3	2	9	-	5	-	-	1
Mysore	10	10	9	-	4	10	-	3	-	-	-
Total	**105**	**99**	**85**	**34**	**60**	**105**	**-**	**78**	**10**	**14**	**7**
Tamil Nadu											
Coimbatore	23	16	20	21	17	23	-	4	2	19	1
Kanyakumari	8	8	3	2	2	8	-	2	-	1	-
Total	**31**	**24**	**23**	**23**	**19**	**31**	**-**	**6**	**2**	**20**	**1**
Andhra Pradesh											
East Godavari	32	17	19	32	32	32	-	6	-	32	-
West Godavari	30	11	9	30	30	30	-	3	-	30	-
Total	**62**	**28**	**28**	**62**	**62**	**62**	**-**	**9**	**0**	**62**	**0**
Total gardens	**490**	**413**	**374**	**288**	**275**	**467**	**52**	**216**	**67**	**152**	**25**

- Not observed

Black pod caused by *P.palmivora*

Charcoal pod rot caused by *Lasiodiplodia theobromae*

Chupon blight caused by *P.palmivora*

Cocoa garden with zinc deficiency

Symptoms of zinc defiency

Knob gall

Rotting of cherelles and young pods caused by *Colletotrichum gloeosporioides*

Seedling blight caused by *P.palmivora*

Stem canker caused by *P.palmivora* (External lesion)

Stem canker caused by *P.palmivora* (Internal lesion)

J.Res. ANGRAU 39(4)51-56, 2011

A SWOT ANALYSIS ON TEA CULTIVATION IN EASTERN REGION OF NEPAL

KESHAV KATTEL, R. VASANTHA, M. JAGAN MOHAN REDDY AND P. PRASHANTH
Department of Agricultural Extension, College of Agriculture
Rajendranagar, ANGR Agricultural University, Hyderabad-500 030

ABSTRACT

Tea is a major crop in the eastern districts of Nepal. It plays an important role in rural employment, women empowerment and poverty alleviation. The increasing area and production of tea over the last decade has suddenly come to a halt due to many inherent weaknesses and external threats. Keeping these things in mind, a research was carried out to unearth the strengths, weaknesses, opportunities and threats of tea cultivation in Nepal and to formulate suitable strategies for its development. The higher profits from tea cultivation and the plantations can be raised on hilly and slopy lands were some of the strengths, increasing pests and disease problems and high initial investments to be made were some of the weaknesses, congenial climate for tea cultivation and availability of markets in the vicinity were some of the opportunities and inadequate government support and frequent price slashes were some of the threats of tea cultivation in Nepal as indicated by farmers. Based on the results of SWOT, several strategies were suggested for the development of the tea sector such as research and extension, infrastructure development, market regulation, etc.

Agriculture is the major source of Nepalese economy where it provides employment to about 66 per cent of the population. About 26 million hectares of land is under cultivation in Nepal. Tea is an important crop in the eastern districts of Nepal. The total area under tea cultivation in Nepal is 16718 hectares which gives a total production of 16208127 kg of made tea annually (Anonymous, 2010). About 46 per cent of the total area under tea is shared by small farmers. More than 40920 family members of the 8184 small farmers of the region are dependent on tea cultivation (Warakaulle *et al*., 2007). The productivity of tea in Nepal is lower than its neighbouring country India. Also, these farmers are not getting enough prices for their tea leaves coupled with increase in cost of production which has resulted in the stagnation of area under tea cultivation in recent years. Tea is a permanent cash crop. It needs a huge investment to be made during the initial periods of garden establishment. A sudden failure of the tea industry due to any reason can yield disastrous result to the farmers. With this backdrop documented from secondary sources of information, an in depth SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was done in the present study to unearth SWOT in tea cultivation from farmers perspective to provide suitable strategies for its development. Moreover, such type of research is not conducted on this sector till date.

MATERIAL AND METHODS

An exploratory research design was carried out in the study. Jhapa and Ilam districts of the easternmost part of Nepal representing different ecological regions ie, Hills and Terai were selected for the study. Three Village Development Committees (VDCs) from each district were randomly picked and 15 farmers from each VDC were selected thus making a total of 90 respondents. An exhaustive list of twelve numbers of selected parameters in tea cultivation was prepared by thorough consultation with experts and experienced farmers. The parameters were Climate and soil, Crop characteristics, Input availability, quality and costs, Employment, Market and exports, Infrastructure, Government policies and support, Quality and price of tea leaves, Extension and research, Crop yield and economics, Organizations involved and Area under tea cultivation. The respondents were asked to indicate strengths, weaknesses, opportunities and threats associated with each and every selected parameter in tea cultivation and rank them. For each of these ten important strengths, weaknesses, opportunities and threats, Rank Based Quotients (RBQ) were calculated and presented in tables.

RESULTS AND DISCUSSION

The important ten strengths, weaknesses, opportunities and threats in tea cultivation based on rank based quotients are presented in ascending order of ranks from 1 to 10 in Tables 1 to 4.

kattel_k@yahoo.com

Table 1. Strengths ranking of respondents

S. No.	Strengths	Remarks									
		I	II	III	IV	V	VI	VII	VIII	IX	X
1	Higher profits than other crops	34	28	18	10	-	-	-	-	-	-
2	Hilly slopes and undulating lands not suitable for other crops can be effectively utilized for tea cultivation	27	19	20	24	-	-	-	-	-	-
3	Suitable acidic and fertile soils for tea cultivation	9	15	20	15	19	12	-	-	-	-
4	Regular cash generation from short term harvests (7-10 days interval)	10	8	7	9	8	10	18	20	-	-
5	Permanent cash crop giving returns up to 50 years	10	11	6	5	11	9	12	9	17	-
6	Easy availability of inputs such as pesticides, fungicides, etc in domestic market	-	9	7	10	14	8	9	14	19	-
7	Young age bushes of existing gardens (10-15 yrs) producing good quality leaves	-	-	12	9	12	11	8	17	11	10
8	Easy maintenance in terms of trails and drain maintenance, manuring and pruning, etc.	-	-	-	8	14	13	12	11	12	20
9	Family labour can be employed in small farms for majority of operations viz., spraying, manuring, trails and drainage maintenance, irrigations, etc.	-	-	-	-	12	16	12	13	14	23
10	Not damaged by wild animals like elephants which is a common havoc in terai	-	-	-	-		11	19	6	17	37

Table 2. Weaknesses ranking of respondents

S. No.	Weaknesses	Remarks										RBQ
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1.	Increasing pests and disease problems viz., rust, blister blight, sucking pests, loopers, etc.	29	22	12	9	13	5	-	-	-	-	83
2.	High initial investments ranging from Rs. 90,000 to 1,00,000/ha	24	10	19	15	22	-	-	-	-	-	80
3.	Shortage of labour for large scale tea cultivation for practices such as making holes, planting, filling pits, mulching, wedding, etc.	12	10	17	12	11	5	13	-	-	-	69
4.	Long gestation period required (5-7 years) for initial commencement of harvests.	15	13	11	17	9	7	18	-	-	-	71
5.	Poor quality of inputs such as pesticides, fungicides and fertilizers	10	15	22	11	15	7	-	-	10	-	70
6.	Higher input costs	-	19	9	17	11	22	12	-	-	-	65
7.	High costs of cultivation (maintenance) ranging from Rs. 40,000 to 65,000/ha per year	-	1	-	5	7	25	28	15	9	-	43
8.	Lack of farm infrastructure	-	-	-	4	-	5	13	25	16	27	27
9.	Low yields than neighbouring Indian regions	-	-	-	-	2	4	6	25	28	25	24
10.	Very low shelf life of green leaves (less than 10-12 hours after harvest)	-	-	-	-	-	-	-	25	27	38	19

Table 3. Opportunities ranking of respondents

S. No.	Weaknesses	Remarks										RBQ
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1.	Congenial climate for tea cultivation in terms of relative humidity, rainfall, temperature, etc.	34	21	27	8	-	-	-	-	-	-	89
2.	Availability of markets in the vicinity in Terai region	28	21	29	12	-	-	-	-	-	-	87
3.	Scope for higher yields as the bushes grow old	23	15	19	17	12	4	-	-	-	-	81
4.	New processing units under construction in Ilam district for processing of increasing volume of green leaves in a long run	5	19	12	27	15	12	-	-	-	-	73
5.	Small scale cottage industries slowly coming up at village level for tea processing	-	4	3	15	28	22	18	-	-	-	57
6.	Increasing number of cooperative societies and farmer organisations such as HOTPA, HIMCOOP, etc.	-	10	-	11	13	25	17	14	-	-	53
7.	Cheaper than Indian tea so more scope for exports	-	-	-	-	22	15	11	17	25	-	39
8.	Scope for organic and other speciality teas such as green tea as consumer awareness is growing	-	-	-	-	-	12	25	29	19	5	32
9.	Possibility of procuring inputs such as clones, implements, hormones, etc from the Indian border	-	-	-	-	-	-	9	25	29	27	22
10.	Supervision and guidance available from local tea consultants	-	-	-	-	-	-	10	5	17	58	16

Table 4. Threats ranking of respondents

S. No.	Weaknesses	Remarks										RBQ
		I	II	III	IV	V	VI	VII	VIII	IX	X	
1.	Inadequate government support in terms of providing subsidies/loans/special concessions/privileges for tea growers	28	32	22	8	-	-	-	-	-	-	89
2.	Frequent price slashes due to changes in export policies or unregulated domestic markets	25	29	19	17	-	-	-	-	-	-	87
3.	Ineffective Extension and Research on tea by NTCDB	15	22	20	17	16	-	-	-	-	-	80
4.	Migration of labour to cities and towns for the sake of higher wages leading to shortage	12	7	15	27	19	10	-	-	-	-	73
5.	Green leaves to be sold only in domestic market due to ban on Indian traders	10	-	14	12	27	15	12	-	-	-	65
6.	Lack of proper approach roads from farm gate to markets	-	-	-	9	19	22	15	15	10	-	46

S. No.	Weaknesses	Remarks										RBQ
		I	II	III	IV	V	VI	VII	VIII	IX	X	
7.	Frequent transport strikes causing huge losses	-	-	-	-	7	19	28	25	11	-	38
8.	Malpractices by middleman leading to low prices for farmers and high prices in market	-	-	-	-	2	20	28	18	12	10	35
9.	Lack of market information services such as demand, supply, prices (local and international), etc.	-	-	-	-	-	4	5	19	28	34	21
10.	Dependency on technicians across the border especially for nutrition and pests management	-	-	-	-	-	-	2	13	29	46	17

Based on the SWOT analysis on tea cultivation in Nepal, 5 types of strategies were presented for various sectors that are associated with tea for the further promotion of the Nepalese tea industry. They can be described as below:

1. Strategies for the Policy Makers

1.1 Infrastructure Development

Tea farmers are severely hampered by the lack of approach roads in their area and also lack of electricity. Hence, rural infrastructure development is utmost necessary for the development of tea cultivation in Nepal which has to be addressed by the Government of Nepal.

There are no laboratories or survey companies capable of conducting tests and analyses. Therefore there is a need to have a well equipped laboratory in Nepal. The existing Government Food Testing Laboratory should be strengthened with a mandate to do commercial testing of export samples of all agricultural products.

1.2 Provision of Loans and Subsidies to farmers

The Nepal Rastra Bank has put the tea credit in its 'bad portfolio' due to non repayment of credits which is hampering the needy farmers (CADP, 2008). A well-designed procedure for loan sanctions and repayment schedule considering the gestation period of the crop need to be followed to avoid further defaults. Loans for establishing processing plants also need to be granted.

1.3 Loans and Subsidies for input industries

Lack of quality inputs and their exorbitant costs are the major problems in tea cultivation. The state machinery should effectively patrol the borders so that import of inferior quality inputs not only to the tea industry but also to agricultural crops in totality is restricted by not allowing substandard and banned products. Policy decisions are to be taken for sanctioning loans and subsidies for input industries so that inputs can be produced domestically.

1.4 Facilities for Cold Chain

Provision of cold chains helps to ensure the quality of tea leaves remain intact even after hours of tea plucking in the case of distant farms and road blockages which is common in Nepal. The policy makers should take steps to initiate this cold chain from farm gate to import country through Public Private Partnership Mode.

1.5 Creation of tea based employment avenues

Establishment of input industries, new processing units, small scale cottage industries, nurseries, etc will open doors for increased avenues for employment for all sectors of people including labour which can reduce the problem of migration. Also, farm mechanization can be promoted by providing opportunities for duty free imports of the implements for tea cultivation. However, there is a problem of unwanted political interference in the tea sector. For this, certain stringent measures in tea zones such as prohibition of strikes in declared tea zones should be implemented, government should also support the factories to run their business in the best practical manner to achieve quality products without allowing labour or outside influences to dictate terms to factory staff on good management practices.

2. Strategies for Research and Extension

Government of Nepal, keeping the prevailing constraints in research and extension in mind and also realising the prospects in International market should immediately establish a research station specifically for tea with all relevant divisions undertaking work on tea production. Nepal Agriculture Research Council (NARC) is the sole organisation for research in agriculture in Nepal and Tea should also be incorporated into its mandate and research activities should be initiated. For this research scientists should be recruited for undertaking research on tea. Research should concentrate on developing location specific package of practices for orthodox, organic, speciality and value added tea. As problem of pests and diseases is increasing day by day, research should focus on the development of HYV's, resistant varieties to get better improvement in leaf quality.

National Tea and Coffee Development Board (NTCDB) is responsible for the extension of latest tea cultivation technologies. There is an acute shortage of experts in tea cultivation and extension functionaries. Hence, there is a need to establish a tea training centre or tea school to develop human resources required for the tea sector. Extension staff should popularise the technologies developed by research on orthodox, speciality and value added tea through trainings and demonstrations. NTCDB should also initiate steps towards establishment of a Village Knowledge Centre or an Information Kiosk for single window delivery of services and inputs to tea cultivators. It should contain infrastructure such as computer, internet, printer, fax, camera, etc for fast transfer of technology and problems from extension agents to farmers and farmers to extension agents respectively.

3. Strategies for Non-Government Organisation

With the increase in numbers of non-government organisations in the tea growing areas, they should focus on location specific research on tea. They should develop suitable package of practices on concepts of NonPesticidal Management, Integrated Pest Management and Organic tea cultivation. The formation of self-help groups, commodity interest groups and capacity building of farmers should be the prime focus of the non-government organisations. In addition, they should also focus on establishing nurseries by adopting superior clones.

4. Strategies for Market Regulating Agencies

4.1 Regulation of Market

The problems of unregulated market and price fluctuations were to be addressed by the concerned authority and provide an environment where there is a win-win situation for the producers as well as the processors. Also, a high level committee need to be created to fix minimum prices of the tea leaves depending upon the internal and external demands of tea and the cost of cultivation incurred by the farmers. A central marketing facility such as auction house need to be established for buying and selling of Nepal tea. Moreover, the market information services are rather poor in Nepal. Proper infrastructure should be developed to provide timely information to the farmers about the market prices. Necessary steps should be taken to make minimal interference of middlemen.

4.2 Regulating the Quality of the products

The marketing regulating agencies should ensure uniform quality of the Nepalese tea. For this extension workers should educate farmers on production of good quality leaves and export oriented production. Since the tea leaves are marketed within 10-12 hours after plucking, proper transportation and cold storage facilities are to be developed. Scientific handling, harvesting and storage facilities should be advocated to the farmers.

4.3 Export Marketing

Government of Nepal should be more prudent to work with marketing and distributing companies who are experienced in handling food items and specifically beverages and tea. As the orthodox tea is considered a special product, it would also be more beneficial to work with the Speciality Tea Associations and such bodies established in a number of countries.

5. Strategies for processing factories and other industries

Factory and industry people should make exhaustive discussions and interactions with the policy makers and strive to get grants for establishment of processing industries, labs, facilities for export, etc. Since the importance for organic tea is increasing organic certification facilities should be developed. Efforts should be made to make packing materials free from import duties.

REFERENCES

Anonymous. 2010. Smarika: Tea and Coffee. National Tea and Coffee Development Board. New Baneshwor, Kathmandu.

Commercial Agriculture Development Project. 2008. Final Report Product Chain Study Orthodox Tea. Ministry of Agriculture and Cooperatives, Department of Agriculture, Nepal.

Warakaulle, Mahinda, Ramesh Munankami and Bastiaan Bijl. 2007. Sector study on Tea. International Trade Centre, UNCTAD/WTO.

Reserch Notes
J.Res. ANGRAU 39(4)57-58, 2011

SEED YIELD OF DHAINCHA (*Sesbania aculeata)* AS INFLUENCED BY SOWING DATES AND PLANT DENSITIES DURING RABI SEASON

R. SANGEETHA, M. YAKADRI, M. SRINIVASA RAJU and A. SAI RAM
Department of Agronomy, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad – 500030

Dhaincha (*Sesbania aculeata)*, being quick growing, succulent and easily decompostable, is grown as green manure crop to increase crop productivity and to sustain the soil fertility. It also withstands salinity or alkalinity and poor drainage situation better than other crops. A lot of work on its utility as green manure crop has been done (Shah *et al*., 2000). But no serious efforts were made to develop proper agronomic practices for seed crop of Dhaincha in Southern Telangana Zone of Andhra Pradesh in *rabi* season. Keeping this in view the present study was undertaken to evaluate the seed production of Dhaincha as influenced by sowing dates and plant densities.

The experiment was conducted at College of Agriculture, Rajendranagar during *rabi* season of 2010-2011. The soil was sandy clay loam in texture and slightly alkaline in reaction (pH 8.3), medium in organic carbon, low in available nitrogen and medium in available phosphorous and potassium.

The experiment was laid out in a randomized block design with factorial concept, replicated thrice, having fifteen treatment combinations of five sowing dates and three plant densities (table). A basal dose of 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} was applied through urea and single super phosphate, respectively, at sowing time. Irrigation was given as and when required keeping in view the rainfall. During the crop period the rainfall received was 349.8mm, out of which 46.4, 26.8 and 10.3 percent was received in September, October and November respectively. No pest and disease incidence was observed and the crop was weeded twice. The crop was harvested in pickings during the months of February and March, threshed, dried and seed yield was recorded.

Crop sown on September 15 produced higher seed yield of 967 kg ha^{-1} closely followed by that sown on October 1st. Lowest yield of 68 kg ha^{-1} was recorded with November 16th sowing. The significant increase in yield of early sowing over delayed sowing dates might be due to partition of higher proportion of its total dry matter into component parts of the plant. Added to the above, better growth and development of crop at this date when compared to other dates of sowing in aspects might have reflected in better yield expression. Same trend was seen in seed yield of Dhaincha in S_1 to S_2 also observed in yield attributes viz., number of pods $plant^{-1}$, seeds pod^{-1} and test weight which have played prominent role. More particularly increased seed per pod gave much impetus to seed yield. Kumar and Singh (1998) also expressed similar views of that higher seed yield with the early sown crop due to more congenial growth conditions during the crop period and sufficient time to complete all physiological processes properly than late sown crop. The yield reduction with delayed sowings may be the cumulative effects of lower values of growth and development. Besides, the reduction in yield with delayed sowing dates can also be attributed to unfavourable weather conditions viz., low temperature with low sunshine hours experienced by the crop.

Higher seed yield (630 kg ha^{-1}) was produced with highest plant density of 74,000 plants ha^{-1} (45 cm x 30 cm) closely followed by that from 60 cm x 30 cm spacing, while the lowest seed yield of 522 kg ha^{-1} was observed at the lowest plant density of 37,000 plants ha^{-1} (90 cm x 30 cm). Though all the yield attributing characters were higher at wider spacings, these improvements were not sufficient to compensate the loss in plant population per unit area from closer spacing. Similar increase in seed yield at closer spacing was also reported by Yaragoppa *et al*. (2003), Kumar *et al*. (2006). Early sowing (September 15) and closer spacing (45 cm x 30 cm) contributed to higher seed yield which inturn increased the gross returns, net returns and Benefit – cost ratio. Ulemale and Shivankar (2003) also reported similar findings in sunhemp.

sangeetharegu@gmail.com

Table 1. Effects of dates of sowing and plant densities on yield and yield attributes of Dhaincha

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	Seed yield (kg ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
DATES OF SOWING						
S_1 – September 15	38.88	30.88	967	24179	17229	2.12
S_2 – October 1	37.22	30.44	935	23374	16424	2.31
S_3 - October 16	34.88	29.22	772	19302	12373	1.60
S_4 – November 1	8.00	28.55	205	5133	-1817	-0.23
S_5 - November 16	4.00	22.33	68	1711	-5239	-0.68
SE (m)±	0.44	0.57	16	422	423	0.07
CD at 5 %	1.27	1.66	48	1222	1225	0.21
PLANT DENSITIES						
D_1 - 74,000 plants ha^{-1} (45 cm x 30 cm)	23.40	26.80	630	15758	8608	1.08
D_2 – 55,000 plants ha^{-1} (45 cm x 30 cm)	24.46	29.20	616	15408	8470	1.10
D_3 – 37,000 plants ha^{-1} (90 cm x 30 cm)	25.93	28.86	522	13054	6304	0.88
SE (m)±	0.34	0.44	13	327	38	0.05
CD at 5 %	0.98	1.29	37	947	949	0.16

REFERENCES

Kumar, S., Singh, R. C and Kadian , V. S. 2006. Response of dhaincha (*Sesbania aculeata)* genotypes to sowing dates and row spacing. *Indian Journal of Agronomy*. 51 (2): 152-153.

Kumar, R and Singh, N.P. 1998. Effect of dates of sowing on growth and yield of cowpea (*Vigna unguiculata* (L.) Walp). *Legume Research*. 21(1): 54-56.

Shah, R.R., Rai, R.K and Mukherjee, P.K. 2000. Effect of green manuring dhaincha and phosphorous on growth, yield and phosphorous uptake by wheat. *Indian Journal of Agronomy*. 45 (4): 707-710.

Ulemale, R.B and Shivankar, R.S. 2003. Effect of sowing dates, row spacings and phosphate levels on yield and economics of sunhemp. *Legume Research*. 26(1): 71-72.

Yaragoppa, S.D., Desai, B.K., Halepyati, A.S and Pujari, B. T. 2003. Influence of plant densities and phosphorus management on growth and seed yield of *Sesbania aculeate* (Wills.) Poir. *Karnataka Journal of Agricultural Science*. 16(2): 297-299.

Reserch Notes
J.Res. ANGRAU 39(4)59-62, 2011

EFFECT OF LEVELS OF NITROGEN AND POTASSIUM ON YIELD, UPTAKE AND ECONOMICS OF POTATO GROWN ON ALFISOLS OF ANDHRA PRADESH

D. VIJAYA LAKSHMI, G. PADMAJA AND P. CHANDRASEKHAR RAO
Dept. of Soil Science & Agricultural Chemistry, College of Agriculture
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030

Potato production depends on many factors, among them judicious application of N and K plays a vital role. Keeping in view the significance of N and K on productivity of potato, field experiment was conducted on a sandy loam soil (Alfisol) at College Farm, College of Agriculture, Rajendranagar, Hyderabad during *rabi* seasons of 2009-10. The experiment was laid out in Randomized Block Design with factorial concept consisting of sixteen treatment combinations with four levels of nitrogen (0, 60, 120 and 180 kg ha^{-1}) and four levels of potassium (0, 60, 120 and 180 kg ha^{-1}). Nitrogen and potassium were applied in the form of urea and muriate of potash in 3 splits as per treatment combinations. A basal dose of 60 kg P_2O_5 ha^{-1} was applied in the form of single super phosphate to all the treatmental plots.

The experimental soil is sandy loam in texture, slightly alkaline (7.9 pH) in reaction, non saline (0.58 dS m^{-1}) in nature and low in organic carbon (3.5 g kg^{-1}). The soil under study was Low in available nitrogen (200.7 kg N ha^{-1}), medium in available phosphorus (32.19 kg P_2O_5 ha^{-1}) and potassium (272.5 kg K_2O ha^{-1}). Dry matter production and tuber yield of potato was recorded at harvest. Plant samples collected at harvest was dried in an oven and analyzed the contents of N and K as per procedure given by Piper (1966). From the yield and content, the uptake was calculated and the data were statistically analyzed. The additional benefit cost ratios for different nitrogen and potassium levels were computed through partial budgeting technique by taking into consideration the additional cost incurred due to imposition of the treatments and the additional returns realized, expressed in monetary terms.

The effect of levels of nitrogen, potassium and their interactions were found to have significant effect on total dry matter production of potato (haulm + tuber) at harvest. The increase in total dry matter production of potato at 180 kg N ha^{-1} level was found to be 7.89, 21.25 and 45.33 per cent over 120, 60 and 0 kg N ha^{-1}, respectively. With regard to potassium levels, the increase in total dry matter production of potato at 180 kg K ha^{-1} level was found to be 4.47, 11.73 and 24.49 per cent over 120, 60 and 0 kg K ha^{-1}, respectively. The per cent increase in dry matter production at $N_{180}K_{180}$, compared to control (N_0K_0) was 76.1 (Table 1). Nitrogen showed significant effect on vegetative growth which was reflected through increase in dry matter production with increase in levels of nitrogen (Malik *et al.,* 2002). Potassium plays an important role in translocation of assimilates at different growth stages (Bhattacharya *et al.,* 2009).

The effect of levels of nitrogen, potassium and their interactions had significant effect on tuber yield of potato (Table 1). The tuber yield increased to an extent of 29.2 (60 kg N ha^{-1}), 65.8 (120 kg N ha^{-1}) and 92.0 per cent (180 kg N ha^{-1}) over no N application. Similarly, K application increased the tuber yield by 24.1, 50.9 and 62.9 per cent at 60, 120 and 180 kg K_2O ha^{-1}, respectively over no K application. The results revealed that the increase in potato tuber yield was mainly influenced by nitrogen levels rather than potassium levels. Among the interactions, $N_{180}K_{180}$ recorded higher tuber yield (223.9 q ha^{-1}) but it was on par with $N_{180}K_{120}$ (214.6 q ha^{-1}) and significantly superior over lower interactions. Higher rate of nitrogen provides better growth, development and translocation of photosynthates from source to sink (tuber) which resulted in higher yield of tubers (Patel and Patel, 2001). Potassium promotes large size of tubers by increasing water accumulation in tubers resulting in higher tuber yield (Perrenoud, 1993). Higher tuber bulking rate over tuber bulking period resulted in higher yield at high fertility level as reported by Malik and Ghosh, (2002).

e-mail: soilprabhakar@gmail.com

Table 1. Effect of levels of nitrogen, potassium and their interactions on total dry matter production (kg ha^{-1}) and tuber yield (q ha^{-1}) of potato at harvest

Levels	Total dry matter production (kg ha^{-1})					Tuber yield (q ha^{-1})				
	K_0	K_{60}	K_{120}	K_{180}	**Mean**	K_0	K_{60}	K_{120}	K_{180}	**Mean**
N_0	2036.4	2237.3	2376.0	2591.1	**2310.2**	67.33	84.3	112.3	133.1	**99.26**
N_{60}	2393.5	2748.0	2876.5	3057.9	**2768.9**	85.01	122.7	147.2	158.0	**128.2**
N_{120}	2722.8	3038.0	3272.8	3413.9	**3111.9**	133.4	154.4	178.1	192.2	**164.5**
N_{180}	3003.9	3294.7	3545.6	3584.8	**3357.3**	148.9	174.8	214.6	223.9	**190.5**
Mean	**2539.2**	**2829.5**	**3017.7**	**3161.9**		**108.7**	**134.1**	**163.1**	**176.8**	

	S.Ed±	CD (5%)	S.Ed±	CD (5%)
N	10.28	20.99	3.14	6.42
K	10.28	20.99	3.14	6.42
N × K	20.55	41.98	6.28	12.83

N – Nitrogen K – Potassium

Table 2. Effect of levels of nitrogen, potassium and their interactions on total N and K contents (%) in potato tuber at harvest

Levels	Total N content (%)					Total K content (%)				
	K_0	K_{60}	K_{120}	K_{180}	**Mean**	K_0	K_{60}	K_{120}	K_{180}	**Mean**
N_0	2.78	2.89	3.07	3.02	**2.94**	3.07	3.23	3.37	3.44	**3.28**
N_{60}	3.04	3.13	3.16	3.23	**3.14**	3.32	3.46	3.55	3.64	**3.50**
N_{120}	3.32	3.36	3.43	3.47	**3.39**	3.44	3.64	3.85	3.94	**3.72**
N_{180}	3.50	3.58	3.66	3.76	**3.62**	3.80	4.01	4.15	4.23	**4.05**
Mean	**3.16**	**3.24**	**3.33**	**3.37**		**3.41**	**3.58**	**3.73**	**3.81**	

	S.Ed±	CD (5%)	S.Ed±	CD (5%)
N	0.02	0.04	0.008	0.017
K	0.02	0.04	0.008	0.017
N×K	0.04	0.07	0.017	0.034

Table 3. Effect of levels of nitrogen, potassium and their interactions on total N and K uptake (kg ha^{-1}) by potato (haulm + tuber) at harvest

Levels	Total N uptake (kg ha^{-1})					Total K uptake (kg ha^{-1})				
	K_0	K_{60}	K_{120}	K_{180}	**Mean**	K_0	K_{60}	K_{120}	K_{180}	**Mean**
N_0	56.52	64.66	73.03	78.24	**68.11**	62.45	72.29	80.09	89.06	**75.97**
N_{60}	72.75	86.04	90.85	98.66	**87.07**	79.52	95.04	102.2	111.4	**97.78**
N_{120}	90.26	102.0	112.3	118.4	**105.7**	93.78	110.6	126.1	134.6	**116.3**
N_{180}	105.2	117.9	129.6	134.8	**121.9**	114.2	132.0	147.3	151.6	**136.3**
Mean	**81.17**	**92.65**	**101.5**	**107.5**		**87.48**	**102.5**	**113.9**	**121.7**	

	S.Ed±	CD (5%)	S.Ed±	CD (5%)
N	0.58	1.18	0.45	0.93
K	0.58	1.18	0.45	0.93
N × K	1.15	2.36	0.91	1.85

Table 4. Effect of levels nitrogen, potassium and their interactions on additional benefit cost ratio of potato

Levels	Additional Benefit Cost Ratio				
	K_0	K_{60}	K_{120}	K_{180}	**Mean**
N_0	-	30.42	47.33	49.04	**42.26**
N_{60}	24.84	50.22	52.44	48.07	**43.89**
N_{120}	52.57	52.82	54.31	51.36	**52.77**
N_{180}	45.28	49.00	56.98	52.61	**50.97**
Mean	**40.90**	**45.62**	**52.76**	**50.27**	

Combined application of nitrogen and potassium had synergistic effect on nutrient content (Table 2). The higher content of nutrients under higher N and K levels can be attributed to an increase in root proliferation through the action of nitrogen on cellular activities and translocation of certain growth stimulating compounds to roots, which in turn helped in better tuber growth and uptake of nutrients (Sharma and Sood, 2002). Rai *et al*. (2002) reported that application of N increased the K content in tubers, which suggested that nitrogen improved K utilization by the plant.

The total N and K uptake by potato (haulm + tuber) at harvest showed an increase with increasing levels of nitrogen up to 180 kg N ha^{-1} (N_{180}) and the per cent increase being 78.9 and 79.4 per cent over N_0, respectively. Similarly, the total N and K uptake at K_{180} level increased to an extent of 32.4 and 39.1 per cent over K_0, respectively (Table 3). Among the combinations, $N_{180}K_{180}$ has recorded higher uptake of N and K, the per cent increase being 139.4 and 142.8, respectively, over N_0K_0. The higher uptake at higher N and K levels was due to better absorption of N and K from the fertilizers during the different growth stages of the crop (Chadha *et al*. 2006).

The effect of levels of nitrogen and potassium on additional benefit cost ratio is shown in table 4. Among the nitrogen levels, the highest benefit cost ratio was noticed with N_{120} (52.77) followed by N_{180} (50.97). With regard to potassium levels, the highest benefit cost ratio was recorded with K_{120} (52.76) followed by K_{180} (50.27). Among the interactions, $N_{180}K_{120}$ has recorded the highest benefit cost ratio (56.98) followed by $N_{120}K_{120}$ (54.31).

Though the tuber yield recorded at $N_{180}K_{180}$ level was high, the benefit cost ratio in terms of money invested for one kilogram of fertilizer is not economical. Hence, keeping in view the requirement of nutrients viz., N and K at different growth stages of potato and the net returns, it can be suggested to apply 180 kg N ha^{-1} combined with 120 kg K_2O ha^{1} for better productivity and economic returns from potato grown on light textured red sandy loam soils (Alfisols) of Andhra Pradesh.

REFERENCES

Bhattacharya, A., Borah, D and Saikia, M. 2009. Effect of potassium on growth, total tuber yield and residual status of nutrients on true potato seed transplants. Crop Research 38(1, 2 & 3): 88-91.

Chadha, S., Rana, S.S., Rameshwar, G and Chaudhary, D.R. 2006. Effect of split doses of N and K and FYM levels on the productivity of seed potato in cold desert regions of H.P. Potato Journal 33(1-2): 94-96.

Malik, G.C and Ghosh, D.C. 2002. Effect of fertility level, plant density and variety on growth and productivity of potato. In Potato, Global Research and Development, Volume II, 866-871.

Malik, Y.S., Bhatia, A.K., Singh, N., Nehra, B.K and Khurana, S.C. 2002. Effect of nitrogen, seed size and spacing on potato production in cv. Kufri Sutlej. In Potato, Global Research and Development, Volume II, 861-865.

Patel, J.C and Patel, L. R. 2001. Effect of irrigation and nitrogen on yield attributes in potato. Journal of Indian Potato Association 28(2-4): 285-287.

Perrenoud, S. 1993. Fertilizing for high yield of potato. Bulletin of International Potash Institute, Basel, Switzerland, pp. 58-71.

Piper, C.S. 1966. Soil and Plant Analysis. Inter Science Publishers, New York, pp.59.

Rai, G.K., Verma, M.M and Singh, J. 2002. Nitrogen and potassium interaction effect on yield attributes of potato. Journal of Indian Potato Association 29(3-4): 153-154.

Sharma, R.C and Sood, M.C. 2002. N and K interaction on the tuber yield, quality and organic carbon status of Shimla soils. In Potato, Global Research and Development, Volume II, 843-851.

Reserch Notes
J.Res. ANGRAU 39(4)63-65, 2011

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON SOIL DEHYDROGENASE ACTIVITY, NUTRIENT UPTAKE AND FRUIT YIELD OF TOMATO (*Lycopersican esculentum* L.)

T. CHAITANYA, G. PADMAJA, P. CHANDRASEKHAR RAO and K.B.SUNEETHA DEVI
Dept. of Soil Science & Agricultural Chemistry, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad- 500 030

Keeping in view the significance of organic manures in sustaining the soil health, particularly biological properties of soil and importance of vegetables in human nutrition, an attempt has been made to examine the effect of integrated nutrient management in tomato on dehydrogenase activity in soil, nutrient uptake and yield.

A field experiment was conducted on a sandy loam soil (Alfisol) at Student Farm, College of Agriculture, Rajendranagar, Hyderabad during *kharif* season of 2010. It was laid out in Randomized Block Design with 3 replications and 10 treatments.

The soil was sandy loam in texture. It was slightly alkaline (7.9 pH) in reaction, non saline (0.13 dS m^{-1}) in nature and low in organic carbon (4.6 g kg^{-1}). The soil under study was low in available nitrogen (230.7 kg N ha^{-1}), medium in available phosphorus (25.4 kg P_2O_5 ha^{-1}) and potassium (284.5 kg K_2O ha^{-1}). Dehydrogenase activity in soil (µg TPF produced g^{-1} soil 24 h^{-1}) was assayed at vegetative, flowering and final harvest by the calorimetric determination of 2,3,5-triphenyl formazan produced from the reduction of 2,3,5-triphenyl tetrazolium chloride as described by Casida *et al*. (1964). The plant samples were also analysed for nutrient contents to compute nutrient uptake by plants. Fruit yield was also recorded to know the impact of different treatment combinations under INM.

Significantly highest dehydrogenase activity of 161.0, 177.1 and 133.4 ìg of TPF produced g^{-1} soil d^{-1} was recorded in T_9 (50% VC + 50% PM) at vegetative, flowering and harvest stages of tomato, respectively. The values were on par with those of T_8 (100% PM) and T_4 (100% VC) and significantly superior to those of all other treatments (Table 1). The lowest dehydrogenase activity was found in treatment T_1 (control) at different growth stages. The dehydrogenase activity was found to be low in treatment receiving 100% RDNF (T_5) compared to integrated combinations of organics and fertilizers. This may be attributed to the lack of sufficient substrate i.e., OC with fertilizers which act as energy source for proliferating microbial population. The increased enzymatic activity with increase in manure level may be ascribed to the increased population of microbes, due to increased availability of substrate (OC). Similar results were reported by Reddy and Reddy (2008). Vajantha *et al*. (2010) also reported highest dehydrogenase activity (35.23 µg TPF g^{-1} soil d^{-1}) with application of 100% N through poultry manure to maize crop.

Dehydrogenase activity assayed at different growth stages of tomato showed that the enzyme activity increased from vegetative to flowering and later showed a decrease from flowering to harvest. The sharp increase in the enzyme activity at flowering which coincided with the active growth stage of the crop, enhanced root activity and the release of extra cellular enzymes into soil solutions which resulted in higher rate of mineralization of nutrients in the soil. The results were in conformity with the findings of Reddy *et al*. (2010). The nutrient uptake by plants also showed similar trend (Table 2). The total nutrient uptake by tomato in T_3, T_5 and T_7 were on par with each other and significantly superior over other treatments. The fruit yield was also higher in T_3 (84.97 q ha^{-1}), T_5 (80.73 q ha^{-1}) and T_7 (84.06 q ha^{-1}) and superior over other treatments (Table 2).

The results indicated that combined application of fertilizer (75%) and manure (25%) *viz*., vermicompost or poultry manure helped in sustaining soil productivity and biological activity rather than fertilizer application alone.

E-mail : tukkanichaitanya@gmail.com

Table 1. Effect of INM practices on dehydrogenase activity (µg TPF produced g^{-1} soil 24 h^{-1}) in soil at different growth stages of tomato crop

Treatments	Vegetative stage	Flowering stage	Harvest
T_1 Control	107.7	118.8	88.6
T_2 50% N-F + 50% N-VC	140.5	155.0	115.9
T_3 75% N-F + 25% N-VC	128.8	141.8	106.4
T_4 100% N-VC	160.6	176.3	132.9
T_5 100% N-F	123.1	136.8	101.7
T_6 50% N-F + 50% N-PM	140.2	154.6	115.2
T_7 75% N-F + 25% N-PM	128.6	141.5	106.1
T_8 100% N-PM	160.2	175.6	131.9
T_9 50% N-VC + 50% N-PM	161.0	177.1	133.4
T_{10} 50% N-F + 25% N-VC + 25% N-PM	141.0	155.6	116.7
CD (5%)	3.56	2.35	2.16
SE(d) ±	1.68	1.11	1.02

RDN = 150 kg N/ha

F = Fertilizer
VC = Vermicompost
PM = Poultry manure

Table 2. Effect of INM practices on fruit yield and total nutrient uptake (kg ha^{-1}) by tomato

Treatments	Fruit yield q ha^{-1}	Nutrient uptake (kg ha^{-1})		
		N Uptake	P Uptake	K Uptake
T_1 Control	31.30	47.86	6.80	24.53
T_2 50% N-F + 50% N-VC	75.93	90.01	16.08	53.41
T_3 75% N-F + 25% N-VC	84.97	103.76	17.40	61.82
T_4 100% N-VC	61.73	81.61	14.57	49.26
T_5 100% N-F	80.73	106.35	17.36	60.70
T_6 50% N-F + 50% N-PM	74.77	91.36	15.39	54.21
T_7 75% N-F + 25% N-PM	84.06	104.62	17.26	61.24
T_8 100% N-PM	60.93	82.16	14.46	51.46
T_9 50% N-VC + 50% N-PM	62.77	83.53	15.06	52.47
T_{10} 50% N-F + 25% N-VC + 25% NPM	76.01	90.01	15.95	56.15
CD (5%)	6.52	5.43	0.73	3.49
SE(d) ±	3.08	2.56	0.34	1.65

REFERENCES

Reddy, R.U and Reddy, M.S. 2008. Physical properties of soil as influenced by integrated nutrient management in tomato (*Lycopersican esculentum* L.) – onion (*Ellium cepa*) cropping system. *Journal of Research.* ANGRAU. 2008. 36(2/3): 64-70.

Reddy, T.P., Padmaja, G and Rao, P.C. 2010. Integtated effect of vermicompost and nitrogen fertilizers on soil dehydrogenase enzyme activity and yield of onion-radish cropping system. *Journal of soils and crops*. 20(2): 189-195.

Vajantha, B. Reddy, K. S and Ramavatharam, N. 2010. Effect of integrated nitrogen management on soil enzyme activities in maize. Research on Crops. 11(1): 31-36.

Reserch Notes
J.Res. ANGRAU 39(4)66-69, 2011

IDENTIFICATION OF THERMOTOLERANT SINGLE CROSS HYBRIDS BASED ON TEMPERATURE INDUCTION RESPONSE (TIR) TECHNIQUE IN MAIZE (*Zea mays* L.)

RAJESH P, RAMESH T, FARZANA JABEEN, KESHAVULU K and PRAKASH BABU
Department of Seed Science and Technology, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030

Maize crop in India covers an area of 8.17 million hectares with an production of 19.73 million tonnes and productivity of 2.41 tonnes ha^{-1} (CMIE, 2009-10). The maize area under irrigation has increased marginally from ~11% (1950-51) to ~20% (2009-10). Most of the crop cultivated as rainfed suffers from abiotic stresses. High temperature stress has been the second major abiotic problem after drought, thereby grain yield reduced by >15 per cent (ICAR, 2010). To sustain maize production it has become imperative to breed varieties which tolerate high temperature stress. Single cross hybrids in lieu of double or triple cross hybrids in maize have become popular with farmers and seed industry due to their cost effectiveness in production (ICAR, 2010). TIR technique (Kumar *et al.,* 1999) aids in identification of inbreds / hybrids for their suitability to tolerate high temperature. The present study was therefore taken up to identify high temperature tolerant single cross hybrids.

Plant material

Maize seeds of DHM-117 hybrid (single cross) were pre imbibed for 1 hour and allowed to germinate in petri dishes at room temperature. The germinated seedlings of 1 – 1.5 cm plumule length were used in the study.

Challenging temperature

Seedlings were subjected to different temperatures that ranged from 50 to 55°C and duration of 1, 2 and 3 h and were immediately allowed to recover at 30°C for 72 h in an incubator. At the end of the recovery period the temperature treatment at which 80 per cent mortality of the seedlings occurred was taken as the challenging temperature.

Determination of optimum induction treatments for seedlings

Seedlings were maintained at 35°C for 3 h, 40°C for 3 h and 45°C for 3 h, 35°C-1h + 40°C-1h + 45°C-1 h, 35°C-2 h + 40°C-1 h + 45°C-1 h, 35°C-1 h + 40°C-2 h+ 45°C-1 h and 35°C-1 h + 40°C-1 h + 45°C-2 h and immediately transferred to the challenging temperature.

Recovery growth

Seedlings subjected to challenging temperature were allowed to recover at room temperature for 72 h. At the end of recovery, the per cent survival was recorded. Simultaneously a set of seedlings maintained at room temperature throughout the experimental period were considered as absolute control.

Genetic variability for thermotolerance in maize

Fifteen selected maize genotypes were evaluated for temperature tolerance. Seedling survival was assessed in these selected genotypes. Desirable genotypes were identified by collecting the data on two parameters *i.e.,* survival during recovery and per cent reduction of survival in induced over absolute control. Tolerant genotypes were identified by plotting Z-distribution for the stated two parameters (Rajesh, 2011). Genotypes were categorized into one of the four possible quadrants *viz*., highest per cent reduction over absolute control and highest absolute growth during recovery (highly tolerant hybrids), high per cent reduction over absolute control and high absolute growth during recover (moderately tolerant hybrids), low per cent reduction over absolute control and low absolute growth during recovery (moderately susceptible) and lowest per cent reduction over

Email: thatikunta_r@rediffmail.com

absolute control and lowest absolute growth during recovery (highly susceptible).

Validation of maize hybrids for thermotolerance

The experiment material was further validated by allowing the seedling to grow up to twenty one days in plastic containers and their growth was assessed. The supporting data for temperature tolerance was recorded in terms of two parameters namely dry weight and chlorophyll content estimated following Arnon (1949).

Optimum lethal temperature

Exposure to 53°C for 3 h resulted in 80 per cent mortality of seedlings. Hence, 53°C for 3 h was considered as optimum lethal temperature for per cent seedling survival. Senthil kumar *et al*., (2003) had fixed the lethal temperatures at 51°C for 2 h in sunflower. Gangappa *et al.,* (2006) found 55°C for 3 h as lethal temperature in groundnut and Lakshmamma and Lakshmi Prayaga (2006) recorded 49°C for 2 h as lethal temperature for seedling survival in castor.

Optimum induction temperatures

The Seedlings exposed to the gradual induction temperature (35°C-1h + 40°C-1h + 45°C-2h) prior to the challenging temperature exhibited higher seedling survival (64 %) compared to those exposed to other induction treatments (24 – 49 %) and the non-induced seedlings (19 %). Gangappa *et al.,* (2006) in groundnut found 35°C-1h + 40°C-1h + 45°C-2h as induction temperature whereas Lakshmamma and Lakshmi Prayaga (2006) in castor fixed induction temperatures at 30°C + 40°C + 45°C for 2 + 2 + 1h. Srinivas *et al.,* (2006) in sunflower reported induction temperatures of 30°C + 40°C + 45°C for 2 + 1 + 1h, where 90 per cent seedlings survived even after exposure to lethal temperatures. The observed higher recovery growth in induced seedlings can be attributed to the enhanced expression of genes during induction (Lindquist and Craig, 1988). Other studies clearly showed that genetic variability for the stress response could only be seen upon exposure to an induction stress (Venkatachalayya *et al*., 2002).

Assessment of genetic variability in maize genotypes

The per cent seedling survival was recorded at the end of recovery period in fifteen maize hybrids. Superior survival per cent was recorded in five genotypes *viz*., 30V92 (195%), RHM20 (194%), RHM25 (181%), Kaveri50 (181%) and FMH8899 (181%) (Table.1). Based on Z-Distribution analysis, the maize genotypes were distributed into four categories namely highly tolerant types (RHM25, Kaveri50, 30V92), moderately tolerant types (KHM225, 30B11, RHM20, PAC740, FMH8899), moderately susceptible types (KHM218, Syngenta 1, RHM7, RHM4) and highly susceptible types (GHM145, GK3060, BIO9637).

Following similar protocols thermotolerant lines were identified from sunflower population, cv. Modern, parental lines (CMS-234 A, CMS-234 B and 6D-1) of sunflower hybrid KBSH-1 (Senthilkumar *et al*., 2003), sunflower (Srinivas *et al*., 2006), and groundnut (Gangappa *et al*., 2006). Genetic variability among pea genotypes was assessed by subjecting to Z-analysis and the genotypes were grouped into thermotolerant and susceptible genotypes (Venkatachalayya, 2002).

Validation of maize hybrids for thermotolerance

Upon perusal of data it has been clear that induction treatments influenced all the growth stages studied. Superior hybrids in terms of per cent reduction of dry weight in induced over absolute control were RHM25 (33%), Kaveri50 (36%) and 30V92 (38%) (Table.1). The same three genotypes RHM25, 30V92 and Kaveri50 recorded 82.43, 78.41, and 78.16 % superiority in CSI respectively.

TIR was found to be a potential technique to identify thermotolerant hybrids. Present study elicited the variation among the genotypes for temperature tolerance. The plant characters that showed consistency for temperature tolerance included seedling survival, recovery growth, dry weight and chlorophyll stability index. Among the fifteen genotypes studied, RHM25, Kaveri50 and 30V92 showed acquired tolerance. These temperature tolerant hybrids as such can straight away be recommended for cultivation as single cross hybrids or utilized in breeding programmes to select segregating material for future use.

Table 1. Seedling survival per cent, dry weight and chlorophyll stability index (CSI) of fifteen maize hybrids

Maize Hybrids	Per cent increase in survival of induced over non-induced	Per cent reduction in dry weight of induced over absolute control	CSI in induced seedlings (%)
KHM218	95	57	71.60
KHM225	141	52	62.64
RHM4	131	48	62.83
RHM7	106	47	78.63
RHM20	194	47	80.59
RHM25	181	33	82.43
PAC740	105	45	76.87
FMH8899	181	43	73.85
GK3060	108	67	64.32
BIO9637	122	71	74.72
30V92	195	38	73.41
30B11	131	46	76.89
Kaveri50	181	36	78.16
Syngenta1	119	51	69.60
GHM145	117	54	71.93
S E(m)	-	-	2.01
CD at 5%	-	-	5.81

REFERENCES

Arnon, D.T. 1949. Copper enzymes in isolated Chloroplast polyphenol oxidase in Beta vulgaris. *Plant Physiology*. 24: 1-15.

CMIE. 2010. Crop Statistics. Centre for Monitoring Indian Economy (CMIE) Pvt. Ltd. Mumbai. June 1-10.

Gangappa, E., Ravi, K and Veera kumar, G.N. 2006. Evaluation of Groundnut (*Arachis hypogaea* L.) genotypes for temperature tolerance based on Temperature Induction Response (TIR) technique. *Indian Journal of Genetics and Plant Breeding*. 66(2):127-130.

ICAR (2010). Abiotic Stressess in Maize. Some Issues and Solutions. Directorate of Maize Research, Pusa Campus, New Delhi-110012.

Kumar, G., Krishnaprasad, B. T., Savitha, M., Gopalakrishna, R., Mukhopadhyay, K., Ramamohan, G and Udaya Kumar, M. 1999. Enhanced expression of heat shock proteins in thermotolerant lines of sunflower and their progenies selected on the basis of temperature induction response (TIR). *Theoretical and Applied Genetics* 99: 359–367.

Lakshmamma, P and Lakshmi Prayaga. 2006. Screening Castor (*Ricinus communis* L.) germplasm lines for thermal tolerance. *Journal of Oilseeds Research*. 23(2):353-355.

Lindquist, S and Craig, E.A. 1988. The heat shock proteins. *Annual Review of Genetics.* 22: 631-677.

Rajesh Paladugu. 2011. Studies on assessment of genetic variability for seed vigour under high temperature in maize (*Zea mays* L.). M.Sc. Thesis, Acharya N. G. Ranga. Agricultural University, Hyderabad, India.

Senthil kumar, M., Srikanth Babu, V., Mohan Raju, B., Ganesh Kumar, V., Shiva Prakash and Uday Kumar. 2003. Screening of inbred lines to develop a thermotolerant Sunflower hybrid using the temperature induction response (TIR) technique: a novel approach by exploiting residual variability. *Journal of Experimental Botany*. 54(392):2569-2578.

Srinivas, B., Kuledeepsingh., Lakshmi and Sudheerkumar. 2006. Screening of Sunflower genotypes by temperature induction response (TIR) technique. *Journal of Oilseeds Research*. 23(2):372-373.

Venkatachalayya Srikanthbabu., Ganeshbabu., Krishna Prasad, B. T., Ramaswamy Gopal Krishna., Madappa Savitha and Makarla Uday kumar. 2002. Identification of Pea genotypes with enhanced thermotolerance using temperature induction response (TIR) technique. *Journal of Plant Physiology*. 159 (5):535-545.

Reserch Notes
J.Res. ANGRAU 39(4)70-72, 2011

COMBINING ABILITY AND HETEROSIS INVOLVING COLD TOLERANT RICE (*Oryza Sativa* L.) GERMPLASM LINES AT SEEDLING STAGE

G. SHIVA PRASAD, L.V. SUBBA RAO, M .SUJATHA, and U. CHAITANYA
Department of Genetics and Plant Breeding, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad – 500 030.

Rice yields are low in Telangana region during *rabi* season due to cold effect. In Telangana region the low temperature vary from 8°C to 16°C starting from December to first fortnight of February. Seedling stage is the most sensitivity one at the whole rice growth stages to cold stress, which severely affects rice yields. Therefore, the development of rice lines with cold tolerance at the seedling stage in rice was taken up by using combining ability analysis.

In the present study, 4 lines were crossed with 4 testers in L X T mating design and the resultant 16 F_1s were used to determine the heterosis, combining ability as well as the gene action on yield and yield components. Roy and Mandal (2001).

The parents used as lines were IR-64, vikas, Krishna Hamsa, MTU1010. Testers were Malida, Ujala Depama, Bhurma bhuki, Parwa Panki. In 2010 *Rabi* season, the F1 hybrids along with parents were grown in trays in green house conditions up to 30 days seedlings to study the effect of cold on Rice seedlings. The seedlings were exposed to cold stress at 8^0C to 10^0C in green house conditions. Observations were recorded on five competitive plants of each plot for five morphological parameters viz. germination %, coleoptile length, seedling growth, radical length and seed vigor.

Significant variances due to lines x testers interaction for all the characters suggested the presence of significant variances for SCA among the hybrids (Table 1). Estimates of highly significant GCA and SCA variances for all the characters indicated the importance of both additive and non additive gene action in the expression of the characters. The ratio of ó2 gca/ó2 sca was less than unity for all the characters and this also indicated pre- ponderence of non- additive genetic variance. It suggested greater importance of non-additive gene action in their expression and indicated very good prospect for the exploitation of non- additive genetic variation for grain and its component characters through hybrid breeding.

IR-64, Ujala Depama and Malida are identified as good general combiners for the germination percentage. IR64 X Ujala Depama, IR64 X Malida and Krishna Hamsa X Bhurma Bhuqi are recorded as good specific combiners for the character germination percentage. IR64 X Ujala Depama, IR64 X Malida and Vikas X Bhurma Bhuqi are good heterotic combinations for the character germination percentage. These results are in accordance with Changrong Ye *et al* (2008).

Krishna Hamsa, MTU1010 and Parwa Panki are recognized as good general combiners for coleoptile length. IR64 X Parwa Panki, IR64 X Bhurma Bhuqi and Vikas X Malida are identified as good specific combiners for the character coleoptile length. Krishna Hamsa X Ujala Depama, Krishna Hamsa X Parwa Panki and MTU-1010 X Ujala Depama are the best heterotic combinations for the character coleoptile length. These results follows the Rahimi *et al* (2010).

Ujala Depama, IR-64 and Krishna Hamsa are good general combiners for the character seedling growth. IR64 X Ujala Depama, Krishna Hamsa X Parwa Panki and MTU1010 X Bhurma Bhuqi are identified as good specific combiners for the character

Email. Shiva0843@gmail.com

Table 1. Good general combiners, good specific combinations and gca effects of parents involved and heterotic combinations for the characters related to cold tolerance.

Character	Good general combiner	Good specific combinations	gca effects	Heterotic combinations (Standard heterosis)
Germination %	IR-64	IR64 X Ujala Depama	20.04	IR64 X Ujala Depama
	Ujala Depama	IR64 X Malida	12.96	IR64 X Malida
	Malida	Krishna Hamsa X Bhurma Bhuqi	3.80	Vikas X Bhurma Bhuqi
Coleoptile length	Krishna Hamsa	IR64 X Parwa Panki	7.36	Krishna Hamsa X Ujala Depama
	MTU1010	IR64 X Bhurma Bhuqi	4.19	Krishna Hamsa X Parwa Panki
	Parwa Panki	Vikas X Malida	2.75	MTU-1010 X Ujala Depama
Seedling growth	Ujala Depama	IR64X Ujala Depama	5.23	Krishna Hamsa X Ujala Depama
	IR-64	Krishna Hamsa X Parwa Panki	4.81	IR64 X Ujala Depama
	Krishna Hamsa	MTU1010 X Bhurma Bhuqi	0.03	IR64 X Malida
Radical length	MTU1010	IR64 X Parwa Panki	711.42	MTU-1010 X Malida
	Krishna Hamsa	IR64 X Bhurma Bhuqi	518.69	MTU-1010 X Ujala Depama
	Parwa Panki	Vikas X Ujala Depama	434.85	IR64 X Bhurma Bhuqi
Seed vigor	IR-64	IR64 X Ujala Depama	865.83	IR64 X Ujala Depama
	Ujala Depama	IR64 X Malida	324.17	IR64 X Malida
	MALIDA	MTU-1010 X Ujala Depama	253.25	Krishna Hamsa X Parwa Panki

seedling growth. Krishna Hamsa X Ujala Depama, IR64 X Ujala Depama and IR64 X Malida are the best heterotic combinations for seedling growth and results are found in accordance with Vanaja *et al* (2000).

MTU1010, Krishna Hamsa and Parwa Panki are good general combiners for the character radical length. IR64 X Parwa Panki, IR64 X Bhurma Bhuqi and Vikas X Ujala Depama are good specific combinations for the character radical length. MTU-1010 X Malida, MTU-1010 X Ujala Depama and IR64X Bhurma Bhuqi are identified as best heterotic combinations for the character radical length. These results are in accordance with Muhammad Rashid *et al.* (2007).

IR-64, Ujala Depama and MALIDA are identified as good general combiners for the character seed vigor. IR64 X Ujala Depama, IR64 X Malida and MTU-1010 X Ujala Depama are good specific combinations for the character seed vigor. IR64 X Ujala Depama, IR64 X Malida and Krishna Hamsa X Parwa Panki are the best heterotic lines for the character seed vigor.

REFERANCES

Changrong Ye.,Shu Fukai., Russell Reinke., Ian Godwin., Peter Snell and Jaya Basnayake. 2001. Screening rice genetic resources for cold tolerance at different growth stages. Proceeding of the 10th Australian Agronomy

Conference, Hobart, Australia, 28 January 28- 1 February.

Muhammad Rashid., Akbar Ali Cheema and Muhammad Ashraf. 2007. Line x tester analysis in basmati rice. Pakisthan Journal of Botaney., 39(6): 2035-2042.

Rahimi,M., Rabiei,B., Samizadeh,H and Kafi Ghasemi, A. 2010. Combining Ability and Heterosis in Rice (Oryza sativa L.) Cultivars. Journal of Agricultural Science Technology., Vol. 12: 223-231.

Roy, B and A.B. Mandal. 2001. Combining ability of some quantitative traits in rice. Indian Journal of Genetics., 61(2): 162-164.

Vanaja,T., Luckins,C,. Babu., Radhakrishnan,V.V and Pushkaran, K. 2003. Combining ability analysis for yield and yield components in rice varieties of diverse origin. Journal of Tropical Agriculture 41: 7-15.

Reserch Notes
J.Res. ANGRAU 39(4)73-75, 2011

A STUDY ON THE ADOPTION OF RECOMMENDED TEA CULTIVATION PRACTICES BY THE FARMERS OF NEPAL

KESHAV KATTEL, R. VASANTHA, M. JAGAN MOHAN REDDY AND P.PRASHANTH
Department of Agricultural Extension, College of Agriculture
Rajendranagar, ANGR Agricultural University, Hyderabad-500 030

There was a sudden increase in the area under tea cultivation in Nepal from the middle 1990's with an increased participation of small and marginal farmers. However, the trend has declined sharply in recent years with stagnation in the area under tea cultivation in Nepal. The yield of the tea leaves has been lower than the adjoining regions of India coupled with lower quality of the harvested leaves. With this background, a research was conducted to access the level of adoption of recommended tea cultivation practices by farmers that might provide insights on the reasons for the underperformance of the Nepalese tea industry.

An exploratory research design was adopted for the study. Jhapa and Ilam districts of the easternmost part of Nepal representing different ecological regions i.e., Hills and Terai were selected for the study. These two districts also had highest area on tea cultivation in Nepal. Three Village Development Committees (VDCs) from each district were randomly picked and 15 farmers from each VDCs were selected thus making a total of 90 respondents. A well prepared interview schedule consisting of 24 items testing the extent of adoption of all recommended practices in tea cultivation by respondents was prepared. The responses in the form of full adoption, partial adoption and non adoption were obtained and the raw adoption score of each respondent was converted into the Adoption Quotient (AQ). The general adoption level of the respondents on all recommended tea cultivation practices put together was measured by employing the procedure adopted by Sen Gupta (1967).

Majority (60%) of the respondents were in the category of medium level of adoption of recommended tea cultivation practices followed by 22.00 per cent with low adoption and remaining 18.00 per cent with high level of adoption. In order to find out the extent of adoption of tea cultivation for each and every practice, item analysis was done as presented in the table below. The major aim of this item analysis was to identify deficiency areas, specifically, so that in future, extension activities can be targeted only towards deficiency areas instead of being too general.

Table 1. Item response analysis of extent of adoption of recommended package of practices of tea cultivation by the farmers

S.No.	Item	Fully Adopted (%)	Partially Adopted (%)	Not Adopted (%)
1.	Tea cultivation under recommended climatic conditions	100	0	0
2.	Tea cultivation under recommended soil conditions	100	0	0
3.	Land preparation	76	9	16
4.	Time of Planting	72	0	28
5.	Selection of varieties	78	0	22
6.	Proportion of Seed and Clone maintained	0	0	100
7.	Recommended type of planting	100	0	0
8.	Age of Seedlings (at least12 mature buds)	69	0	31

kattel_k@yahoo.com

S.No.	Item	Fully Adopted (%)	Partially Adopted (%)	Not Adopted (%)
9.	Spacing	80	0	20
10.	Use of mulches in the field	29	0	71
11.	Provision of Shade trees	100	0	0
12.	Maintenance of height of Permanent Frame	67	0	33
13.	Dose of Fertilizers	28	36	37
14.	Method of fertilizer application	100	0	0
15.	Depth of pits for planting	33	0	67
16.	Use of micronutrients	40	0	60
17.	Irrigation Management	78	0	22
18.	Recommended use of pesticides	17	28	56
19.	Recommended use of fungicides	22	28	50
20.	Recommended use of Bio fertilizers	24	0	76
21.	Recommended use of Bio pesticides	29	0	71
22.	Time of Pruning	100	0	0
23.	Methods of Plucking the leaves	100	0	0
24.	Plucking Cycle followed	78	0	22

A cent percent adoption was noted with some of the recommended practices in tea cultivation such as the climatic and soil requirement, use of shade trees in the plantations, recommended type of planting, method of fertilizer application, time of pruning and methods of plucking of tea leaves. It was evident from the present study that 70-80 per cent of the farmers were following the prescribed methods of land preparation, actual time of planting, recommended varieties for cultivation, spacing, recommended plucking cycles and irrigation management. Surprisingly, no body adopted the proportion of seed and clone varieties in their fields as recommended by the scientists. Only 29.00 per cent of the farmers used mulches in their fields and only 33.00 per cent of them adopted the proper depth of pits while planting.

With regard to use of fertilizers, only 28.00 per cent of the respondents adopted the recommended doses of the fertilizers and micronutrients were used by 40.00 per cent of the respondents. 24.00 per cent of the respondents applied bio fertilizers in their fields. In the case of plant protection measures, only a small percentage of the respondents fully adopted the appropriate and prescribed doses of pesticides (17.00%) and fungicides (22.00%) which was followed by 28.00 per cent of the respondents who partially adopted in both of the cases.

Farmers have not adopted recommended proportions of seed and clone varieties of tea plant in their fields which is treated as very important practice by tea experts since mixing of different varieties help to save the plantations during pests and diseases outbreak. The reasons for this might be their poor knowledge and/or unavailability of these varieties. Since, it is recommended as most important yield determining practice by experts, Government/ NGO's should take steps to create awareness among the farmers on optimum seed to clone ratio and measures should be carefully taken for adoption. Similarly, the farmers have not adopted the prescribed depth of pits while transplantation. Most of them have gone for shallow depth of pits which may lead to poor establishment and uprooting of plants due to high rainfall.

The recommended dose of fertilizers in tea cultivation is complex as it varies according to the

age of the tea plants and it was found that the farmers were using fertilizers randomly according to their instincts. Also, in the case of application of micronutrients, only 40.00 per cent of the respondents were using them in their fields. Hence, time has come for the stakeholders involved in the promotion of tea cultivation in Nepal to have a close look on this matter and educate the farmers on the use of correct doses and time of application of fertilizers in their fields for improving yields of tea. The use of bio fertilizers is restricted to the hilly areas where the production of organic tea is predominant. Organic tea cultivation can also be extended to the terai area keeping in view of increasing demand for organic tea.

The tea growing areas in Nepal are conducive to a large number of pests and diseases. Less than 17.00 per cent of the respondents were using the recommended pesticides and their doses. With ever growing concern over pesticide residues and the rising cost of the pesticides, monitoring of pests for their early detection, Integrated Management of Pests (IPM) and discretion of choice of pesticides to be used on tea is utmost important. Government should take steps to regulate unregistered dealers and spurious pesticides in the market which was also indicated by Warakaulle *et. al.,* 2007. There is an urgent need for all stakeholders of tea cultivation to focus on this aspect and educate the farmers on IPM and production of organic tea before doors of all nations are closed for Nepal tea.

REFERENCES

Sengupta, T. 1967. A simple adoption scale for farmers for high yielding variety Paddy. Indian Journal of Extension Education. pp: 107-115

Warakaulle, Mahinda, Ramesh Munankami and Bastiaan Bijl. 2007. Sector study on Tea. International Trade Center, UNCTAD/WTO.

Reserch Notes
J.Res. ANGRAU 39(4)76-78, 2011

STUDIES ON SEED RATE FOR PROMISING GROUNDNUT VARIETIES UNDER RAINFED CONDITIONS OF SOUTHERN TELANGANA ZONE, ANDHRA PRADESH

B. SOUMYA, K. B. SUNEETHA DEVI, Y. SIVA LAKSHMI and K. UMA MAHESHWARI
Department of Agronomy, College of Agriculture
Acharya N.G. Ranga Agriculrtural University, Rajendranagar, Hyderabad -500 030

An experiment was conducted to find out a suitable groundnut variety with optimum seed rate for southern Telangana region of Andhra Pradesh. The experiment was conducted during *kharif* season, 2010 at college farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad. The soil was sandy loam in texture, low in available N (223 kg ha^{-1}) and medium in phosphorus (28.6 kg P_2O_5 ha^{-1}) and potassium (252.9 kg K_2O ha^{-1}). The experiment was laid out in Randomized Block Design with 16 treatmental combinations consisting of four varieties (Narayani, ICGV 91114, K 6 and JCG 88) and four seed rates (75, 100, 125 and 150 kg ha^{-1}) which were replicated thrice. The crop was sown on 17 July at an interrow spacing of 30 cm. Spacing within the row was adjusted according to the seed rate used. i.e. 7.5, 10, 12.5 and 15 cm for 150, 125, 100 and 75 kg ha^{-1} seed rate. 20 N, 60 P_2O_5 and 30 K_2O kg ha^{-1} were applied as basal and gypsum was applied at 30 DAS @ 500 kg ha^{-1}. Rainfall received during the crop growth period was 733.2 mm with 44 rainy days indicating well distributed rainfall during crop growing season.

The results indicated that plant height and LAI at 60 DAS were significantly higher with Narayani

Table 1.Agronomic traits of groundnut as influenced by varieties and seed rates

Treatments	Plant height at 60 DAS (cm)	LAI at 60 DAS	DMP at 60 DAS (g m^{-2})	No.of Branches pt^{-1} at 60 DAS	Total pods pt^{-1}	No.of seeds pod^{-1}	100-Kernel weight	Shelling %	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index
Varieties											
V_1: Narayani	35.9	3.76	192	5.4	23.8	1.8	37.25	72.9	1835	2851	38.99
V_2: ICGV 91114	28.2	3.42	144	5.0	16.9	1.7	40.83	72.4	1125	2113	34.69
V_3: K 6	32.5	3.62	188	5.3	22.2	1.8	38.20	72.6	1651	2678	37.91
V_4: JCG 88	23.5	3.56	173	6.6	18.8	1.8	39.55	72.3	1365	2411	35.99
S.E(m)	0.6	0.02	2	0.1	0.4	0.0	0.34	0.1	24	39	0.51
CD at 5%	1.6	0.05	6	0.2	1.0	0.1	0.99	0.3	68	113	1.49
Seed Rates (kg ha^{1})											
S_1: 75	26.4	3.32	156	6.2	22.8	1.8	39.50	72.1	1224	2237	35.22
S_2: 100	29.6	3.54	168	5.8	21.1	1.8	39.28	72.4	1352	2394	35.90
S_3: 125	31.3	3.70	179	5.4	19.5	1.8	39.05	72.9	1666	2685	38.01
S_4: 150	32.8	3.80	193	5.0	18.3	1.8	38.00	72.7	1733	2736	38.46
S.E(m)	0.6	0.02	2	0.1	0.4	0.0	0.34	0.1	24	39	0.51
CD at 5%	1.6	0.05	6	0.2	1.0	NS	0.99	0.3	68	113	1.49
Varieties x Seed rates											
S.E(m)	1.1	0.03	4	0.1	0.7	0.0	0.68	0.2	47	79	1.03
CD at 5%	NS	Sig.	Sig.	NS	NS	NS	NS	NS	Sig.	NS	NS

soumya.soumyab@gmail.com

Table 2. Interaction between varieties x seed rates on LAI, dry matter production at 60 DAS and pod yield of groundnut

	LAI at 60 DAS				DMP at 60 DAS				Pod yield (kg ha^{-1})			
Treatments	**S_1**	**S_2**	**S_3**	**S_4**	**S_1**	**S_2**	**S_3**	**S_4**	**S_1**	**S_2**	**S_3**	**S_4**
Varieties												
V_1	3.49	3.72	3.82	4.00	162	187	187	229	1440	1710	2040	2150
V_2	3.10	3.38	3.50	3.70	131	138	148	160	966	1030	1200	1304
V_3	3.38	3.35	3.74	3.80	171	180	198	205	1386	1430	1820	1968
V_4	3.32	3.52	3.74	3.68	159	168	179	193	1105	1240	1603	1510
S.E(m)	0.03				4				47			
CD at 5%	0.09				12				136			

variety followed by K 6. Dry matter production at 60 DAS was higher with Narayani but was at par with K 6. More number of branches per plant was observed with short statured groundnut variety JCG 88. Branches per plant in Narayani and K 6 varieties at par and higher than ICGV 91114.

Total pods plant^{-1}and shelling percentage were significantly higher with Narayani variety and was followed by K 6, JCG 88 and ICGV 91114 respectively. Number of seeds pod^{-1} was higher with K 6, Narayani and JCG 88 and significantly higher than ICGV 91114. 100-Kernel weight was higher with ICGV 91114 while 100-Kernel weight of K 6 variety was at par with that of Narayani variety.

Maximum pod yield, haulm yield and harvest index were obtained with Narayani and next best variety was K 6 and both were superior to JCG 88 and ICGV 91114. Lower yield was obtained with ICGV 91114 due to less number of pods plant^{-1}, seeds pod^{-1} and shelling percentage as recorded by this variety compared to the rest of the varieties.

Plant height increased with each higher level of seed rate (i.e., 75 >100 >125 >150 kg ha^{-1}) significantly and maximum was obtained at a seed rate of 150 kg ha^{-1}. Higher plant density might have resulted in mutual shading of the plants which increased competition for light and might have forced plants to grow taller. Similar findings were reported by Hirwe *et al*. (2005). Similar trend was observed for LAI and dry matter production due to more number of plants per unit area that resulted in higher dry matter. Similar results were reported by Kathirvelan and Kalaiselvan (2006).

Maximum pod yield, haulm yield and harvest index were obtained at 150 kg ha^{-1} seed rate, but these effects were at par with those of 125 kg ha^{-1} seed rate. However branches per plant and yield components viz., total number of pods per plant and 100 kernel weight decreased significantly with increase in seed rate. This might be due to sufficient space for plants which encouraged to produce more vigorous plants and also lesser interplant competition for space, light, nutrients and moisture and resulted in more partitioning efficiency. Number of seeds pod^{-1} was not influenced by seed rates. The reduction in pod yield under wider spacing was associated with lower plant population per unit area. These results were in accordance with the findings of Senthil Kumar (2009), Kathirvelan and Kalaiselvan (2006).

The interaction effect of varieties x seed rates was found significant in case of dry matter production, LAI at 60 DAS and pod yield. Maximum LAI at 60 DAS was recorded with Narayani variety at a seed rate of 150 kg ha^{-1}. Dry matter production was also maximum with Narayani variety at a seed rate of 150 kg ha^{-1}. Lowest dry matter was produced with ICGV 91114 at seed rate of 75 kg ha^{-1}. Pod yield of Narayani at 150 kg ha^{-1} seed rate (2150 kg ha^{-1}) was at par with that of seed rate of 125 kg ha^{-1}. Similar high yields with Narayni were reported by Sahadeva Reddy *et al.* (2009).

The results indicated that for realizing maximum pod yields, Narayani variety with a seed rate of 125 kg ha^{-1} may be adopted in sandy loam soils of Southern Telangana zone, Andhra Pradesh.

REFERENCES

Hirwe, N.A., Ulemalle, R.B., Kubde, K.J and Chikate, R.R. 2005. Effect of plant density on growth and yield of groundnut under polythene film mulch. Annuals of Plant Physiology.**19** (2):245-246.

Kathirvelan, P and Kalaiselvan, P. 2006. Growth characters, physiological parameters, yield attributes and yield as influenced by the confectionary groundnut varieties and plant population. Research Journal of Agriculture and Biological Sciences. **2** (6):287-291.

Sahadeva Reddy, B., Malliswara Reddy, A., Padmalatha, Y and Shakunthala, P. 2009. Influence of seed size in different varieties of groundnut on its productivity. Legume Research. **32** (4):298-300.

Senthil Kumar, N. 2009. Effect of plant density and weed management practices on production potential of groundnut (*Arachis hypogaea L.*). Indian Journal of Agricultural Research. **43** (1):57-60.

Reserch Notes
J.Res. ANGRAU 39(4)79-82, 2011

ECONOMICS OF INTERCROPPING IN BAJRA NAPIER HYBRID AS INFLUENCED BY CUTTING INTERVALS

K. C. VERMA, K.B. SUNEETHA DEVI, A.P.K.REDDY AND G. JAYA SREE
Department of Agronomy, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500030

Hybrid napier is an interspecific hybrid between Pearl millet (*Pennisetum americanum*) and Napier grass (*Pennisetum purpureum*). It is an excellent perennial grass with profuse tillering, more leafiness and erect growing habit having higher yield potential (Narayanan and Dabadghao, 1972). The cutting interval for hybrid napier is 40-45 days irrespective of season, but in winter, the growth rate of hybrid napier is very less and harvesting at 40-45 days is not profitable due to less green fodder yield. From October to March, the growth is less due to winter dormancy (Islam and Thakuria, 2002).

Evaluation of cutting interval of hybrid napier by growing legumes as intercrops to substantiate the production of green fodder per unit area was done during *rabi* season 2007-08 at student's farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad. The soil of the experimental site was sandy loam in texture, low in available N, high in P and K content with a pH of 7.2. The experiment was laid out in split plot design and replicated thrice. The treatments comprised of five cutting intervals as main plots viz. 5, 6, 7, 8 and 9 weeks and four intercrops as sub plots viz. cowpea (var.COFC-8), berseem (var. JB-1), Lucerne (var. Anand-2) and clusterbean (var. RG-8). The recommended dose of fertilizers to hybrid napier (60: 60: 30 kg N, P_2O_5 and K_2O ha^{-1}) as basal and 30 kg N ha^{-1} after each cut was applied.

Uniform harvesting of hybrid was done on 9-10-2007 and intercrops were sown. Cowpea and clusterbean as they are single cut in nature were sown on 11-10-2007 and 8-1-2008 in between rows of hybrid napier at 10 cm intra row spacing and harvested on 3-1-2008 and 18-3-2008 respectively. Berseem and lucerne due to their multicut nature were sown as solid rows on 11-10-2007 and harvested on 3-1-2008, 10-2-2008 and 18-3-2008. Recommended fertilizer dose of legume crops was added. The total rainfall received during the experimental period was 99 mm in 6 rainy days. The mean maximum temperature ranged from 27.9 to 35.1°C, whereas the mean minimum temperature varied from 10.7 to 20.1 °C. Green fodder yields of hybrid napier and intercrops were recorded at different cuts. Gross and net returns for each treatment were calculated by considering prevailing input costs and market price of forages.

The green fodder yield of hybrid napier increased with increase in cutting interval from 5 weeks to 9 weeks and reached maximum of 198.3 q ha^{-1}. The increase in yield with increasing cutting intervals over 5 weeks was 14.7, 36.1, 47.0 and 70.2 q ha^{-1} with cutting interval of 6, 7, 8 and 9 weeks respectively. The increase in the green fodder yield of hybrid napier cut at 8 weeks as against that of 7 weeks was not significant.

The influence of different legume fodder crops as intercrops on green fodder yield of hybrid napier was found significant. Cowpea and berseem as intercrops, appeared to be complementary with hybrid napier and as such the green fodder yields of hybrid napier were higher. Green fodder yields of hybrid napier were affected by intercropping with clusterbean.

Interaction between cutting intervals and intercrops was found significant on green fodder yield of hybrid napier (Table 2). Highest green fodder yield was achieved at cutting interval of 9 weeks with cowpea as intercrop (224.3 q ha^{-1}) and was at par with same cutting interval with bersem as intercrop (219.3 q ha^{-1}) and cutting interval of 7 weeks with cowpea as intercrop (210.4 q ha^{-1}).

Among the intercrops, green fodder yield of cowpea was significantly higher over other intercrops. Green fodder yield of Lucerne was significantly higher than berseem. Clusterbeen gave less green fodder

e-mail : kailashagro@yahoo.co.in

Table 1. Green fodder yield, gross, net returns and benefit cost ratio of hybrid napier as influenced by intercropping and cutting intervals of hybrid napier (Total of two cuts)

Treatment	Green fodder yield (q ha^{-1})			Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Benefit cost ratio
	BN hybrid	Intercrops	Totral			
Cutting intervals						
5 weeks	128.1	33.2	161.3	10572.5	1257.5	1.13
6 weeks	142.8	32.5	175.4	11383	1678	1.17
7 weeks	164.2	32.1	196.4	12668	2443	1.24
8 weeks	175.1	31.6	208.4	13266.5	2521.5	1.23
9 weeks	198.3	32.2	230.6	14715	3765	1.34
SE ±	6.4	2.4	7.0			
CD at 5%	14.8	NS	16.1			
Intercrops						
Cowpea	183.8	78.5	262.3	17312.4	7312.4	1.72
Berseem	172.0	20.1	192.1	12315.2	2115.2	1.20
Lucerne	151.9	27.0	180.3	11820.8	1260.8	1.11
Clusterbean	139.1	3.8	143.0	8635.6	-1356.4	0.85
SE ±	8.5	1.8	7.9	-	-	-
CD at 5%	17.3	3.7	16.2	-	-	-
Interaction (m x s)	Sig.	NS	Sig.	-	-	-

Market rate:

Crops	Fodder cost(Rs.q^{-1})
BN hybrid	60
Cowpea	70
Berseem	100
Lucerne	100
Clusterbean	50

Table 2. Effect of interaction between cutting interval and intercrops on green fodder yield of hybrid napier and hybrid napier + intercrops

(a) Green fodder yield of hybrid napier

Intercrops	Cutting intervals					Mean
	5 weeks	6 weeks	7 weeks	8 weeks	9 weeks	
Cowpea	122.1	181.2	210.4	181.1	224.3	183.8
Berseem	128.1	149.1	183.0	180.6	219.3	172.0
Lucerne	132.7	136.5	136.4	164.6	189.6	151.9
Clusterbean	129.4	104.3	127.1	174.5	160.2	139.1
Mean	128.1	142.8	164.2	175.1	198.3	
Sub at same level of main						
SE ±	18.9					
CD at 5%	38.7					
Main at same or different level of sub						
SE ±	14.6					
CD at 5%	30.3					

(b) Total green fodder yield of hybrid napier + intercrops

Intercrops	Cutting intervals					Mean
	5 weeks	6 weeks	7 weeks	8 weeks	9 weeks	
Cowpea	207.1	261.6	287.1	254.1	302.0	
Berseem	146.1	170.0	204.2	201.6	238.6	
Lucerne	159.5	162.0	163.8	199.2	217.1	
Clusterbean	132.8	108	130.6	178.8	164.7	
Mean	161.4	175.4	196.4	208.4	230.6	
Sub at same level of main						
SE ±		17.8				
CD at 5%		36.3				
Main at same or different level of sub						
SE ±		15.0				
CD at 5%		31.3				

yield among all intercrops. No significant interaction was observed between cutting intervals and intercropping on green fodder yield of intercrops grown in hybrid napier. Tripathi *et al.* (1984) tested cowpea and velvetbeen as intercrops in guinea grass and hybrid napier at Jhansi and reported that cowpea as intercrop contributed highest green and dry fodder yield of 82.0, 16.0 q ha^{-1} to hybrid napier + cowpea system.

Total green fodder yield (BN hybrid + Intercrop) significantly increased from cutting intervals 5 to 9 weeks and reached a maximum at cutting interval of 9 weeks. Lowest total green fodder yield was obtained with cutting interval of 5 weeks and was on par with cutting interval of 6 weeks. The experiments conducted during *kharif* season reported that cutting interval of 4 weeks was optimum for higher green fodder yield of hybrid napier + intercrops (Verma *et al*., 1997). Total green fodder yield was maximum when cowpea was grown as intercrop. Berseem and lucerne performed equally well and contributed higher than clusterbean. This clearly shows that cowpea, berseem and lucerne are suitable intercrops in hybrid napier during winter season in southern India. Reddy and Naik (1999) tested five annual forage legumes (clusterbean, rice bean, field bean, horse bean and cowpea) as intercrop in BN hybrid in sandy loam soils of Hebbal station, Banglore and reported that intercropping with cowpea gave highest green forage yield of hybrid napier (33.6 t ha^{-1}) followed by field bean (31.5 t ha^{-1}) and the least (28.2 t ha^{-1}) was with clusterbean. Total Green fodder yield was significantly influenced due to interaction between intercropping and cutting intervals. Total green fodder yield was highest at cutting interval of 9 weeks with cowpea as intercrop but with on par was cutting interval of 7 weeks with same intercrop.

Gross returns, net returns and benefit cost ratio of hybrid napier + intercrops increased with increase in cutting interval from 5 weeks to 9 weeks and reached maximum at 9 weeks. Intercropping with cowpea resulted in increased gross returns, net returns and benefit cost ratio and was in accordance with results of Lakshmi *et al.* (2002). The next best intercrops were berseem and Lucerne. Intercropping with clusterbean resulted in net loss.

The results indicated that, cutting interval of 8 or 9 weeks can be adopted for hybrid napier during winter. Cowpea is the best intercrop (berseem is next to it) to complement the green fodder yield as well as economics of hybrid napier cultivation during winter months in this agro climatic region of southern Telangana of A.P.

REFERENCES

Islam, M and Thakuria, K. 2002. Seasonal variation in green fodder production of important perennial grasses and legumes intercropping system. Journal of Agriculture Science, Society of north east India 15(2): 192-195.

Lakshmi, S., Girija Devi, L., Achuthan Nair, M and Vidya, C. 2002. Yield and economics of fodder legume hybrid Napier intercropping systems. Forage Research. 28 (1): 13-15.

Narayanan, T. R and Dabadghao, P. M. 1972. Forage crops India. Indian Council of Agricultural Research, New Delhi. 73-76.

Reddy, V. C and Naik, G. 1999. Effect of intercrops of annual forage legumes and nitrogen levels on the performance of hybrid Napier. Forage Research. 22 (4): 275-276.

Tripathi, S. N., Singh, R. A and Gill, A. S. 1984. Forage production potential of grass-legume crop sequences. Forage Research. 10(1): 45-47.

Verma, S. S., Virendra Singh and Joshi, Y. P. 1997. Effect of cutting frequency and nitrogen levels on forage yield, quality and economics of Napier bajra hybrid (NB- 21). Forage Research 23 (1 & 2): 71 – 76.

Reserch Notes
J.Res. ANGRAU 39(4)83-85, 2011

FERTILIZER MANAGEMENT FOR MAXIMIZING PRODUCTIVITY AND PROFITABILITY OF EXPORT ORIENTED GROUNDNUT [*Arachis hypogaea* (L.)]

S.TIRUMALA REDDY, D.SRINIVASULU REDDY AND G.PRABHAKARA REDDY
Department of Agronomy, S.V. Agricultural College,
Acharya N.G.Ranga Agricultural University, Tirupati-517502.

Groundnut is leading edible oilseed crop of India. Recent reports indicated that consumption of groundnut kernels for table purpose and value added confectionery is progressively increasing. However, the type of kernel used for table purpose is supposed to be different from that being used for oil extraction. Consumer preference is for kernels of bold size, with low oil and fatty acid content and high sugar and protein content. Bold kernel type of groundnut has got vast export potential and fetch premier price in the market compared to normal sized kernel types. Apart from the management of major nutrients, application of micronutrients has become inevitable to realize the yield potential of groundnut and especially, it becomes more imperative in respect of bold sized kernel type of groundnut.

Due to micronutrient deficiencies, particularly Zn and B, yield reduction of groundnut is substantial (Tripathy *et al.*, 1999). Hence the present study was conducted with a view to improve yield and protein content in the kernel and to get higher income through premier price in the market.

A field experiment was conducted during *rabi*, 2005 in dry land farm of S.V.Agrilcultural College, Tirupati. The soil was sandy clay loam in texture and the initial nutrient status was 230, 21.4 and 205 N-P-K kg ha^{-1}, respectively. The experiment was laid out in split plot design replicated thrice, with the treatments consisting of three levels of major nutrients *viz.,* 30-40-50, 45-60-75 and 60-80-100 N-P_2O_5-K_2O kg ha^{-1} assigned to main plots and six micronutrient management practices *viz.,* no micronutrient application, $ZnSO_4$ @ 10 kg ha^{-1}, Borax @ 5 kg ha^{-1}, $FeSO_4$ @ 2.5 kg ha^{-1}, $CuSO_4$ @ 5 kg ha^{-1} and combined application of all the four micronutrients allotted to sub plots. The variety selected for experiment was Asha. Entire dose of all the fertilizers except nitrogen were applied basally. Nitrogen was applied in two equal splits *i.e.* first half at the time of sowing as basal and remaining half as top dressing at 30 days after sowing. Oil (NMR technique) and protein (Lowry *et al, 1951*) content was estimated by using standard techniques. Economic returns were worked out based on the cost of variable inputs and out puts.

The export oriented groundnut produced significantly more number of filled pods per plant with higher shelling percentage and test weight by the application of 45-60-75 N-P_2O_5-K_2O kg ha^{-1} compared to the high dose of 60-80-100 N-P_2O_5-K_2O kg ha^{-1} (Table 1). Eventually, the pod and haulm yield were also significantly more at 45-60-75 N-P_2O_5-K_2O kg ha^{-1} than the high level of fertilization. Similar results were reported by Gundalia *et al.* (2004).

The soil application of micronutrients *viz.,* $ZnSO_4$ @ 10 kg ha^{-1}, Borax @ 5 kg ha^{-1}, and $CuSO_4$ @ 5 kg ha^{-1} significantly improved the yield attributes, pod and haulm yield significantly. The application of FeSO4 @ 2.5 kg ha^{-1} was not beneficial to the crop. Maximum pod yield of 2592 kg ha^{-1} was realized by the combined application of all micronutrients. This was significantly more than the yield improvement due to the application of any one of them. Application of Zn, B and Cu involved in regulatory functions, auxin production, and efficient translocation of assimilates which resulted in increased stature of all the yield attributes led to higher pod yield. Similar findings were reported by Subrahmaniyan *et al.* (2001). Interaction effect of major and micronutrients was found significant with respect to pod yield, but not with haulm yield. The highest pod yield was recorded with 45-60-75 N-P_2O_5-K_2O kg ha^{-1} along with combined application of all four micronutrients. These findings were in accordance with Janakiraman *et al.* (2005).

E-mail I.D: tirumalareddy7@gmail.com.

Table 1. Effect of major and micro nutrients on yield attributes and yield of groundnut

Treatment	No. filled pods plant^{-1}	Shelling percent	Test weight (g)	Pod yield kg ha^{-1}	Haulm yield kg ha^{-1}
Major nutrients(N-P_2O_5-K_2O kg ha^{-1})					
M_1 : 60-80-100	25.5	64.91	58.0	1984	3834
M_2 : 45-60-75	29.0	68.84	61.1	2175	4022
M_3 : 30-40-50	29.8	69.73	62.2	2244	4094
SE±	0.37	0.32	0.94	25.91	65.31
CD at 5%	1.0	0.92	2.6	72	182
Micro nutrients					
S_1 : No micronutrient application	23.8	63.2	54.8	1742	3594
S_2 : $ZnSO_4$ @ 10 kg ha^{-1}	31.1	69.3	62.4	2383	4235
S_3 : Borax @ 5 kg ha^{-1}	29.3	67.8	59.3	2279	4131
S_4 : $FeSO_4$ @ 2.5 kg ha^{-1}	25.8	67.4	59.0	1808	3660
S_5 : $CuSO_4$ @ 5 kg ha^{-1}	25.1	66.9	58.3	2002	3854
S_6 : Combined application of all the four micronutrients	33.4	71.9	68.7	2592	4426
SE±	0.92	0.89	1.22	87.61	101.14
CD at 5%	1.9	1.8	2.5	118	206
M x S interaction					
CD at 5%	3.3	NS	4.3	207	NS

Table 2. Influence of major and minor nutrients on quality and economics of groundnut

Treatment	Protien content %	Oil content %	Gross Returns (Rsha^{-1})	Net Returns kg ha^{-1}	B : C Ratio
Major nutrients(N-P_2O_5-K_2O kg ha^{-1})					
M_1 : 60-80-100	32.00	50.42	48575	37147	4.24
M_2 : 45-60-75	34.32	47.32	53194	40966	4.34
M_3 : 30-40-50	36.46	43.17	54888	42660	4.48
SE±	0.056	0.950			
CD at 5%	0.19	2.62			
Micro nutrients					
S_1 : No micronutrient application	31.66	45.37	42812	31299	3.72
S_2 : $ZnSO_4$ @ 10 kg ha^{-1}	34.89	48.36	58196	46183	4.84
S_3 : Borax @ 5 kg ha^{-1}	34.84	48.43	55684	43921	4.73
S_4 : $FeSO_4$ @ 2.5 kg ha^{-1}	34.04	47.84	44380	32762	3.82
S_5 : $CuSO_4$ @ 5 kg ha^{-1}	33.56	48.21	49044	37041	4.08
S_6 : Combined application of all the four micronutrients	36.57	48.61	63196	50338	4.91
SE±	0.084	0.749			
CD at 5%	0.18	1.58			
M x S interaction					
CD at 5%	0.31	NS			

Cost of Nutrients: N @ 10.86, P2O5 @ 20.25 and K2O @ 7.7 Rs. kg^{-1}
$ZnSO_4$ @ 50, Borax @ 50, $FeSO_4$ @ 42 and
CuSO4 @ 98 Rs. kg^{-1}

Cost of Produce: Groundnut pods @ 24 and haulms @ 0.25 Rs kg^{-1}

The protein content increased with increasing level of fertilizer application from 30-40-50 to 60-80-100 kg ha^{-1} N-P_2O_5-K_2O. Since the nitrogen forms the principal constituent of protein and undisputedly, protein content is always in direct proportion to nitrogen. The increased rate of nutrient level beyond 40 kg N and 45 kg K_2O was known to reduce the oil content in groundnut kernel. The protein content increased significantly by the application of micronutrients *viz.,* $ZnSO_4$ @ 10 kg ha^{-1}, Borax @ 5 kg ha^{-1}, FeSO4 @ 2.5 kg ha^{-1}, $CuSO_4$ @ 5 kg ha^{-1}. The higher oil content might be due to involvement of boron in catalyzing the metabolism of carbohydrates and Fe and Zn increasing in enzyme activity and other biological oxidation reactions. Findings of the present investigation are in agreement with those of Krishnappa *et al.* (1994).

The economics of fertilizer application showed that it is ideal to apply relatively low dose of 45-60-75 N-P_2O_5-K_2O kg ha^{-1} to realize maximum gross and net returns as well as B: C ratio. These economic variables were also enhanced by the application of the four micronutrients. But, the combined application of these micronutrients was most profitable due to significantly higher yields with high returns.

The study revealed that export oriented groundnut could be successfully raised with application of 45-60-75 N-P_2O_5-K_2O kg ha^{-1} along with basal application of Zn, B, Fe and Cu.

REFERENCES

Janakiraman, N., Venkataramana, P and Seenappa, C. 2005. Effect of iron, zinc and boron on yield and seed quality of ground nut *(Arachis hypogeae L.).* Mysore Journal of Agricultural Sciences. **39** (1) : 286 – 288.

Gundalia, J. D., Polara, K. B and Polara, J. V. 2004. Effect of K levels at recommended and higher NP rates on yield of summer groundnut GG-2. Advances in Plant Science. **17** (2): 591-596.

Krishnappa, M., Srinivasan, C. N., Sarkar, P. W and Sastry, J. A. 1994. Effect of iron, zinc and molybdenum on protein content of groundnut varieties. Journal of Maharashtra Agricultural Universities. **17** (2) : 232-235.

Lowry D. H., Rose Brough L. A and Randall R.J. 1951. Protein measurement with tolin phenol reagent. Journal of Biological Chemistry. 193 : 265-25.

Subrahmaniyan, K., Kalaiselvan, P and Arulmozhi, N. 2001. Response of confectionery groundnut to micronutrients. Legume Research. **24** (2): 139-140.

Tripathy, S. K., Patra, A. K and Samui, R. C. 1999. Effect of micronutrients on nodulation, growth, yield and nutrient uptake of summer groundnut *(Arachis hypogeae L.).* Annals of Agricultural Research. **20** (4) : 439 – 442.

Reserch Notes
J.Res. ANGRAU 39(4)86-88, 2011

EFFECT OF BORON APPLICATION ON TOTAL DRY MATTER, GRAIN FILLING AND GRAIN YIELD IN RICE (*Oryza sativa* L.)

Tulasi G, Ramesh T, Rao P. R and Sreedhar M.
Department of Plant Physiology, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030

In India the areas that show boron (B) deficiency include Northern Bihar, part of Assam, West Bengal, Meghalaya, Northern Orissa, all parts in North East India together with Karnataka Gujarat (Shorrocks, 1997) and in Andhra Pradesh state (Singh, 2006).

To correct the deficiency of B, soil application has been a common method but its availability has been limited due to its immobile nature. In the present investigation B was applied as foliar spray.

The main functions of B in plant relate to sugar transport, flower production, retention, pollen tube elongation and germination, translocation of carbohydrates and sugars to reproductive organs, which in turn improved the spikelet number and spikelet fertility that influenced the yield and productivity (Ahmad *et al*., 2009). The present study was taken up to know effect of B on total dry matter (TDM), grain filling and grain yield.

Seven genotypes viz., IET 20979, IET 21007, IET 21007, IET 21114, IET 21519, IET 21540 and Rasi (check) were grown at Directorate of Rice Research farm during *kharif* 2010. Rasi variety was used as check variety because of its excellent grain filling qualities. Experiment was laid out in Randomized Block Design (factorial concept) with three replications. Spacing of 10 x 20 cm was adopted. 8.0 x 7.0 m^2 plots were maintained. Soil analysis of DRR farm revealed low B status (DRR Annual Progress Report, 2009). Fertilizers were applied @ 100 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare. Boron (H_3BO_3) in the form of foliar spray was given at anthesis stage and the treatments with B included, control (no B spray), B @ 0.2 (= 0.375 kg B ha^{-1}), 0.4 (= 0.75 kg B ha^{-1}) and 0.8 ppm (= 1.5 kg B ha^{-1}). TDM at harvest was measured from five plants from the area demarcated for destructive sampling. Grain filling (%) was calculated by counting total number of spikelets and total number of grains formed in each panicle. After crop harvest and threshing, the produce was sundried, cleaned and grain yield were recorded.

The dry matter production was higher with spray of 0.4 ppm B concentration. Among the genotypes, IET 20979 (1289 g m^{-2}) recorded higher DMP compared to the rest. The interaction effect was significant. IET 20979 at 0.2 ppm B concentration produced more dry matter (1377 g m^{-2}) while IET 21114 could produce 1360 g m^{-2} with 0.8 ppm of B. Debnath *et al*. (2009) reported an improvement in total dry weight of rice because of increased plant height and number of tillers upon application of 1.5 kg B ha^{-1}.

B application significantly increased the spikelet fertility. Significant variations were recorded among different levels of B spray in the present study. The spikelet fertility was 80.8 per cent in control and it improved to 83 per cent by spraying 0.4 ppm B. However, grain filling was not affected by spraying at other concentrations. Among the genotypes, grain filling was higher in Rasi. In case of Rasi, the grain filling improved with boron spray up to 0.4 ppm, while in case of IET 21106, the grain filling was affected (decreased) with 0.8 ppm spray of B. Subedi *et al*. (1997) reported that 8-10 per cent sterility can be reduced by spraying B in certain genotypes only and genotypes vary in their response to B application.

Maximum grain yield (691 g m^{-2}) was recorded at 0.4 ppm B treatment. Genotypes showed significant variations for grain yield. Among the genotypes, maximum grain yield (722 g m^{-2}) was recorded by IET 20979 followed by IET 21106 (712 g m^{-2}). In case of genotypes IET 21007, 21519 and Rasi, the grain yield increased and was higher with 0.8 ppm Boron; IET 21114 produced higher yield with 0.4 ppm B, IET 21106 with 0.2 ppm B and IET

e-mail : Thatikunta_r@rediffmail.com

Table 1. Effect of Boron on Total dry mattat harvest, grain filling and grain yield

	TDM at harvest (g m^{-2})					Grain filling (%)					Grain yield (g m^{-2})				
Treatments	B spray concentration (ppm)					B spray concentration (ppm)					B spray concentration (ppm)				
Genotypes	Control	0.2	0.4	0.8	Mean	Control	0.2	0.4	0.8	Mean	Control	0.2	0.4	0.8	Mean
IET 20979	1218	1378	1368	1193	1289	84.8	83.2	85.5	81.2	83.7	675	777	772	665	722
IET 21007	992	1004	1001	1122	1030	70.4	72.0	73.6	72.0	72.0	522	558	558	620	565
IET 21106	1200	1332	1284	1242	1264	87.6	86.3	89.2	80.9	86.0	665	758	715	710	712
IET 21114	1238	1106	1315	1360	1255	82.7	84.5	86.8	84.9	84.7	693	602	758	705	690
IET 21519	1159	1245	1248	1319	1243	75.4	75.4	77.3	78.8	76.7	643	665	690	720	680
IET 21540	1227	1309	1320	1149	1251	77.7	72.5	75.0	75.8	75.3	673	637	670	583	641
Rasi (Check)	1225	1068	1192	1293	1194	86.9	92.4	93.8	89.4	90.6	685	605	677	738	676
Mean	1180	1206	1247	1240		80.8	80.9	83.0	80.4		651	657	691	677	
	S Em ±		CD (p = 0.05)			S Em ±		CD (p = 0.05)			S Em ±		CD (p = 0.05)		
Treatments (T)	1.1		3.4			0.4		1.19			1.2		3.5		
Genotypes (G)	1.6		4.5			0.5		1.58			1.6		4.6		
Interaction(T×G)	3.2		9.1			1.1		3.16			3.2		9.3		

21540 without B spray. Hence, the response to B was found to be highly variable (Table 1).

Genotypes responded to spray of B at various concentrations. IET 20979 recorded maximum yields with B spray of 0.4 ppm. IET 20979 also recorded high total dry matter and grain filling which contributed in high yields by way of partitioning of dry mater in to grains.

REFERENCES

Ahmad, W., Niaz, A., Kanwal, S., Rahmatullah and Rasheed, M.K. 2009. Role of boron in plant growth: A review. *Journal of Agriculture Research*. 47(3): 329-338.

Debnath, P., Chandra, G and Ghosh, K.S. 2009. Critical limit of available Boron for rice under red and laterite zone of West Bengal, India. *SAARC Journal of Agriculture.* 7(1): 99-105.

DRR Annual Progress Report. 2009. Plant physiology. Influence of boron on spikelet fertility under varied soil conditions. 3: 6.20-6.27.

Shorrocks, V.M. 1997. The occurrence and correction of boron deficiency. *Plant and Soil* 193: 121-148.

Singh, M.V. 2006. Emerging Boron Deficiency in Soils and Crops in India and Its Management. *Plant Responses and Adaptation to Ionic Stresses – Theater.* July 9-15, 2006. Philadelphia, Pennsylvania, USA 18th World Congress of Soil Science.104-118.

Subedi, K.D., Budhathoki, C.B and Subedi, M. 1997. Variation in sterility among wheat (*Triticum aestivum L*.) cultivars in response to boron deficiency in Nepal. Euphytica. 95: 21–26.

Reserch Notes
J.Res. ANGRAU 39(4)89-93, 2011

YIELD BASED SCREENING OF SUNFLOWER (*Helianthus annuus* L.) GENOTYPES UNDER DROUGHT CONDITIONS

A. GEETHA, A. SIVASANKAR, J. SURESH, LAKSHMI PRAYAGA and G. ANURADHA
Department of Plant Physiology, College of Agriculture,
Acharya NG Ranga Agricultural University, Rajendranagar, Hyderabad-500 030

Sunflower (*Helianthus annuus* L.) occupies a prominent place among oilseed crops as it contributes about 12 % to the world edible oil production. In India, sunflower is cultivated under rainfed situation, where intermittent moisture stress is most prevalent. Although the area under sunflower has increased (2 m.ha) over years in the country, the productivity is still lowest among the sunflower growing countries. The decrease in productivity in oilseeds in general and in sunflower in particular is mainly due to abiotic stresses. Drought is the most limiting of all abiotic stresses as it causes more than 70% reduction in biomass and seed yield in sunflower (Umashanker, 1991).Hence present investigation was undertaken to identify varieties suitable for growing under drought to increase the productivity.

The experiment was laid out in Random Block Design with two levels of irrigation and 12 genotypes which were replicated thrice during *rabi*, 2009-10 at College Farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad. The irrigation levels consisted of control (irrigated) and water stresses. Control plots were irrigated at 10 days intervals throughout the crop growth period whereas, in stress treatment irrigation was withheld for twenty days from 40 DAS to 60 DAS *i.e*. flower bud initiation stage. Each genotype was sown in two rows at 5 m length with spacing of 60 x 30 cm. Two to three seeds were sown per hill to achieve uniform stand. Thinning was done at two weeks after sowing to retain one seedling per hill. Recommended package of practices were followed to raise a healthy crop. The data were recorded on capitulum weight , capitulum diameter, total number of seeds per capitulum, thousand seed weight , seed filling parameters , oil content , seed yield per plant and drought susceptibility index at harvest stage from ten randomly selected plants from each plot. Drought susceptibility index (S) was calculated according to Fischer and Maurer (1978): $S= (1-Y/Y_p) / (1-X_d/X_p)$ Where, Y is the achene yield per head of a given genotype under drought, Y_P is the achene yield per head of he same genotype under irrigation,Xd is the mean achene yield of all the genotypes within group (inbred or parent) under drought, Xp is the achene yield per head of all genotypes within group under irrigation .

The quality 1-Xd/Xp is the drought intensity Fischer and Maurer (1978) with the range 0 to 1.

The capitulum weight was reduced by drought stress compared to control (Table 1). Among genotypes, SH-491 under non stress environment and DSF-111 under stressed environment showed higher capitulum weight over rest of the genotypes. Capitulam weight was unaffected by stress in certain cultivars. RSF-101, RSF-106 and ASF-104 registered negligible reduction of capitulam weight under stress. The decrease in capitulum weight under water stress in sunflower cultivars like TSF-103, ASF-107, SH-177, DSF-111 and SH-491 was due to poor photosynthetic machinery and decreased assimilatory surface (Reddy *et al.*, 2003). The findings are in agreement with the results of Andrich *et al*., 1996.

The capitulum diameter was reduced in stress compared to non stress treatment (Table 1). Significant variation in head diameter was exhibited by sunflower cultivars uniformly under control and stressed conditions. In stress condition, ASF-107, TSF- 103 and DSF-114 recorded less reduction in capitulum diameter. The reduction of capitulum diameter in other genotypes like RSF-106 and DSF-111SH-491 may be attributed to reduction in leaf area index and inefficient photosynthetic activity leading to poor translocation of photosynthates from source to sink.

The number of seeds per capitulum was significantly reduced when stress was imposed at

E-mail:geethagri_100@yahoo.co.in

flower bud initiation stage (Table 1). The percent reduction in total number of seeds was 10.8 over control. Among genotypes, SH-177 and DSF-111 under control and DSF-111 and SH-177 under stress had more seeds per capitulum over other genotypes. The research findings of Kafi *et al*.(2000) revealed that reduction in seeds number per capitulum under drought stress may be due to reduction in leaf area and depression of photosynthetic process. The results are in accordance with findings Reddy *et al.,* 2003 and Nezami *et al.,* 2008.

Drought induced at flower bud initiation stage decreased thousand seed weight (Table 1). Genotypes exhibited significant variation in thousand seed weight. Genotype SH-491 recorded highest thousand seed weight in control as well as under stress. While RSF-101 recorded lowest thousand seed weight under both conditions. Rauf (2008) reported that reduction of 1000-achene weight may occur due to lower photosynthates production as a result of excessive loss of leaves at flower bud initiation stage.

Seed filling percentage was highly reduced under water stress (Table 2). The percent reduction in seed filling during stress was 16 %. Among genotypes SH-491 followed by DSF-111 exhibited higher seed filling percentage both under control and stress environments. SH-491 recorded highest seed filling percent followed by DSF-111 in interaction. The decrease in seed filling percent was due to decrease in the duration of grain filling period (Rao and Singh., 1994).

Water stress induced at flowering bud initiation stage caused reduction in seed yield per plant (Table 2). Maximum seed yield was recorded in control treatment, which was significantly superior to stress treatment. Among genotypes there was significant difference in seed yield per plant. Genotype SH-491 recorded highest seed yield per plant in non stress, stress and interaction were superior over rest of the genotypes. As per Amrutha *et al.*, 2007 the decrease in yield might be due to decreased sink size (mainly number of seeds) and seed weight.

Stress treatment recorded decrease in oil content per cent compared to control (Table 2). Among the genotypes SH-177 recorded highest oil content in control, stress and combined effect than remaining eleven cultivars. Genotype DSF -114 recorded lowest oil content in mean effect. Oil content was reduced by moisture stress. On contrary, some workers like Parihar and Ehsanullah (1990) found that water availability has no significant effect on oil content.

Drought susceptibility index may prove a very useful selection criterion for drought-tolerance breeding in sunflower (Rauf and Sadqat, 2007). Water stress induced at flower bud initiation stage cause reduction in yield (Table 2). Three genotypes *viz.,* ASF -107 (2.16) , SH-177 (2.15) and RSF-101(1.81) recorded higher DSI, while TSF-106 recorded lowest DSI value followed by TSF-103, RSF-106, RSF-107 , DSF-104 and DSF-114 which were on par. A higher value of susceptibility index indicates higher susceptibility of a genotype to the stress. Higher drought susceptibility index of some genotypes under water stress situations may be due to degradation of membrane system due to poor defense mechanism.

Based on results obtained three genotypes, SH-491, DSF-111 and SH-177 are considered as promising lines and can be grown successfully under limited water conditions.

REFERENCES

Amutha, R., Muthulaksmi, S., Baby Rani, W., Indira, W. K and Mareeswari, P. 2007. Alleviation of High Temperature Stress in Sunflower (Helianthus Annus L.) By Plant Growth Regulators and Chemicals Research Journal of Agriculture and Biological Sciences. **3**(12):1658-1662.

Andrich, G., Balzini, S., Zinnai,A., Silvestri, S and Galoppini, C .1996. The effect of drought stress on some characteristics of sunflower seeds. Agricoltura Mediterranea. **126** (3): 285-291.

Fischer, R.A. and Maurer, R. 1976. Drought resistance in spring wheat cultivar. I. Grain yield responses. Australian Journal of Agricultural Research. **29**: 897-912.

Kafi, E .Z., Kamkar, B., Sharifi, H .R and Goldani, M .2000. Plant Physiology. Vol (2). (translated) Ferdowsi University Press.

Table 1. Yield attributes of sunflower cultivars influenced by moisture stress

S.No.	Genotype	Capitulum weight (g)			Capitulum diameter (cm)			Total number of seeds per capitulum			Thousand seed weight (g)		
		Control	Stress	Mean	Control	Stress	Mean	Control	Stress	Mean	Control	Stress	Mean
1	RSF-101	48.1	46.1	47.1	17.3	15.1	16.2	518.7	477.3	498.0	54.6	43.0	48.8
2	TSF-103	92.2	54.0	73.1	26.0	22.6	24.3	716.0	694.7	705.3	66.2	62.3	64.3
3	ASF-107	92.0	76.3	84.1	26.8	23.8	25.3	664.0	532.3	598.2	65.1	64.8	65.0
4	DSF-114	40.7	32.3	36.5	22.9	20.6	21.7	302.0	270.7	286.3	60.7	52.5	56.6
5	SH-177	103.0	87.0	95.0	17.2	14.3	15.7	1222.7	1163.3	1193.0	52.7	50.6	51.6
6	DSF-104	60.6	50.6	55.6	19.9	15.5	17.7	557.0	544.0	550.5	58.8	55.2	57.0
7	RSF-106	46.2	41.0	43.6	23.8	18.7	21.3	441.3	406.7	424.0	55.6	47.7	51.6
8	DSF-111	134.0	113.1	123.6	23.3	19.7	21.5	1217.0	1182.7	1199.8	75.0	68.3	71.7
9	RSF-107	120.4	104.7	112.5	22.3	20.3	21.3	983.3	752.3	867.8	71.1	68.9	70.0
10	ASF-104	43.3	39.4	41.4	20.7	15.8	18.3	489.0	442.0	465.5	57.4	53.3	55.4
11	TSF-106	83.0	72.6	77.8	20.3	17.7	19.0	749.3	663.3	706.3	65.2	56.7	60.9
12	SH-491	151.0	89.4	120.2	23.0	18.7	20.8	935.0	718.3	826.7	83.0	74.3	78.7
Mean		84.5	67.2	75.9	22.0	18.6	20.3	733.0	654.0	693.5	63.8	58.1	61.0
CD at 5% for treatments		1.69			1.36			7.91			1.83		
CD at 5% for genotypes		4.14			3.34			19.36			4.49		
CD at 5% for T x G		5.56			NS			27.38			NS		
S.E		0.25			0.15			1.24			0.18		

Table 2. Seed filling percentage, oil content (%), seed yield per plant (g) and drought susceptibility index (DSI) of sunflower cultivars influenced by moisture stress

S.No.	Genotype	Seed filling percentage			Oil content (%)			Seed Yield per plant (g)			DSI
		Control	Stress	Mean	Control	Stress	Mean	Control	Stress	Mean	Mean Value
1	RSF-101	85.5	64.4	74.9	37.1	34.6	35.9	25.3	14.9	20.1	1.81
2	TSF-103	86.8	68.7	77.7	36.7	35.2	36.0	44.2	42.0	43.1	0.25
3	ASF-107	77.1	64.3	70.7	36.8	36.2	36.5	42.7	21.7	32.2	2.16
4	DSF-114	60.3	46.8	53.5	33.3	32.9	33.1	11.1	9.3	10.2	0.76
5	SH-177	89.8	70.0	79.9	40.4	39.8	40.1	66.2	34.4	50.3	2.15
6	DSF-104	80.1	74.4	77.3	36.6	35.8	36.2	23.3	20.9	22.1	0.45
7	RSF-106	76.4	72.4	74.4	36.0	34.5	35.2	19.9	18.5	19.2	0.29
8	DSF-111	97.4	83.2	90.3	39.9	37.8	38.8	84.6	66.3	75.5	0.95
9	RSF-107	94.10	75.9	85.0	38.8	38.3	38.6	65.0	59.5	62.3	0.36
10	ASF-104	75.3	65.5	70.4	39.2	35.7	37.4	19.1	14.2	16.6	1.10
11	TSF-106	86.10	74.3	80.2	37.2	37.0	37.1	40.3	39.1	39.7	0.13
12	SH-491	97.8	85.2	91.5	37.3	37.2	37.3	104.7	80.5	92.6	1.00
Mean		83.9	70.4	77.2	37.4	36.2	36.8	45.5	35.1	40.3	0.94
CD at 5% for treatments		1.34			0.21			1.28			0.64
CD at 5% for genotypes		3.27			0.52			3.13			
CD at 5% for T x G		4.63			0.73			4.42			
SE		0.21			0.03						0.02

Nezami, A., Khazaeia,H.R., Boroumand Rezazadehb, Z and Hosseinic, A.2008. Effects of drought stress and defoliation on sunflower (*Helianthus annuus*) in controlled conditions. Desert. **12**:99-104.

Parihar, U.K and Ehsanullah, M.D. 1990. Effect of irrigation and nitrogen on soil and plant N, leaf water potential,growth and yield of mustard. Annals of Agriculture Research. **11**(1):47-55.

Rao, A.S and Singh, K.C.1994. Influence of meteorological factor on forage and seed productivity of Cenchrus ciliaris. Annals of Arid zone. **33**(1):39-44.

Rauf, S and Sadaqat, H.A. 2007.Effect of varied water regimes on root length, dry matter partitioning and endogenous plant growth regulators in (*Helianthus annuus L*.) Plant interactions. **2**:41-51.

Rauf, S. 2008. Breeding sunflower (*Helianthus annuus L*.) for drought tolerance. Communications in Biometry and Crop Science. **3** (1):29–44.

Reddy, G. K .M., Dangi, K. S., Kumar, S. S and Reddy, A. V. 2003. Effect of moisture stress on seed yield and quality in sunflower, Helianthus annuus L. Journal of Oilseeds Research. **20**(2):282–283.

Umashanker, R .1991. Gametophytic screening techniques in identification and development of drought tolerant lines. Proceedings of National Symposium. Recent Advances . Drought Research. Dec,10-13, kottayam, Kerala India , Pp.5.

Reserch Notes
J.Res. ANGRAU 39(4)94-100, 2011

EVALUATION OF SELECTED INSECTICIDES AS SEED PROTECTANTS AGAINST THE PULSE BEETLE (*Callosobruchus chinensis* L.).

AMTUL RAHEEM and D. SRIDEVI
Dept. of Seed Science & Technology, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030

It is in this context that the present study was undertaken to assess the relative toxicity of different seed protectants against the pulse beetle *Callosobruchus chinensis*.

A laboratory experiment was conducted at Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad to study the relative toxicity of newer insecticides *viz*., spinosad, abamectin, emamectin benzoate, novaluron, lufenuron, neem and deltamethrin, by dry film residue method. In this method 1ml of test solution of a particular concentration was taken and spread uniformly to the bottom and lid of petriplate in a thin layer. The petriplate was allowed to dry at room temperature and then 10 adult insects were released into the petriplate. Similarly the procedure was repeated for all the insecticides at different concentrations. Initially mortality was assessed for a wide range of concentrations for each insecticide and based on this narrow range was selected.

Mortality was assessed after 24 and 48 hours and the LC_{50} values were calculated by probit analysis method. The mortality count of insects in three replications of each concentration was recorded and the average per cent mortality in each concentration was calculated. The per cent mortality in the control, if any, was corrected using Abbot's formula (1925).

$$\text{Corrected Moratality (\%)} = \frac{\text{Test mortality(\%) - Control mortality (\%)}}{\text{100-Control mortality (\%)}}$$

The dose mortality regressions were computed by probit analysis (Finney,1971) using Biostat 2009 5.8.00 version software. The relative toxicity of newer insecticides was calculated by taking deltamethrin as standard check

$$\text{Relative toxicity of newer insecticides} = \frac{LC_{50} \text{ of deltamethrin (check)}}{LC_{50} \text{ of newer insecticide}}$$

The results of mortality response and relative toxicity of selected newer test insecticides *viz*., spinosad, abamectin, emamectin benzoate, novaluron, lufenuron, neem and the check deltamethrin against the adults of *C. chinensis* (Table 1) at 24 hours of treatment showed that the highest mortality (96.66%) was observed with emamectin benzoate, novaluron and deltamethrin at 11, 5000 and 8 ppm concentrations with LC_{50} values (Table 2) being 6.23, 149.57 and 2.69 ppm, respectively. Mortality of 93.33, 93.33, 86.66 and 83.33 was recorded for spinosad, abamectin, lufenuron and neem at 10.5, 4,100 and 10,000 ppm, respectively with their LC_{50} values being 5.73, 1.03, 20.30, and 1382.97 ppm, respectively. Based on LC_{50} values, abamectin was found to be relatively more toxic than the remaining insecticides.

The calculated $\prod^2$ values in all the insecticides tested were less than that of table value (12.529) suggesting that the adult population was homogeneous.

With respect to LC_{50} values, the relative toxicity of these insecticides were arranged in the following order: abamectin (2.6116) > deltamethrin (1.0000) > spinosad (0.4694) > emamectin benzoate (0.4317) > lufenuron (0.1325) > novaluron (0.0179) > neem (0.0019) after taking the toxicity of the check deltamethrin as unity.

The LC_{90} value of the insecticide *viz.,* spinosad, abamectin, emamectin benzoate, novaluron, lufenuron, neem and deltamethrin were 12.06, 4.82, 9.96, 1802.24, 151.53, 41086.59 and 8.14 ppm respectively.

The insect mortality increased marginally at 48 hours (Table 3). The highest mortality (100%) was observed with abamectin, emamectin benzoate, novaluron and deltamethrin at 4, 11, 5000 and 8 ppm, respectively. Mortality of 93.33, 90.00 and 90.00 per

e-mail : amieraheem04@gmail.com

cent was observed in spinosad, lufenuron and neem at 10.5, 100 and 10000 ppm, respectively. The LC_{50} values were 4.93, 0.67, 5.57, 68.00, 14.89, 679.41 and 1.91 ppm for spinosad, abamectin, emamectin benzoate, novaluron, lufenuron, neem and deltamethrin, respectively. Abamectin exhibited highest toxicity followed by deltamethrin, spinosad, emamectin benzoate, lufenuron, novaluron and neem.

With respect to LC_{50} values, the relative toxicity (Table 4) of these insecticides were arranged in the following order: abamectin (2.8507) > deltamethrin (1.0000) > spinosad (0.3874) > emamectin benzoate (0.3429) > lufenuron (0.1282) > novaluron (0.0280) > neem (0.0028) after taking the toxicity of check deltamethrin as unity. The data clearly indicated the superior performance of abamectin over others. The calculated $\div^2$ values indicated that the *C. chinensis* adult population used in the study was homogeneous.

On the basis of LC_{90} values, the order of toxicity of insecticides remained the same as in LC_{50} values. The LC_{90} value of the insecticides *viz.,* spinosad, abamectin, emamectin benzoate, novaluron, lufenuron, neem and deltamethrin were 11.99, 2.85, 8.25, 597.01, 114.70, 20007.64 and 6.52 ppm, respectively.

Thus, at both 24 and 48 hours, the most toxic insecticide was abamectin followed by deltamethrin > spinosad > emamectin benzoate > lufenuron > novaluron > neem.

The toxicity was more at 48 hours compared to 24 hours after treatment. This is in accordance to the findings of Lokare *et al*. (1999) who have confirmed that the toxicity increases with the period of exposure.

In this study, abamectin was the most toxic among the insecticides tested against the adults of *C. chinensis*. Abamectin attacks the nervous system of insects causing paralysis within hours and the paralysis cannot be reversed. Hussain and Ashfaq (2009) also reported that abamectin was comparatively more toxic than spinosad and indoxacarb to both malathion-resistant and organophosphates-susceptible strains of *T. castaneum* after 48 hours of treatment through residual film method.

Subsequently, deltamethrin, spinosad and emamectin benzoate in the decreasing order were toxic to the adults of *C. chinensis.* Sanon *et al*. (2010) also reported the lower toxicity of spinosad than deltamethrin in the 24 hour treatment to *C. maculatus.* Deltamethrin, a synthetic pyrethroid has quick knock down effect besides good contact toxicity while spinosad acts mainly by ingestion and contact. Thus this knock down property of deltamethrin might have given an edge over spinosad in the relative efficacy studies. Srivastava and Agarwal (2004) in their findings have also reported the supremacy of deltamethrin over the other synthetic pyrethroids and organophosphate insecticides against the adults of rajma beetle (*Zabrotes subfasciatus)* by residue film method. However, in a study on the effect of spinosad on the adults of eight stored product beetles exposed for 24 hours to deposits of 0.05 and 0.1 mg cm^{-2} mortality of > 98 % was recorded (Subramanyam *et al*., 2003).

Among the insect growth regulators, lufenuron was relatively more toxic than novaluron, while neem was the least effective against *C. chinensis* among all the insecticides tested. Ishaya and Yablonski (1987) reported that chitin synthesis inhibitors were less effective against resistant strain of *T. castaneum.* Rao and Subbaratnam (2002) had reported that the toxicity of chitin synthesis inhibitors increases with the period of exposure but as the present study was confined to only 48 hours of exposure, the toxicity recorded was low. Hussain *et al.* (2005) found that azadirachtin remained effective against larvae of *T. castaneum* but at higher doses (LC_{50} = 20025 ppm). On the other hand Yadav (1993) found azadirachtin to be no more effective against pulse beetles. Our studies also reveal that neem was relatively less effective as the concentration used was low.

The results indicated that abamectin was the most effective insecticide against *C. chinensis* followed by deltamethrin, spinosad, emamectin benzoate, lufenuron, novaluron and neem.

Table 1. Mortality response of selected newer insecticides on the adults of *C. chinensis* at 24 hours after exposure

Spinosad		Abamectin		Emamectin benzoate		Novaluron		Lufenuron		Neem		Deltamethrin	
Concent-ration (ppm)	% mortality	Concen-tration (ppm)	% mortality	Concen-tration (ppm)	% mortality	Concen-tration (ppm)	% mortality	Concen-tration (ppm)	% mortality	Concen-tration (ppm)	% mortality	Concen-tration (ppm)	% mortality
3.5	23.33	0.5	36.66	4	13.33	70	30.00	3	6.66	500	20.00	1	20.00
4.5	36.66	1.0	43.33	5	23.33	100	46.66	5	10.00	700	50.00	2	30.00
5.5	46.66	1.5	53.33	6	46.66	300	66.66	7	23.33	1000	56.66	3	50.00
6.5	53.33	2.0	63.33	7	66.66	500	70.00	10	56.66	3000	60.00	4	63.33
7.5	60.00	2.5	76.66	8	73.33	700	80.00	30	60.00	5000	63.33	5	73.33
8.5	66.66	3.0	83.33	9	80.00	1000	83.33	50	66.66	7000	66.66	6	80.00
9.5	86.66	3.5	86.66	10	90.00	3000	93.33	70	73.33	9000	76.66	7	90.00
10.5	93.33	4.0	93.33	11	96.66	5000	96.66	100	86.66	10000	83.33	8	96.66
control	0.00	control	0.00	control	0.00	control	0.00	control	0.00	control	0.00	control	0.00

Table 2. Relative toxicity of selected newer insecticides on the adults of *C. chinensis* at 24 hours after exposure

Insecticide	Heterogeneity ($\hat{O}^2$) df =6	Regression Equation	LC_{50} (ppm) (95% FL)	Relative toxicity	Order of toxicity	LC_{90} (ppm) (95% FL)	Slope ± SE (b)
Spinosad	1.327	Y=1.992+3.966x	5.73 (5.07-6.33)	0.4694	3	12.06	3.966±0.024
Abamectin	1.959	Y=4.970+1.918x	1.03 (0.73-1.30)	2.6116	1	4.82	1.918±0.064
Emamectin benzoate	0.480	Y=0.002+6.287x	6.23 (5.76-6.67)	0.4317	4	9.96	6.287±0.016
Novaluron	0.454	Y=2.421+1.185x	149.57 (86.20-86.20)	0.0179	6	1802.24	1.185±0.104
Lufenuron	7.324	Y=3.079+1.468x	20.30 (15.31-27.14)	0.1325	5	151.53	1.468±0.063
Neem	4.040	Y=2.266+0.870x	1382.97 (708.03-2156.20)	0.0019	7	41086.59	0.870±0.123
Deltamethrin	2.176	Y=3.847+2.671x	2.69 (2.20-3.16)	1.0000	2	8.14	2.671±0.039

Table 3. Mortality response of selected newer insecticides on the adult of *C. chinensis* at 48 hours after exposure

Spinosad		Abamectin		Emamectin benzoate		Novaluron		Lufenuron		Neem		Deltamethrin	
Concen-tration (ppm)	% mortality (ppm)	Concen-tration (ppm)	% mortality (ppm)	Concen-tration (ppm)	% mortality (ppm)	Concen-tration (ppm)	% mortality (ppm)	Concen-tration (ppm)	% mortality (ppm)	Concen-tration (ppm)	% mortality (ppm)	Concen-tration (ppm)	% mortality (ppm)
3.5	33.33	0.5	50.00	4	20.00	70	40.00	3	13.33	500	33.33	1	36.66
4.5	46.66	1.0	60.00	5	26.66	100	66.66	5	16.66	700	60.00	2	46.66
5.5	56.66	1.5	66.66	6	56.66	300	86.66	7	26.66	1000	63.33	3	56.66
6.5	63.33	2.0	73.33	7	80.00	500	90.00	10	63.33	3000	70.00	4	66.66
7.5	66.66	2.5	86.66	8	83.33	700	90.00	30	66.66	5000	73.33	5	83.33
8.5	70.00	3.0	93.33	9	93.33	1000	93.33	50	73.33	7000	76.66	6	90.00
9.5	86.66	3.5	96.66	10	96.66	3000	96.66	70	80.00	9000	83.33	7	96.66
10.5	93.33	4.0	100	11	100	5000	100	100	90.00	10000	90.00	8	100
control	0.00	control	0.00	control	0.00	control	0.00	control	0.00	control	0.00	control	0.00

Table 4. Relative toxicity of selected newer insecticides on the adults of *C. chinensis* at 48 hours after exposure

Insecticide	Heterogeneity ($\hat{O}^2$) df =6	Regression Equation	LC_{50} (ppm) (95% FL)	Relative toxicity	Order of toxicity	LC_{90} (ppm) (95% FL)	Slope ± SE (b)
Spinosad	0.750	Y=2.696+3.322x	4.93 (4.07-5.59)	0.3874	3	11.99	3.322±0.016
Abamectin	1.745	Y=5.350+2.041x	0.67 (0.42-0.89)	2.8507	1	2.85	2.041±0.083
Emamectin benzoate	1.731	Y=-0.603+7.509x	5.57 (5.16-5.94)	0.3429	4	8.25	7.509±0.015
Novaluron	1.133	Y=2.510+1.358x	68.00 (31.88-107.00)	0.0280	6	597.01	1.358±0.064
Lufenuron	5.283	Y=3.303+1.445x	14.89 (11.05-19.79)	0.1282	5	114.70	1.445±0.035
Neem	2.058	Y=2.529+0.872x	679.41 (247.19-1159.08)	0.0028	7	20007.64	0.872±0.171
Deltamethrin	3.117	Y=4.321+2.406x	1.91 (1.43-2.34)	1.0000	2	6.52	2.406±0.054

REFERENCES

Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology* 18, 265–267.

Finney, D. J. 1971. Probit analysis, 3rd Edition University Press, Cambridge, U. K. 333 pp.

Ishaaya, I and S. Yablonski, 1987. Toxicity of two benzoylphenyl ureas against insecticide resistant mealworms, pp. 131–40. *In*: Wright, J.E. and A. Retnakaran (eds.), *Chitin and Benzoylphenyl Ureas*. Dr. Junk Publishers, Dordrecht, The Netherlands.

Lokare R.U., Chandele A.G and Kharbade S.B. 1999. Avermectins, a class of compounds : implications for use in arthropod pest control. Annual Review of Entomology 36 : 91-117.

Riaz Hussain, Muhammad Ashfaq ,Mushtaq A. Saleem and Sohail Ahmed. 2005. Toxicity of some insecticides with novel modes of action against malathion–resistant and organophosphate–susceptible strains of *Tribolium castaneum* larvae. *International Journal of Agriculture & Biology.* Vol. 7, No. 5.

Riaz Hussain and Muhammad Ashfaq 2009. Susceptibility of malathion-resistant and susceptible *Tribolium castaneum* adults to abamectin, spinosad and indoxacarb. *Kuwait Journal of Science & Engineering*. 36(1a): 113-121. 47 ref.

Rao, D.V.S and Subbaratnam, G.V. 2000. Toxicity of benzoylphenyl ureas to the ragi cutworm, *Spodoptera exigua* (Hubner) on onion. Pest Management and Ecology Zoology 8(2) : 171-175.

Sanon, A. Ba, N.M., Binso-Dabire C.L and Pittendirgh, B.R. 2010 Effectiveness of spinosad in controlling the cowpea storage pest *Callosobruchus maculatus* F. Journal of Economic Entomology 103(1): 203-210.

Srivastava, C and Agarwal, M. 2004. Relative toxicity of some insecticides to the adults of Rajma beetle *Zabrotes subfasciatus* (Boh.). *Indian Journal of Entomology*. 66(1): 40-41. 2 ref.

Subramanyam, B. Toews, M and Fang, L. 22-26 July 2002. 2003. Spinosad: an effective replacement for organophosphate grain protectants. *Advances in stored product protectio*n. Proceedings of the 8th International Working Conference on Stored Product Protection, York, UK, 916-920. 17 ref.

Yadav, T.D. 1993. Olfactory, oviposition and developmental response of four species of pulse beetles to four neem oil treated legumes. In: Singh, R.P., M.S. Chari, A.K. Raheja and W. Kraus (eds.). *Neem and Environment.* Vol. I, pp. 344–8. Oxford and 1BH Publ. Co. Pvt. Ltd., New Delhi.

Reserch Notes
J.Res. ANGRAU 39(4)101-103, 2011

RESPONSE OF *RABI* PIGEON PEA [*Cajanus cajan (L.)*] TO DIFFERENT LEVELS OF DRIP IRRIGATION

K. MAHALAKSHMI, K. AVIL KUMAR, M. D. REDDY and M. UMA DEVI
Water Technology Centre, College of Agriculture, Rajendranagar,
Acharya N.G. Ranga Agricultural University, Hyderabad- 500 030

Raising pigeon pea during winter (*rabi*) season with assured irrigation can provide greater stability and higher productivity. Pigeon pea can also escape the menace of pod borer when grown as a post rainy season crop (Reddy *et al*., 1991). As water is a limiting and costly input its judicious application needs special attention for maximizing pigeon pea yield per unit quantity of applied water.

This field experiment was carried out at Water Technology Centre, College Farm, College of Agriculture, Rajendranagar, Hyderabad (Latitude $17^0$19' N, Longitude $78^0$23' E and altitude of 542.6 m above mean sea level) during *rabi*, 2010-11 to study the effect of variable water supply levels on growth and yield of *rabi* pigeon pea under surface drip irrigation The experiment was laid out in Randomized Block Design with 3 replications and 8 treatments viz., I_1 (0.4 Epan throughout crop life), I_2 (0.6 Epan throughout crop life), I_3 (0.8 Epan throughout the crop life), I_4 (Drip irrigation at 0.4 Epan up to flowering and 0.6 Epan later on), I_5 (Drip irrigation at 0.4 Epan up to flowering and 0.8 Epan later on), I_6 (Drip irrigation at 0.6 Epan up to flowering and 0.8 Epan later on), I_7 (drip irrigation at 0.4 Epan up to flowering, 0.6 Epan from flowering to pod initiation and 0.8 Epan later on and I_8 (furrow irrigation at 0.8 IW /CPE ratio with irrigation water of 50 mm throughout the crop life).

The soil was sandy clay in the texture, alkaline in reaction and non-saline, low in available nitrogen, medium in available phosphorous and high in available potassium. The infiltration rate was 2.3 mm $hour^{-1}$ and hydraulic conductivity was 2.5 mm $hour^{-1}$. The irrigation water was marginally alkaline (pH=7.56) and Class II (C_3S_1) suggesting that it is suitable for irrigating the crop by following good management practices. The RSC levels indicated that there was no residual alkalinity problem. Pigeonpea crop variety – Lakshmi (ICPL 85063) was sown on 16th October 2010 adopting a spacing of 0.60 m between the rows and 0.15 m between the plants with in a row to maintain a desired plant population of 1,11,111 plants ha^{-1}. Irrigations were scheduled based on the USWB Class A pan evaporation rates for treatments under drip irrigation and the calculated irrigation water was delivered in surface irrigation treatment plot directly using a water meter and a flexible pipe. The mean pan evaporation from USWB Class A pan evaporimeter during the cropping period ranged from 1.6 to 3.2 mm day^{-1} with an average of 2.56 mm day^{-1}. The seasonal pan evaporation was 428.4 mm. while the total precipitation received during the cropping period was only 145mm.The calculated irrigation water was delivered in surface irrigation treatment using a water meter x flexible pipe. Based on pan evaporation rates irrigations were scheduled in case of treatment under dip irrigation.

Plant height of pigeon pea increased slowly up to 30 days after sowing (DAS), there after it increased linearly up to 90 DAS, and after that although it continued to increase until maturity it occurred at diminishing rate in different irrigation treatments. The average leaf area index increased was at lower rate up to 30 DAS and there after it increased linearly with the ontogeny of the plant, reaching a peak value at 120 DAS but there after due to senescence of leaves it was found to decrease linearly and at harvest the Leaf area Index (LAI) recorded lower value (Table 1).

Pigeon pea seed yield and dry matter yield were higher when irrigations were scheduled by drip at 0.8 Epan throughout crop life (I_3). However, performance of pigeon pea with 0.6 Epan up to flowering and 0.8 Epan later on (I_6) or 0.6 Epan throughout crop life (I_2) was more or less similar to the above and significantly superior over irrigation scheduling at 0.4 Epan throughout crop life(I_1), 0.4 Epan up to flowering and 0.6 Epan later on (I_4), 0.4 Epan up to flowering and 0.8 Epan later on (I_5), drip

e-mail : maa.luky@gmail.com

Table 1. Response of growth, yield attributing characters and yield of pigeon pea to different levels of drip irrigation

Treatment details	Plant height (cm)	LAI	Number of pods plant^{-1}	Number of seeds pod^{-1}	Pod weight plant^{-1} (g)	Yield (kg ha^{-1})	Total dry matter (kg ha^{-1})
I_1 (0.4 Epan)	52.7	1.31	34	3.7	9.00	478	3031
I_2 (0.6 Epan)	60.3	1.82	42	3.9	15.07	796	3511
I_3 (0.8 Epan)	61.6	2.04	46	4.1	16.15	834	3731
I_4 (0.4+0.6 Epan)	54.6	1.57	38	3.7	11.17	675	3223
I_5 (0.4+0.8 Epan)	56.6	1.59	41	3.6	14.89	690	3292
I_6 (0.6+0.8 Epan)	60.4	1.93	50	3.9	16.80	808	3649
I_7 (0.4+0.6+0.8 Epan)	54.2	1.47	36	3.7	13.60	632	3273
I_8 (IW/CPE = 0.8)	53.9	1.33	35	3.6	9.36	612	3189
SE(m)	1.8	0.06	3	0.1	1.18	27	79
CD at 5%	5.5	0.18	10	NS	3.59	84	242

irrigation at 0.4 Epan up to flowering, 0.6 Epan from flowering to pod initiation and 0.8 Epan later on (I_7) and surface irrigation (Table 1). All the yield attributing characters viz., number of pods plant^{-1}, seeds pod^{-1} and pod weight plant^{-1} were higher in I_2, I_3 and I_6. Lowest yield was observed with drip irrigation at 0.4 Epan throughout the crop life (I_1) treatment. These trends were due to similar variation in growth and yield attributes under these treatments. Maintenance of favourable soil water balance under drip irrigation treatments at 0.8 Epan throughout the crop life (I_3), 0.6 Epan up to flowering and 0.8 Epan later on (I_6) and 0.6 Epan throughout the crop life (I_2) aided the crop plants to put forth more canopy growth and resulted in higher plant height and LAI and in turn improved performance over other treatments in terms of more number of pods plant^{-1}, seeds pod^{-1} and pod weight plant^{-1} since water plays a vital role in the carbohydrate metabolism, protein synthesis, cell wall synthesis and cell enlargement (Gardner *et al.,* 1985).This improved performance of plants resulted in higher yield and dry matter in these treatments. Yield under surface furrow irrigation was statistically inferior in comparison to drip irrigation treatments (I_2 to I_7) except I_1. The increase in yield was 36.2 per cent more when irrigation was scheduled by drip at 0.8 Epan throughout crop life (I_3) compared to surface furrow irrigation at 0.8 IW /CPE ratio (I_8).

The irrigation cycle under conventional furrow method of irrigation (I_8) consisted of a short period of infiltration followed by a long period of redistribution, evaporation and extraction of water by growing plants starting from field capacity moisture content down towards permanent wilting point. It was well documented that during this transition phase in soil moisture variation, it becomes increasingly difficult for the crop plants to extract water with every passing day since progressive decrease in soil-water content increases soil water tension. This decrease in soil water potential and wide fluctuation in soil moisture owing to longer irrigation interval in furrow treatment (8-12 days) as compared to drip (2-4 days irrigation interval) affected the crop growth, development and yield attributing characters resulting in reduced crop yields as is evident from I_8 treatment.

Investigations by others revealed that irrigations scheduled at an IW/CPE ratio of 0.6 (50 mm depth) proved to be beneficial for higher yield of pigeon pea **(**Gajera and Ahlawat, 2006 and Ramulu *et al.,* 2006). Whereas, Sudhakar and Rao, (1996) observed that irrigations scheduled at an IW/CPE ratio of 0.8 produced significantly higher seed yield than 0.6, 0.4 or 0.2 IW/CPE ratio.

The results of present study indicated that pigeon pea grown as *rabi* crop under Rajendranagar conditions can be irrigated with drip system at 0.8 Epan throughout the crop life with an optimal seasonal water requirement of 363 mm to realize higher yield. Under limited water supply situations, scheduling irrigation at 0.6 Epan throughout the crop life is beneficial.

REFERENCES

Gajera, M.S and Ahlawat, R.P.S (2006). Optimization of irrigation and evaluation of consumptive water use efficiency for *rabi* pigeon pea (*Cajanus cajan* (L) Millsp). Legume Research. 29 (2): 140-142.

Gardner, F.P., Pearu, R.B and Mitchell, R.L. 1985. *Physiology of crop plants*. Lowa State University press. Lowa, pp. 327.

Ramulu, V., Suresh, K and Balaguravaiah D. 2006. Effect of irrigation Schedules and sowing methods on *rabi* red gram (*Cajanus cajan*) in NSP left Canal Common of A.P. Journal of Water Management. 14 (2): 125-127.

Reddy, G.M, Ghosh, B.C and Sudhakar, N. 1991. Studies on scheduling of irrigation to winter pigeon pea. Indian Journal of Agronomy. 36(1): 109-111.

Sudhakar, C and Rao, V.P. 1996. Performance of different crops during post rainy season under varied moisture regimes in Southern Telangana region. Journal of Research, Andhra Pradesh. 22: 113-115.

Reserch Notes
J.Res. ANGRAU 39(4)104-109, 2011

STUDIES ON VARIABILITY, HERITABILITY, GENETIC ADVANCE, CORRELATION AND PATH ANALYSIS FOR QUANTITATIVE CHARACTERS IN RICE (*Oryza sativa* L.)

G. SHIVA PRASAD, M .SUJATHA, U. CHAITANYA and L.V. SUBBA RAO
Department of Genetics and Plant Breeding, College of Agriculture,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500030.

The present investigation was undertaken to study the genetic variability for yield and its component characters in various rice germplasm lines and to know the inter-relation among different yield contributing characters and their association with grain yield.

A field experiment was conducted during *Rabi*, 2010 at Directorate of Rice Research (DRR) farm, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Campus Patancheru, Hyderabad, India with 52 genotypes of rice obtained from Rajendra Agricultural University (RAU), Pusa; Vivekananda Parvathiya krishi Anusandan Shala (VPKAS), Almora; Regional Rice Research Station, Khudwani. Each entry was represented by single row of 4.5 m length with a spacing of 20 cm between rows and 15 cm between plants in a Randomized Block Design with three replications. Thirty days old seedlings were transplanted. Five representative plants for each genotype in each replication were randomly selected to record the observations on 16 metric traits. The mean data after computing for each character was subjected to standard methods of analysis of variance following Panse and Sukatme (1957**)**. Phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability (broad sense) and genetic advance as percentage of mean were estimated by the formulae suggested by Burton (1952). Correlations were estimated as suggested by Ali *et al.,* (1958). The partitioning of genotypic correlation coefficients into direct and indirect effects were carried out using the procedure suggested by Dewey and Lu (1959).

Table 1. Analysis of Variance for characters under study

S.No.	Character	Replication (d.f=2)	Treatments (d.f =51)	Error (d.f=102)
1.	Panicle length	0.914	36.088*	0.506
2.	Panicle exsertion	0.00	0.88*	0.0039
3.	Days to maturity	5.044	952.597*	1.554
4.	Spikelet sterility	16.5.9	98.119	2.052
5.	Test weight	0.013	0.334**	0.015
6.	Seed yield/plant	10.399	16.64*	2.039
7.	Early seedling vigor	0.0833	0.520	0.070
8.	Plant height	1.073	432.586*	0.324
9.	Tillers/plant	0.653	35.789*	0.692
10.	Days to 50% flowering	0.519	288.939**	1.473
11.	Productive tillers	0.208	44.144*	0.942
12.	Germination%	0.391	0.426*	0.351
13.	Coleoptile length	34.787	67.085	11.468
14.	Seedling growth	13.842	67.626**	9.0064
15.	Radical length	1.526	3.28**	0.522
16.	Seed vigor	17.769.40	675918.80**	89914.85

The analysis of variance indicated the existence of highly significant differences among genotypes for all the characters studied except spikelet sterility, early seedling vigor and coleoptile length (Table 1). A wide range of variation was observed in the rice germplasm for all the quantitative characters and yield (Table 2). Variation studies revealed that the estimates of PCV were slightly higher than the corresponding GCV estimates for panicle length, spikelet sterility, seed yield per plant and coleoptile length indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits. The characters like spikelet sterility, productive tillers, coleoptile length and days to maturity showed high PCV and GCV estimates. Sinha *et al*., (2004) also recorded similar observations for total tillers per plant, productive tillers per plant and single plant yield.

The estimates of heritability act as predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular character. In the present study, all the characters exhibited high heritability, which ranged from 62.56 to 99.46 % (Table 2). The genetic advance is a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. The genetic advance expressed as a percentage of mean ranged from 0.08 to 74.20 and the characters like spikelet sterility (74.20), productive tillers (74.50), and panicle exsertion (44.61) recorded higher estimates.

The character that shows high heritability with high genetic advance are controlled by additive gene action (Panse and Sukatme, 1957) and can be improved through simple or progeny selection methods. Selection for the traits having high heritability coupled with high genetic advance is likely to accumulate more additive genes leading to further improvement of their performance. In the present investigation, high heritability along with high genetic advance was noticed for all the traits except coleoptiles length and germination percentage, which had moderate magnitude of genetic advance.

Genotypic correlations in general were high as compared to their phenotypic correlations indicating strong inherent association between the characters. Genotypic correlation coefficients of the characters studied are presented in Table 3. Days to 50 per cent flowering had positive and significant correlation with coleoptile length, seedling growth and seed vigor. Plant height (cm) exhibited a positive and non significant association with number of tillers per plant and days to 50% flowering. Panicle exsertion exhibited positive and significant association with radical length.

Test weight (g) had positive and significant correlation with coleoptile length, seedling growth, radical length and seed vigor. Days to maturity exhibited positive and significant correlation with plant height, days to 50% flowering, coleoptile length, seedling growth and seedling vigor. Early seedling vigor recorded a positive and significant correlation with seedling maturity after transplanting. It also had negative and significant correlation with days to 50% flowering. Seedling maturity after transplanting had a negative and significant correlation with days to 50% flowering and plant height.

Germination percentage recorded a positive and non significant correlation with radical length and seed vigor. Coleoptile length recorded a positive and significant correlation with seedling growth and seed vigor. Seedling growth exhibited a positive and significant correlation with seed vigor and negative and non significant correlation with radical length. Radical length recorded a negative and non significant correlation with seed vigor. These results are in conformity the findings of Kuldeep Tyagi *et al.,* (2004).

Path coefficient analysis revealed that seedling growth (cm) exerted the highest direct positive effect on grain yield followed by panicle length, days to 50% flowering , early seedling vigor and seed vigor (Table 4), indicating that the selection for these characters is likely to bring about an overall improvement in single plant yield directly. These results are in accordance with the findings of Agahi *et al.,* (2007). Path coefficient analysis revealed that panicle exsertion showed the highest negative direct effect on grain yield followed by radical length (cm), seedling maturity, number of tillers per plant and days to maturity.

In the present study, eight superior genotypes, *viz.,* Ujala depama, IR-64, Bhurma bhuqi,

Table 2. Summary of genetic parameters for the characters under study.

	Panicle exsertion	Panicle lengthth cm	Days to maturity	Spikelet sterility	Test weight (g)	Seed yield / plant(g)	Early seedling vigor	Seeling maturity	Plant height	Tillers/plant	Days to 50% flower-ing	Productive Tillers	Germination%	Coleo Ptile length (cm)	Seed – ling growth (cm)	Radical length (cm)	Seed vigor
Var Environmental	0.00	0.51	1.55	2.05	0.02	2.04	0.07	0.20	0.32	0.69	1.47	0.94	0.35	11.47	9.01	0.52	89914.85
ECV	2.52	3.06	1.06	9.41	5.37	13.84	13.09	9.61	0.57	5.96	1.19	9.55	0.60	16.86	8.36	4.53	8.36
Var Genotypical	0.29	11.86	317.01	32.02	0.11	4.87	0.15	0.33	144.09	11.70	95.82	14.40	0.03	18.54	19.54	0.92	195334.66
GCV	21.80	14.80	15.20	37.16	13.95	21.38	19.13	12.34	11.98	24.49	9.63	37.33	0.16	21.44	12.31	6.02	12.33
Var Phenotypical	0.30	12.37	318.57	34.08	0.12	6.91	0.22	0.53	144.41	12.39	97.30	15.34	0.38	30.01	28.55	1.44	285249.50
PCV	21.94	15.12	15.24	38.33	14.95	25.47	23.18	15.64	12.00	25.21	9.70	38.53	0.62	27.28	14.88	7.54	14.89
h^2 (Broad Sense)	0.99	0.96	1.00	0.94	0.87	0.70	0.68	0.62	1.00	0.94	0.98	0.94	0.07	0.62	0.68	0.64	0.68
Genetic Advancement 5%	1.11	6.95	36.59	11.30	0.63	3.82	0.66	0.93	24.70	6.85	20.01	7.57	0.08	6.97	7.53	1.58	753.41
Genetic Advancement 1%	1.42	8.90	46.89	14.48	0.80	4.89	0.84	1.20	31.65	8.77	25.65	9.71	0.11	8.93	9.65	2.02	965.54
Gen.Adv as % of Mean 5%	44.61	29.87	31.24	74.20	26.82	36.98	32.53	20.05	24.66	49.02	19.68	74.50	0.08	34.72	20.98	9.91	21.01
Gen.Adv as % of Mean 1%	57.17	38.28	40.04	95.09	34.38	47.39	41.69	25.70	31.60	62.82	25.22	95.48	0.11	44.49	26.88	12.70	26.93
General Mean	2.48	23.26	117.11	15.23	2.34	10.32	2.03	4.65	100.17	13.97	101.69	10.17	99.63	20.08	35.92	15.94	3585.91
Exp Mean next Generation	3.59	30.21	153.70	26.53	2.96	14.13	2.68	5.59	124.87	20.81	121.70	17.74	99.71	27.05	43.45	17.52	4339.32
Var Environmental	0.00	0.51	1.55	2.05	0.02	2.04	0.07	0.20	0.32	0.69	1.47	0.94	0.35	11.47	9.01	0.52	89914.85

Table 3. Phenotypic correlation matrix for the characters under study

	Panicle exertion	Panicle lenghth cm	Days to maturity	Spikelet sterility	Test Weight (g)	Early seedling vigor	Seed ling maturity	Plant height.	Tillers/ Plant	Days to 50% flowering	Produ ctive Tillers	Germin ation %	Coleo ptile Length (cm)	Seed ling growth (cm)	Radical length (cm)	Seed vigor.
Panicle exertion	1.00	0.029	-0.1819*	0.0785	-0.0509	0.1561	0.0822	0.0846	0.1785*	-0.2629**	0.1804*	-0. 100	-0.228**	-0.2185**	-0.0418	-0.2284**
Panicle lenghth cm		1.00	-0.1967*	-0.115	-0.0610	-0.1775*	-2.2627**	0.1952*	0.1081	0.088	0.3510**	0.051	-0.193	-0.1418	0.2214**	-0.146
Days to maturity			1.00	-0.112	-0.0434	-0.2610**	-0.0234	0.2415**	-0.3516**	0.511**	-0.5581**	-0.025	0.520**	0.4927**	0.3462**	0.488**
Spikelet sterility				1.00	-0.0597	0.0067	-0.0816	-0.0188	0.0162	-0.055	0.0086	0.060	-0.068	-0.0608	0.023	-0.06
Test Weight (g)					1.00	0.1283	0.0175	-0.0495	-0.0850	-0.072	-0.019	-0.066	0.334**	0.4212**	0.307	0.401**
Early seedling vigor						1.00	0.6595**	-0.1334	0.0357	-0.339**	0.109	-.155	-0.042	-0.082	0.007	-0.074
Seedling maturity							1.00	-0.1813*	-0.1266	-0.2080**	-0.055	-0.101	-0.086	-0.126	-0.019	-0.122
Plant height.								1.00	0.1045	0.131	-0.004	-0.070	0.129	0.119	-0.117	0.116
Tillers/ Plant									1.00	-0.134	0.597**	-0.017	-0.204*	-0.190	0.159*	-0.167*
Days to 50% flowering										1.00	-0. 383**	0.015	0.264**	0.265**	-0.133	0.265**
Produ ctive Tillers											1.00	-0.07	-0.430**	-0.411**	0.243**	-0.390**
Germin ation %												1.00	-0.046	-0.1019	0.058	0.016
Coleoptile Length (cm)													1.00	0.948**	-0.242**	0.943**
Seedling growth (cm)														1.00	-0.043.	0.991**
Radical length (cm)															1.00	0.046
Seed vigor.																1.00

*Significant at 5 Percent level; ** Significant at 1 Percent level

Table 4. Phenotypic path matrix for the characters under study

		Panicle exertion	Panicle lenghth cm	Days to maturity	Spikelet sterility	Test Weight (g)	Early seedling vigor	Seed ling maturity	Plant height.	Tillers/ Plant	Days to 50% flowering	Produ ctive Tillers	Germin ation %	Coleo ptile Length (cm)	Seed ling growth (cm)	Radical length (cm)
Panicle exertion	**-0.0082**	.0.0002	-0.0015	-0.0006	0.0004	-0.0013	-0.0007	-0.0007	-0.0015	0.0022	-0. 0015	0.0008	0.0019	0.0018	0.0003	0.0019
Panicle lenghth cm	0.0057	**0.1970**	-0.0387	-0.0023	-0.012	-0.035	-0.051	0.038	0.021	0.017	0.069	0.010	-0.038	-0.027	0.043	0.028
Days to maturity	0.066	0.071	**- 0.03628**	0.04	0.015	0.094	0.08	-0.08	0.12	-0.185	0.202	0.009	-0.188	-0.178	0.125	-0.177
Spikelet sterility	-0.001	0.0003	0.002	**-0.0222**	0.001	-0.0001	0.0018	0.0004	-0.0004	0.0012	-0.0002	-0.0013	0.0015	0.0014	-0.0005	0.0013
Test Weight (g)	0.0046	0.0056	0.004	0.005	**-0.0912**	-0.011	-0.001	0.004	0.007	0.006	0.0017	0.006	-0.0314	-0.038	-0.028	-0.036
Early seedling vigor	0.0032	-0.0036	-0.0053	0.0001	0.0026	**0.0204**	0.013	-0.0027	0.0007	-0.0069	0.0022	-0.0032	-0.0009	-0.0017	0.0002	-0.0015
Seed ling maturity	-0.0008	0.0026	0.0002	0.0008	-0.0002	-0.0066	**-0.0101**	0.0018	0.0013	0.0021	0.0006	0.001	0.0009	0.0013	0.0002	0.0012
Plant height.	-0.0021	-0.0048	-0.0059	0.0005	0.0012	0.0033	0.0044	**-0.0245**	-0.0026	-0.0032	0.0001	0.0007	-0.0032	-0.0029	0.0029	-0.0028
Tillers/ Plant	-0.0238	-0.0145	0.047	-0.002	0.011	-0.0048	0.016	-0.014	**-0.1336**	0.0179	-01079	0.002	0.027	0.025	-0.021	0.022
Days to 50% flowering	-0.0117	0.0039	0.022	-0.002	-0.003	-0.015	-0.009	0.005	-0.006	**0.0444**	-0.017	0.0007	0.011	0.011	-0.005	0.011
Produ ctive Tillers	0.009	0.019	-0.030	0.0005	-0.001	0.0036	-0.003	-0.0002	0.032	-0.020	**-0.0546**	-0.003	-0.023	-0.022	0.013	-0.021
Germin ation %	0.003	-0.001	0.0008	-0.001	-0.002	0.005	0.003	0.002	0.0005	-0.0005	0.002	**-0.0321**	0.001	0.0006	-0.001	-0.0005
Coleo ptile Length (cm)	0.011	0.009	-0.026	0.003	-0.017	0.002	0.004	-0.006	0.010	-0.013	0.022	0.002	**-0.0512**	-0.048	0.012	-0.048
Seed ling growth (cm)	-0.058	0.038	0.13	-0.016	0.112	-0.022	-0.033	0.031	-0.051	0.071	-0.011	-0.05	0.254	**0.2678**	0.011	0.265
Radical length (cm)	0.0001	-0.0006	0.0009	0.0001	-0.0008	0.0000	0.0001	0.0003	-0.0004	0.0004	-0.0007	0.0002	0.0007	0.0001	**-0.0027**	0.0001
Seed vigor.	0.006	0.003	0.012	-0.001	0.010	-0.0019	-0.0032	0.003	-0.004	0.007	-0.010	0.0004	0.024	0.025	-0.001	**0.0262**

Malida, Tella hamsa,Kavya,Vldhan-221 and Krishna hamsa were found to be potential enough to be used as parents in heterosis breeding. These genotypes recorded highest values for one or the other yield contributing characters and hence their utilization in combination breeding may help in generating high yielding varieties/ hybrids by pyramiding all the favourable genes.

REFERENCES:

Agahi, K., E. Farshadfar and M.H. Fotokian. 2007. Correlation and path coefficient analysis for some yield-related traits in rice genotypes (Oryza sativa L.). Asian J. Plant Sci., 6: 513-517.

Ali, R.I., Awan ,T.H., Manzoor,Z., Ashraf, M. M., Safdar,M. E and Ahmad, M., 1958 . Screening of rice varieties suitable for direct seeding in Punjab. Animal and plant science. 17.1-2.

Burton, G. W. 1952. Quantitative inheritance in grasses. Proc. Sixth International Grassland Cong. 1: 277-283.

Dewey, D. R and H. K. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grass and seed production. Agron. J. 51(6): 515-518.

Kuldeep Tyagi., Bathshwar Kumar., Ramesh, B., and Ajay Tomer. 2004. Genetic variability and correlations for some seedlings and mature plant traits in 70 genotypes of rice. Research on crops 5 (1): 60-65.

Panse, V. G and P. V. Sukhatme. 1957. Statistical methods for agricultural workers, ICAR, New Delhi, 4th Edn.

Sinha S K., Tripath A. K and Bisen U. K. 2004. Study of genetic variability and correlation coefficient analysis in mid late land races of rice. Annals of agricultural research 25(1):1-3.

Abstracts of Theses Accepted for the Award of Post-Graduate and Doctorate Degrees in the Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030

Influence of cutting intervals and intercropping on growth, yield and quality of bajra napier hybrid (*Pennisetum americanum X Pennisetum purpureum)*

Student: Kailash Chand Verma

Major Advisor: Dr. K.B. Suneetha Devi

Department of Agronomy

An experiment entitled "Influence of cutting intervals and intercropping on growth, yield and quality of Bajra Napier hybrid (BN hybrid) (*Pennisetum americanum X Pennisetum purpureum)"* was conducted at Student farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, during *rabi* season of 2007-08.

Cutting interval of 9 weeks produced maximum plant height of BN hybrid and was on par with 7 and 8 weeks cutting interval at both the cuts but, number of tillers clump^{-1} were maximum at cutting interval of 8 weeks and was on par with cutting interval of 7 weeks. Number of leaves and leaf stem ratio of BN hybrid were not influenced by cutting intervals at both the cuts. Green, dry, crude protein and equivalent yield of BN hybrid increased with increase in cutting interval from 5 to 9 weeks reaching a maximum at 9 weeks but, was on par with cutting interval of 8 weeks at I cut. Crude fibre content of BN hybrid increased with cutting intervals from 5 to 9 weeks reaching a maximum at 9 weeks.

Non significant interaction was obtained between cutting intervals and intercropping on plant height, leaf stem ratio, equivalent yield of BN hybrid at both the cuts, number of tillers clump^{-1}, green dry and crude protein yield of BN hybrid at I cut. At II cut and at total, maximum green, dry and crude protein yield of BN hybrid were recorded at cutting intervals of 9 weeks with cowpea intercropping and was on par with cutting interval of 7 weeks with same intercrop and with berseem intercropping at cutting interval of 9 weeks.

Influence of cutting intervals and intercropping on intercrops revealed that germination percentage of intercrops was higher at cutting interval of 5 weeks which was on par with cutting interval of 8 weeks and 9 weeks. Plant height, number of branches, leaf stem ratio, green, dry fodder and crude protein yield of intercrops at both the cuts and number of leaves plant^{-1} at II cut did not influence by cutting interval of BN hybrid. Number of leaves plant^{-1} of intercrops were significant at I cut and cutting interval of 7 weeks favored higher number of leaves plant^{-1}.

Total green, dry fodder and crude protein yield of BN hybrid +intercrops were maximum at cutting interval of 9 weeks at both the cuts and was on par with cutting interval of 8 weeks during I cut. Cowpea intercropping significantly improved the green, dry and crude protein yield of BN hybrid + cowpea over other combinations. The green, dry and crude protein yield of BN hybrid +intercrops were at par when berseem and lucerne was grown as intercrops.

Significant negative correlation was found between mean and minimum temperature and number of leaves plant^{-1} at I cut and with dry fodder yield at II cut. Green fodder yield of BN hybrid positively correlated with leaf stem ratio. Crude protein yield of BN hybrid was positively correlated with green fodder yield and negatively correlated with leaf stem ratio.

Cutting interval of 9 weeks resulted in higher gross return except in cluster bean where in cutting interval of 8 weeks produced higher gross returns. Cowpea intercropping yielded highest gross returns at all the cuts followed by lucerne, berseem and cluster bean respectively. Total gross returns BN hybrid + intercrops were higher at cutting interval of 9 weeks with cowpea intercropping. Total net returns and benefit cost ratio of BN hybrid + intercrops were higher at cutting interval of 9 and 7 weeks respectively with cowpea intercropping. **M.Sc.(Ag.), 2009.**

Estimation of water requirement in maize using cropwat model

Student: A. Ajay Kumar Major Advisor: Dr. Baby Akula

Department of Agronomy

CROPWAT V 4.2 (Crop Water Requirement Model) developed by Derek Clarke *et.al* (1998) was used to estimate water requirement and yield reduction due to water stress in maize, as it is one of the simple scientific knowledge based tool. A field experiment was laid out in a randomized block design with 7 treatments.

The treatments were replicated thrice during *rabi* 2006-07, at Students Farm, College of Agriculture, Rajendranagar, Hyderabad, to generte necessary data required to achieve the main objective of estimating water requirement in maize using CROPWAT model.

The fully irrigated control treatment i.e. drip at 100 per cent of pan evaporation (I_3) throughout the crop growing season registered significantly higher yield when compared to other treatments.

Crop coefficients for different crop growth sub-periods were estimated and crop curve was constructed for calculation of irrigation requirement. The irrigation water requirement (IWR) was the highest (290.5 mm) in case of I_3 treatment followed by I_6 treatment (264.1 mm), while minimum irrigation water requirement was noticed in drip irrigation at 50 per cent of pan evaporation (I_1) treatment in respect of the quantity of irrigation water applied.

Different test criteria were followed to evaluate the performance of CROPWAT model. Besides, error per cent was also calculated in all the treatments. Close scatter of simulated yields, irrigation water requirement (IWR) and respective measured values around the regression line and 1:1 line indicated better performance of the model in estimating maize yields or yield reduction. CROPWAT model explained 95 per cent variation in yield and 98 per cent variation in irrigation water requirement (IWR). The estimated RMSE (Root Meas Square Error) for yield was 400 kg ha^{1}. Amont the different drip irrigation treatments, error per cent of yield was relatively low in the treatment of I_3 and I_6 as compared with that of other treatments. In all the treatments, under estimation of yield was noticed except in I_3 treatment. In case of net irrigation requirement, in most of the treatments under estimation of IWR was noticed. Thus, model can be usede as a tool in estimating water requirement and subsequently in irrigation scheduling in maize. **M.Sc.(Ag.), 2008.**

Genetic studies in F_2 generation of 15 crosses involving bold-seeded genotypes in groundnut (*Arachis hypogaea* L.)

Student: D. Sudha Jyothi Major Advisor: Dr. R.P. Vasanthi

Department of Genetics and Plant Breeding

The present investigation was carried out during *kharif,* 2007 to study genetics of confectionery traits in addition to yield and yield attributges in F_2 generation of 15 crosses made to develop early maturing bold-seeded confectionery varieties. The experiment was laid out at Regional Agricultural Research Station, Tirupati in a randomized block disign with three replications and data were recorded on fifteen characters for estimation of genetic parameters.

Analysis of variance carried out among F_2 populations and parents revealed Significant differnces for all the characters studied. Plant height, number of primary branches, number or secondary branches, pod yield/plant, seed width, protein content, sucrose content and oil content showed high estimates of GCV and PCV, heritability (broad sense) and GAM. The role of additive gene action seems to be significnat in the inheritance of these traits. Thus phenotypic selection is early generations would help to make improvement in these characters.

The crosses ICGV 99157 x TG 47 and IC GV 99157 x JSSP- HP 21 recorded high mean coupled with higher values of GCV, heritability and GAM for pod yield / plant. For protein content, ICGV 99157 x TG 47 and K4 x TG 47 showed high mean coupled with high heritability. For oil content, TAG 24 x TG 47 and TAG 24 x TKG 19A

showed high heritability coupled with high GAM. K4 x TKG 19A recorded higher values of mean, heritability and GAM for sucrose content. Simple selection could be practiced in all these crosses for improving these characters. For number of mature pods, all the crosses exhibited low heritability estimates except the cross ICGV 99157 x TG 47. The crosses ICGV 99157 x TG 47, ICGV 99157 x TKG 19A, K4 x JSSP - HP 21 recorded low to moderate estimates of heritability and moderate to high estimates of GCV and GAM. In these crosses, selection may be postponed for later generations for improvement of number of mature pods per plant.

Inheritance of plant height, pod length, pod width, seed length and seed width was studied in a different set of crosses grown during *rabi* 2007-08. F_2 phenotypic data for plant height was a good fit to a phenotypic ratio of 1:4:6:4:1 and 1:2:1 respectively in two crosses studied indicating the involvement of more than two genes. For pod length, seed lengh and seed width similar ratios were observed. In these crosses values of GCV and GAM for the traits studied were found to behigh indicating the role of additive variance in their inheritance. However, these results have to be further verified by F_3 progeny studies.**M.Sc.(Ag.),2008.**

Genetic divergence for yield, physiological and quality traits in groundnut (*Arachis hypogaea* L.)

Student: Boya A.V.G. Sudhakar Major Advisor: Dr. O. Venkateswarlu

Department of Genetics and Plant Breeding

The present investigation was carried out during *kharif,* 2007 to study genetic divergence, charecter association, path analysis and genetic parameters in 74 genotypes of groundnut (*Archis hypogaea* L.). The experiment was laid out at Regional Agricultural Research Station, Tirupati, in a randomized block desing with three replications and data was re corded on sixteen characters.

Analysis of variance indicated the existence of significant differences among genotypes for all the characters studied. The genotypes ICGV 95477, FDRS 79, TCGS 913 and TG 41 showed high mean performance for pod yield and its components.

Genetic divergence studies by Mahalanobis D^2 analysis indicated the existence of significant diversity in 74 groundnut genotypes and were grouped into 12 clusters. The mode of distribution of genotypes to various clusters was at random suggesting that there is no relationship between geographical distribuion and genetic diversity. Based on intercluseter distances, the clusters VII vs X, VI vs XII and X vs XII were adjusted the divergent. Hence, the genotypes in these clusters namely ICGV 99032 (cluster VI), TCGS 647, JL 220(cluster VII), ICGV 95477, JL 24, ICGV 99054, ICGV 86699 (cluster X) and ICGV 99029 (cluster XII) were suggested for inclusion in hybridization programme for obtaining superior and desirable recombination. The characters 100- kernel weight, shelling percentage and harvest index contributed maximum towards genetic divergence in both D^2 analysis and canonical root analysis. Further, canonical root analysis confirmed the clustering pattern obtained by D^2 analysis.

Character association studies revealed that the traits *viz.* shelling percentage, mature pods per plant and pod yield per plant had significant positive association with kernel yield. Path analysis revealed that shelling percentage, pod yield per plant were the important attributes in formulating selection criterion for effective improvement of kernel yield.

The analysis of genetic parameters revealed high PCV, GCV, heritability and GAM for sucrose content and kernel yield per plant indicating that simple selection could be practiced for improving these characters. **M.Sc.(Ag.), 2008.**

Selection criteria in rice under SRI management system

Student: Ch. Madhu Sudhan Rao Major Advisor: Dr. M. Hemanth Kumar

Department of Genetics and Plant Breeding

The present investigation was under taken in rice (*oryza sativa* L.) to evaluate the promising rice varieties for SRI cultivation, assess, variability and estimate heritability and genetic advance as per cent of mena, character association and path coefficient analysis for ten genotypes under SRI and conventional managements. The experiment was laid out at S.V. Agricultural College, Tirupati during *rabi*, 2006.

Analysis of variance revealed that significant differences among the genotypes for the characters studied indicating the existence of genetic variability among the genotypes. Based on the mean performance Sravani, Swathi and Swarnamukhi were considred to be best suited for cultivation under SRI management.

High variability was observed for grain yield per plant followed by root mass and total dry matter production. Whereas moderate variability existed for plant height, total tillers per plant, number of effective tillers, number of grains per panicle, root to shoot ratio, test weight and leaf area index at 90 DAS.

Grain yield per plant exhibited positive significant correlation with plant height, panicle length, total dry matter production, root mass and harvest index under SRI management and with total dry matter production alone under conventional management. Direct selection for total dry matter production and root mass and indirect selection through root to shoot ratio and harvest index in SRI management and direct selection for days to maturity, harvest index and leaf area index at 90 DAS in conventional management would be effective for improving grain yield. **M.Sc.(Ag.), 2008.**

Genetic diversity and biological control of *Sclerotium rolfsii* (Sacc.) causing stem rot of groundnut (*Arachis hypogea* L.)

Student: S. Durga Prasad Major Advisor: Dr. N.P. Eswara Reddy

Department of Plant Pathology

Groundnut (*Arachis hypogea* L.) is a major legume and an important oil seed crop in India, covering nearly half of the area under oil seeds. Groundnut is affected by several diseases of which stem rot caused by *Sclerotium rolfsii* Sacc. is an important disease with yield losses of over 25 per cent.

A detailed study was carried on cultural, morphological and pathogenic variabilities among the isolates of *S. rolfsii. In vitro* antagonism of microflora isolated from seed and root habitats against *S. rolfsii* and their compatibility with different fungicides. Molecular characterization of *S. rolfsii* isolates by using RAPD and RDNA analysis by ITS-PCR and ITS-RFLP.

Roving survey was conducted in Chittoor and Kadapa districts of Andhra Pradesh to collect stem rot infected samples. The average percent disease incidence of 10.38% in Chittoor and 17.84 per cent in Kadapa was recorded. The pathogen was isolated from infected stem bits of groundnut, purified and identified as *S. rolfsii* Sacc.

In pathogenic variability, the isolates CSr 4, KSr 19 and KSr 20 exhibited maximum per cent disease incidence (100%) while the isolate KSr 13 and KSr 15 recorded the lowest PDI.

A total of 48 antagonistic microflora (8 fungi and 40 bacteria) were obtained as seed and root endophytes from groundnut.

Different fungicides were tested *in vitro* for compatibility with bioagents, mancozeb was found highly compatible with *Trichoderma* isolate (GSEF 3). Among the bacterial isolates GSE 1 was more compatible with mancozeb and less compatible with thiophanatemethyl. The isolate GRE 29 also recorded more compatibility with mancozeb and less in case of copper oxychloride.

The RAPD banding pattern with random primers *viz.,* OPA-01, OPA-12, OPA-17, OPA-18 and OPA-20 reflected the genetic diversity among the isolates with formation of 2 main cultures. Amplified ITS region of rDNA with universal primers ITS-1 and ITS-4 produced approximately 650-700 bp fragments as expected. ITS-RFLP results with *AluI, HinfI* and *MseI* enzymes have not shown any polymorphism among the isolates under the study. **M.Sc.(Ag.), 2008.**

Studies on cultural, morphological, pathogenic variability and biological control of (*Colletotrichum gloeosporioides* Penz., causing mango anthracnose (Coastal and Telangana Regions of Andhra Pradesh)

Student: K. Aruna

Major Advisor: Dr. N. P. Eswara Reddy

Department of Plant Pathology

The present investigation was undertaken to study the variability with respect to cultural, morphological, pathogenic and fungicidal sensitivity among the 16 isolates of *C.gloeosporioides* collected from Coastal and Telangana regions of Andhra Pradesh and also to isolate a fungicidal tolerant potential biocontrol agent from phylloplane and leaf endophytes.

Isolate Cg5 recorded the maximum sporulation (5.82 x 10^4 conidia/ml) while the least sporulation was observed in Cg14 (0.34 x 10^4 conidia/ml). Maximum conidial size was recorded in Cg6 (16.66 x 5.25 conidia/ µm), while isolate Cg8 (12.65 µm) recorded the least conidial length Cg14 (4.11 µm) recorded the lowest width.

Thirty seven antagonistic microflora were isolated from phylloplane (15 bacteria + 10 fungi) and endophytes (12 bacteria) Potential antagonists were identified based on their ability to inhibit the growth of *C. gloeosporioides* in dual culture technique. PB_5, PB_{15}, EB_8 and EB_{12} isolates completely inhibited the growth of *C. gloeosporioides* whereas T_4 and T_7 isolates of *Trichoderma* recorded 88.88 per cent of inhibition.

Fungicidal compatibility studies were conducted on these potential antagonists by using poisoned food technique for fungal antagonists and spectrophotometry for bacterial antagonists. EB_8 was found to be more compatible with most of the fungicides used followed by PB_5 and the least compatibility was recorded in PB_{15}.

T_4 and T_7 isolates gave different degrees of compatibility with different fungicides. They were highly compatible with mancozeb and incompatible with carbendazim and propiconazole. **M.Sc.(Ag.), 2008.**

Studies on Genetic Diversity in Maize (*Zea mays* L.)

Student: R.T. Maruthi

Major Advisor: Dr. K. Jhansi Rani

Department of Genetics and Plant Breeding

The present investigation was undertaken to estimate the genetic variability and genetic diversity in maize and to carry out yield component analysis through correlation and path analysis. Forty stabilized inbredlines along with three checks were sown in a randomized block design with three replications, during *rabi* 2008-2009 at College Farm, College of Agriculture, Rajendranagar.

There was a significant difference between genotypes for all the characters, which revealed wide range of variability and high heritability for all the characters.

From correlation studies it was observed that grain yield per plant exhibited high significant positive association with ear girth followed by ear length, number of kernels per row, 100 grain weight, plant height and ear height. Path analysis revealed that, the maximum positive direct effect on grain yield per plant was exhibited by number of kernels per row. Days to 50 per cent tasseling and days to 50 per cent siling recorded low and negligible negative direct effects on grain yield, respectively.

D^2 analysis was carried out for even characters which partitioned the forty three genotypes in to six clusters. The maximum inter cluster distance was observed between cluster I and cluster V. Grain yield per plant, plant height, umber of kernels per row and 100 grain weight contributed greatly towards diversity. **M.Sc.(Ag.), 2009.**

Characterization and evaluation of land suitability for important crops grown on lateritic soils in medak district of Andhra Pradesh

Student: T. Basanta Singh Major Advisor: Dr. A. Sairam

Department of Soil Science and Agricultural Chemistry

The study was conducted to characterize and evaluate the suitability of Laterite sols of Medak district for rice, sugarcane and potato crops. The site and profile characteristics of six pedons were studied in the field.

The soils were low in available nitrogen and potassium and low to medium in available phosphorus content. The soils were sufficient in zinc, iron, copper and manganese supply, with high percentage of sesquioxides and responded to liming materials.

For cultivation of rice, Parvatapur and Bilalpur series were marginally suitable and Rejental, Algol, Zaheerabad and Krishnapur series were moderately suitable. For growing sugarcane Rejental, Algol, Bilalpur and Zaheerabad series were considered to be moderately suitable whereas Parvatapur and Krishnapur were marginally suitable. Potato cultivation was considered to be marginally suitable in Algol, Zaheerabad and Krishnapur whereas Rejental, Parvatapur and Bilalpur series were not suitable because of textural limitations.

The water samples collected from the study area were neutral to alkaline in reaction, Dominance of cations and anions in these samples were in the order of $Ca^{2+}>Mg^{2+}>Na^{+}>K^{+}$ and $Cl^{-}>HCO_3^{-}>CO_3^{2-}$ respectively based on which it was as C_3S_1.**M.Sc.(Ag.), 2009.**

Studies on establishing molecular identity for genetic purity assessment of popular rice (*oryza sativa* L.) varieties using EST-SSR markers

Student: Krishna Moorthy K. Major Advisor: Dr. Prakash Babu

Department of Seed Science and Technology

The present investigation was carried out with an objective to identify distinguishable EST-SSR (Expressed Sequence Tag derived Simple Sequence Repeat) alleles to assess the genetic diversity and genetic purity for twelve popular rice varieties, to validate the utility of EST-SSR markers in seed genetic purity assessment. A set of 12 morphological traits were used for GOT and 98 hyper variable EST-SSR markers were used for molecular marker analysis. The study was also intended to develop molecular fingerprints or IDs for these varieties using locus specific EST-SSR markers and to test their utility in seed genetic purity assessment.

The cluster analysis based of Jaccard's similarity coefficient using UPGMA (unweighted Pair Group Method with Arithmetic Averages) grouped the varieties into four clusters. The genetic similarity between the genotypes ranged from 0.3 to 0.92 Principal component analysis (PCA) revealed that the 12 varieties were scattered into three distinct clusters.

Utility of EST-SSR marker alleles as molecular IDs in monitoring genetic purity of seeds was established. The results indicated the practical usefulness of EST-SSR markers in assessing genetic purity of rice varieties and diversity among them. **M.Sc.(Ag.), 2009.**

Studies on genetic divergence in medium duration elite rice genotypes (*Oryza sativa* L.)

Student: C. Manikya Minnie Major Advisor: Dr. T. Dayakar Reddy

Department of Genetics and Plant Breeding

The present investigation was carried out during *kharif,* 2008 to study the genetic parameters, genetic divergence, characters association and path coefficient analysis in 81 diverse genotypes of rice (*Oryza sativa* L.) The experiment was laid out at Rice Section Farm of Agricultural Research Institute, Rajendranagar, Hyderabad in a Randomized Block Design with two replications.

The analysis of variance indicated the existence of significant differences among genotypes for all the characters studied. Small difference between GCV and PCV was recorded for all the characters under study which indicated less influence.

Genetic divergence studies by Mahalanobis D^2 analysis indicated the existence of significant diversity in 81 rice genotypes which were grouped into gen clusters. The pattern of distribution of genotypes into various clusters revealed that there was no relationship between geographical distribution and genetic diversity.

Character association studies indicated the significant positive correlation of number of productive tillers per plant, plant height, panicle length and number of grain per panicle with grain yield per plant and among themselves indicting the simultaneous selection for these characters would result in improvement of high yielding rice genotypes.

Path analysis revealed that number of productive tillers per plant, panicle length and number of grains per panicle were the most important characters which could be used as selection criteria for effective improvement of grain yield. **M.Sc.(Ag.), 2009.**

Studies on cultural, morphological variability and bioligical control of *Fusarium solani,* Incitant of dry root-rot of citrus

Student: M. Ravichandran Major Advisor: Dr. M. Reddi Kumar

Department of Plant Pathology

Acid lime (*Citrus aurantifolia* Swingle) is one of the important citrus fruits, constitutes nearly 20% of the total citrus production in India. Andhra Pradesh is one of the important citrus producing states in the country with a total area of about 1.66 lakh hectares and an annual production of 2.23 lakh tones.

Roving survey was conducted on dry root-rot disease incidence based on prevalence of disease in major acid lime growing areas of Ananthapur and Chittoor districts of Andhra Pradesh. Maximum percentage of the disease incidence was recorded in Narpala mandal (22.14%), while the least percent disease incidence (13.91%) was recorded in Singanamala mandal of Ananthapur district.

Soil inoculation method was followed in pathogenicity test to know the most virulent isolate of *F. solani.* The maximum dry root-rot incidence was observed in CFS_9 isolate. The pathogen was reisolated from the infected plants and the characters of the pathogen were similar to that of with original strain (CFS_9) isolated from the field and thus proved Koch's postulates.

Among the 36 isolates of *Trichoderma* spp. tested, maximum percentage of inhibition (84.3%) was recorded in ACT_6 isolate. Among the isolates tested, thirteen isolates showed maximum percentage of inhibition. Least percentage of inhibition was observed in the isolate ACT_7.

The studies were also focussed to find out the effective treatment to control dry root-rot of acid lime using bioagent, *Trichoderma* spp. isolate ACT_6 and organic amendments (neem cake and gypsum) at different concentrations in pot culture experiment. Soil

application with antagonist @ 8g and neem cake 100g/ kg of soil (T_{10} treatment) recorded least percent pre-emergence disease incidence (13.8%) compared to control. Soil application with antagonist alone recorded maximum percentage of disease incidence. Soil application of antagonist @ 8g/kg soil and neem cake @ 100g/kg soil gave best control of post-emergence disease with no wilt incidence compared to control.

Incrased shoot length was recorded in T_{10} treatment (Soil application with antagonist @8g and neem cake 100g/kg of soil) and it was 8.3 cm compared to control. T_{10} treatment showed 42 per cent increased shoot length over control. Maximum root length (8.5 cm) recorded in the same treatment over control. Seed treatment with antagonist @ 4g/kg of seed alone recorded least root length of acid lime. **M.Sc.(Ag.), 2008.**

Studies on pathogenic variability and biological management of *Colletotrichum gloeosporioides* penz., causing mango anthracnose (Chittoor and Kadapa Districts of Rayalaseema Region, Andhra Pradesh)

Student: J. suvarna

Major Advisor: Dr. S. V. Ramakrishna Rao

Department of Plant Pathology

The present investigation was made to study the variability with respect to cultural, morphological, pathological and fungicidal sensitivity/ tolenrance among the 20 isolates of *Colletotrichum gloeosporioides* collected from Chittoor and Kadapa districts of Rayalaseema region of Andhra Pradesh and also to isolate potential fungicidal tolerant biocontrol agents from phylloplane and leaf endophytes.

Maximum mean sporulation was recorded in isolate (6.33×10^4 conidia ml^{-1}), while the least sporulation was recorded in KCg12 isolate (0.46×10^4 conidia ml^{-1}). Maximum conidial size was recorded in KCg17 (16.62 x 5.46 µ m), while isolate CCg3 (13.04 µm) recorded the least conidial length and CCg9 (4.08 µ m) recorded the least conidial width.

The differential sensitivity of isolates to systemic fungicides *viz.,* carbendazim (50 and 100 ppm), thiophanate-methyl (50 and 100 ppm), propiconazole (25 and 50 ppm), hexaconazole (25 and 50 ppm) and non-systemic fungicides *viz.,* mancozeb (500 and 1000 ppm), copper oxychloride (500 and 1000 ppm) revealed that carbendazim(50 and 100 ppm), thiophanate-methyl(50 and 100 ppm) and propiconazole (25 and 50 ppm) inhibited the growth of the *C. gloeosporioides* isolates within the class of highly sensitive to sensitive. Isolates CCg2, CCg6, CCg10 and Kcg13 were moderately resistant to hexaconazole at 25 ppm while, KCg19 and KCg20 were moderately resistant at both 25 and 50 ppm. Isolate CCg9 was resistant to mancozeb at 500 ppm and moderately resistant at 1000 ppm. Isolate KCg12 was resistant to copper oxychloride at 500 ppm and moderately resistant at 1000 ppm.

Fifty nine antagonistic microflora wre isolated from phylloplane (19 fungi + 13 bacteria) and leaf endophytes (27 bacteria). EB7 and EB9 showed 100 per cent inhibition of growth of *C. gloeosporioides* in dual culture. Among the phylloplane fungi *Trichoderma* isolates T_{17} and T_3 were found to be effective as they inhibited the growth of *C. gloeosporioides* to an extent of 88.64 pe cent and 88.07 per cent respectively. **M.Sc.(Ag.), 2008.**

Physiological charactrization of blackgram(*vigna mungo* (L.) Hepper) genotypes for high biomass and water use efficiency

Student: K. Renuka Devi

Major Advisor: Dr. G. Rama Rao

Department of Plant Physiology

Field and pot culture experiments were conducted to study the “Physiological characterization of blackgram (*Vigna mungo* (L.) Hepper) genotypes for high biomass and water use efficiency”. Field experiment was conducted in wet land farm of S.V. Agricultural College, Tirupati in a Randomised Block Design with 15 genotypes during *rabi*, 2007-08.

Significant differences were observed among the cultivars for dry matter production and growth characters. Among the cultivars tested, LBG-735 recorded higher leaf dry matter (7.25 g $plant^{-1}$), stem dry matter (6.25 g $plant^{-1}$), pod dry matter (4.10 g $plant^{-1}$), total dry matter (17.60 g $plant^{-1}$), leaf area (1800 cm^2 $plant^{-1}$), leaf area index (4.0), leaf are duration (47.47 cm^2 day^{-1}), CGR (20.30 g m^{-2} day^{-1}), NAR (0.0442 g dm^{-2} day^{-1}), SCMR (49.7), chlorophyll a (1.141 mg g^{-1} tissue) and lower SLA (248.27 cm^2 g^{-1}) compared to all other cultivars. WBG-26 recorded the lowest values of the above parameters except SLA.

Cultivars differed significantly for yield and yield components, Among the cultivars tested, LBG-735 recorded highest number of pods per plant (27.1), number of seeds per pod (7.2), test weight (5.1g), harvest index (44.79%) and seed yield (1650 kg ha^{-1}) when compared to all other cultivars. The lower yield and yield components were recorded in WBG-26.

The selected blackgram cultivars were tested for direct measurement of WUE by gravimetric approach. The results revealed that the SCMR, dry matter had positive correlation with WUE and SLA had negative correlation with WUE.

The present investigation revealed that blackgram is a compacitance type where dry matter and WUE were significantly correlated. SCMR and SLA ca be used as alternate methods for measuring WUE in blackgram as both had established association with WUE. The cultivars LBG-735, LBG-17, LBG-685 and LBG-645 can directly be recommended to drought prone areas or used as donor parents in developing drought tolerant blackgram cultivars.**M.Sc.(Ag.), 2008.**

Genesis, classification and evaluation of soils in Renigunta Mandal of Chittoor District, Andhra Pradesh

Student: S. Selvaraj Major Advisor: Dr. M.V.S.Naidu

Department of Soil Science and Agricultural Chemistry

The present investigation involves study of genesis, classification and evaluation of soils in Renigunta mandal of Chittoor district in Andhra Pradesh. For this seven representative pedons wre selected in seven different locations of the study area covering all types of soils. All the seven pedons were described for their morphological features in the field and horizon-wise samples were collected and analyzed in the laboratory for physical, physico-chemical and chemical properties.

The study area was characterized by semi-arid monsoonic climate with distinct summer, wintr and rainy seasons. The pedons selected were confined to plain and gently sloping topography. Pedons 4 and 7 were originated from calcareous murrum and alluvium parent materials, respectively. However, the remaining pedons wee originated from granite-gneiss.

The morphological features indicated the presence of AC (Pedons 2, 3 and 7) and ABC (Pedons 1, 4, 5 and 6) profiles. The soils were deep to very deep in depth, yellowish brown to dark yellowish brown in colour, loamy sand to silty clay loam in texture and had sub-angular blocky, angular blocky and single grain structure. **M.Sc.(Ag.), 2008.**

Survey on nutrient status of acid lime (*citrus auruntifolia* swingle) grown soils in venkatagiri division of Nellore District in Andhra Pradesh

Student: R. surendra Naik Major Advisor: Dr. Keerthi Venkaiah

Department of Soil Science and Agricultural Chemistry

An investigation was carried out to study the nutritional status of soil and index leaf of acid lime crop grown in different villages of various mandals in Venkatagiri division of Nellore district.

The soil samples were analysed for physical properties like texture, physico-chemical characteristics *viz.,* pH, EC, OC, CEC and free $CaCO_3$ and chemical characteristics *viz.,* available N, P, K, Ca, Mg, S, Fe, Mn,

Zn and Cu. Similarly, leaf samples were analysed for N, P, K Ca, Mg, S, Fe, Mn, Zn and Cu and fruit samples were analysed for TSS, acidity and vitamin 'C'. In addition the irrigation water samples were analysed for pH, EC, K^+, Na^+, Ca^{+2}, Mg^{+2}, CO^{-2}, HCO_3^-, Cl^-, B and RSC to judge its quality.

Regarding the nutrients status, the acid lime grown soils were low in available nitrogen, medium in available phosphorus and low to high in available potassium. Almost all the soils were sufficient in available Ca, Mg and S. As far as the distribution of primary and secondary nutrients are concerned, all these nutrients in acid lime orchards were decreased with increase in depth of the soil. Among the available micronutrients, the acid lime grown soils were sufficient in available Mn and Cu and deficient in available zinc and iron. Almost all the micronutrients in acid lime grown soils were decreased with increase in depth of the soil.

The leaf manganese and copper contents were found to be sufficient whereas leaf iron and zinc contents were found to be dificient. The leaf N, Ca and Mg were positively and significantly correlated with their respective soil nutrients. As far as fruit quality is concerned, the TSS was positively and significantly correlated with leaf N, P, K and Ca and Zn.

The irrigation wter being used for acid lime cultivtion was neutral to moderatelyh alkaline in reaction, good to marginally saline and excellent to moderately good in chlorides. The RSC values were found to be normal. **M.Sc.(Ag.), 2008.**

Evaluation of Biochemical changes in *Spodoptera litura* Fab. and *plutella xylostella* L. due to treatment of plant products

Student: K. Narahari

Major Advisor: Dr. J. Satyanarayana

Department of Entomology

Field and the laboratory investigations were carried out during 2007-2008 at College of Agriculture, Rajendranagar, Hyderabad on Evaluation of Biochemical changes in *Spodoptera litura* Fab. and / or *Plutella xylostella* L. due to treatment of plant products.

During the study, crude neem oil, NSKE, neem oil, jatropha leaf extract, pongamia seed extract and accephate treated leaves and unteated leaves were fed to test insects larvae of *S. litura* and *P. xylostella.*

The third instar larvae of *S. litura* reached on plant products treated leaves showed the maximum reduction of proteins and sugars with neem oil (19.39 and 26.47 mg/g) compared to control (29.72 and 32.22 mg/g), whereas in case of lipids more reduction was observed with NSKE (10.27 mg/g) comapred to control (16.20 mg/g).

Food consumption studies in *S. litura* larvae revealed that the larvae fed on neem oil tgreated leaves recorded low food consumption, faecal matter production, mean larval weight and weight grain which were significantly different from control.

In the bioefficacy studies, among the plant product treatments against second instar larvae of *S. litura* and *P.xylostella,* neem oil caused maximum cumulative mortality of 70.00 per cent is *S.litura* and 80.00 per cent in *P. xylostella*. All the treatments were found to be significantly superior over the control.

With respect of morphological studies, not much colour variation was observed in *S. litura* larvae reared on treated (crude neem oil, NSKE, neem oil, jatropha leaf extract, pongamia seed extract and acephate) and untreated leaves.

Effect of plant products on weight of *P.xylostella* larvae revealed that the larvae reared on neem oil treated leaves recorded less weight gain (1.86 mg) compared to control (2.93 mg). In all the treatments the weight of the larvae increased gradually from first day afte feeding to fifth day after feeding. **M.Sc.(Ag.), 2008.**

Studies on the varietal preference, biology and management of the groundnut bruchid *Caryedon serratus (*Olivier)

Student: Hasansab. A Nadaf

Major Advisor: Dr. S. R. Koteswara Rao

Department of Entomology

Studies on the varietal preference, biology and management of groundnut bruchid, *Caryedon serratus (*Olivier) were conducted in the Department of Entomology, College of Agriculture, Rajendranagar during November, 2007 to June, 2008.

The preference of different groundnut varieties by *C. serratus* was tested based on fecundity, number of adults emerged, mean dev elopment period, index of susceptibility, index of suitability, growth index, per cent survival of *C. serratus* and per cent weight loss of pods.

Studies on the biology of *C. serratus* at ambient conditions, 30^{0}C+RH 50%, 30^{0}C+RH 80% and 30^{0}C+RH 90% revealed that the average egg period 6.3, 10.42, 5.48 and 7.12 days, the grub period 21.08, 23.08, 20.72 and 19.18 days and the pupal period 9.22, 13.66, 9.4 and 9.66 days at ambient conditions, RH 50%, 80% and 90% at tempeature 30^{0}C, respectively.

Studies on relative efficacy of grain protectants against *C. Serratus* indicated that the treatment of groundnut pods with sweet flag rhizome powder (10g) was found to be effective in disrupting the bruchid development by recording pods with no eggs, no pod damage and no adult emergence for the first two months. The pods treated with neem seed kernel powder (10 g) protected the pods effectively against *C. serratus* damage for the first two months by recording 1.69 and 2.06% pod damage when compared with the control, wherein 14.11 and 17.79% pods damage was noticed during first and second month, respectively. Spinosad and deltamethrin proved their merit throughout experimental period by achieving zero per cent pods with egg, pod damage for first two months and adult emergence for first three months. Even though, sweet flag rhizome powder (10 g) and deltamethirn (0.02 g) continued to be effective for the first two months by recording zero per cent pods with eggs, pod damage and adult emergence, in the latter months these treatements were less effective than deltamethrin (0.4 g) and both the concentrations of spinosad. Therefore, spinosad (0.5 and 1.0 ml) and deltamethrin (0.04g) can be recommended for use as pre storage grain protectants. **M.Sc.(Ag.), 2008.**

Studies on entomopathogenic nematode, *steinernema* spp. on major lepidopteran pests of cabbage

Student: Sreeramaiah V. N.

Major Advisor: Dr. T. Uma Maheswari

Department of Entomology

Studies related to infectivity / pathogenicity of entomopathogenic nematode, *Steinernema asiaticum,* against major lepidopteran insect pests of cabbage, its survival and mass multiplication, effect of temperature, U.V. radiation and storage period on survival and pathogenicity of *S. asiaticum* on host insects were carried out in the laboratory, Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad from October 2007 to July 2008.

Studies made on pathogenicity of *S. asiaticum* against two lepidopteran pests of cabbage *i.e. Plutella xylostella* and *Spodoptera litura* and the laboratory check, *Corcyra cephalonica* revealed that, *P.xylostella* was more susceptible to *S. asiaticum* recording maximum mortality of 67 per cent within 72 hrs of inoculation at a dose of 180 IJs per larva followed by *C. cephalonica* showing 61 percent mortality within 120 hrs of inoculation at 210 IJs per larva.

With regard to mass multiplication of *S. asiaticum* on three hosts *i.e. P. xylostella, S. litura* and *C. cephalonica,* the results revealed that *C. cephalonica* was found to be the suitable host recording a maximum recovery of 1,24,600 IJs when inoculated with 90 IJs per larva followed by *S. litura* recording 45,200 juveniles at 60 IJs. However, *P.xylostella* was the least suitable host for mass multiplication as only 6,060 juveniles could be recovered when 90 IJs were inoculated per larva.

Studies on the effect of temperature on survival of the nematode, *S. asiaticum* made under laboratory conditions revealed that temperature ranging from 5 to 20^0C is said to be optimum for getting juveniles with a maximum survival percentage ranging from 94 to 100. However, it was clear from the experiment that more than 90 per cent of juveniles of *S. asiaticum* could survive at a temperature of 20^0 C. When the temperature was beyond 20^0C, the rate of survival of juveniles reduced.

Attempts made to investigate the impact of U.V. radiation on survival of juveniles of *S. asiaticum* revealed that time of exposure of IJs to U.V radiation had significant effect on the survival of juveniles which further influenced their infectivity expressed in terms of mortality of the host insect.

Ageing of IJs on infectivity was elucidated against three hosts revealed that the juveniles of *S. asiaticum* stored for 15 days when inoculated to the third instar larvae of *P. xylostella, S. litura* and *C.cephalonica* resulted in causing maximum morality of 68.8, 50 and 58 per cent as compared to control mortality of 77.6, 61 and 65 per cent, respectively. Maximum mortality of only 22.4, 6 and 8 per cent was recorded against *P. xylostella, S. litura* and *C. cephalonica,* respectively when the larva were inoculated with IJs that were stored for a long period of 754 days. Storage period, adversely affect the infectivity of the *S. asiaticum* on host insect. **M.Sc.(Ag.), 2008.**

Combining ability and heterosis studies in castor (*Ricinus communis* L.)

Student: K. Yogitha Major Advisor: Dr. M. Bharathi

Department of Genetics and Plant Breeding

The present investigation “combining ability and heterosis studies in castor (*Ricinus communis* L.)” was carried out with twelve lines (PPL-11, PPL-12, PPL-13, PPL-14, PPL-15, PPL-165, PPL-17, PPL-18, PPL-19, PPL-20, PPL-21 and PPL-22) and three testers (48-1, DCS-107 and JC-2).

The analysis of variance for combining ability revealed significant differences among the lines, testers and line x testers for all the traits studied. Further, nonadditive gene action was found to be preponderant for seed yield and yield components in the present investigation favouring a hybrid beeding programme.

Combining ability analysis revealed that among the parental lines PPL-20, PPL-19, PPL-21, PPL-14, PPL-17 and 48-1 were found to be good general combiners for early flowering. Further, parents PPL-21, PPL-16, PPL-20, PPL-19, PPL-12, 48-1 and DCS-107 were found to be early maturing. More over parents PPL-20, PPL-21, PPL-14, PPL-16, PPL-19 and DCS-107 were adjudged as the best general combiners for seed yield per plant. The parental lines *viz.,* PPL-20, PPL-16, PPL-21, PPL-14 and 48-1 possessed favourable genes for oil content. Hence, the female lines possessing good combining ability for seed yield may be crossed to the best combining male parents for earliness and related traits or *vice versa* in order to obtain desirable segregants.

The hybrids PPL-14 x JC-2, PPL-16 x 48-1 and PPL-22 x 48-1, PPL-22 x DCS-107 are good specific combiners for earliness. The hybrids PPL-18 x JC-2, PPL-14 x JC-2, PPL-17 x48-1, PPL-21 x DCS-107 and PPL-20 x 48-1 which recorded positively significant *sca* effects for seed yield were the good specific combiners. Therefore, these hybrids could be recommended for heterosis breeding.

The maximum values of heterosis over mid parent and better parent was observed in the cross combinations, PPL-20 x 48-1 followed by PPL-17 x 48-1, PPL-11 x DCS -109, PPL-21x DCS-107 and PPL-20 x 48-1 which recorded positively significant *sca* effects for seed yield were the good specific combiners. Therefore, these hybrids could be recommended for heterosis breeding.

The maximum values of heterosis over mid parent and better parent was observed in the cross combinations, PPL-20 x 48-1 followed by PPL-17 x 48-1, PPL-11 x DCS -109, PPL-21 x DCS-107 and PPL-14 x JC-2. High heterotic response in these hybrids for seed yield per plant resulted mainly due to the substantial heterosis for other important yield contributing characters.

The seed yield per plant exhibited significant positive correlation with effective spike length, number of spikes per plant, 100 seed weight, oil content and number

of capsules per plant, indicating the importance of these characters in selection.

Studies on path coefficient analysis emphasized the need for selection, based on number of capsules per plant, 100 seed weight, plant height, number of nodes upto primary spike, days to maturity, effective spike length and oil content. Since, these were found to be the important direct contributors for seed yield. **M.Sc.(Ag)., 2008.**

Heterosis and combining ability studies for grain yield and its components in maize (*Zea mays* L.) genotypes

Student: Ram Reddy Vadala Major Advisor: Dr. A. Seshagiri Rao

Department of Genetics and Plant Breeding

The present investigation on "Heterosis and combining ability studies for grain yield and its components in maize (*Zea mays* L.) genotypes" was under taken with ten lines.

During *Kharif,* 2007 the ten elite inbred lines were crossed with four testers in Line x Tester design, at maize Research Centre, ARI, Rajendranagar. Subsequently in *Rabi*, 2007-08, the 40 F_1 crosses along with standard check (DHM-115) and parents (lines and testers) were evaluated at College Farm, College of Agriculture, Rajendranagar, Hyderabad.

The analysis of variance revealed significant differences among the genotypes for all the traits studied. Further, non-additive gene action was found to be preponderant for grain yield and yield components in the present investigation favoring a hybrid breeding programme. The hybrids in general were tall and high yielding, compared to the parents. High level of heterosis was noticed for grain yield per plant followed by number of kernels per row and 100-seed weight.

The combining ability analysis revealed importance of non-additive gene action in governing the characters studied. Among the parental lines, CM-208 and NBML-3027 were good general combiners for earliness *viz.,* days to 50 per cent tasseling, days to 50 per cent silking and days to 50 per cent maturity. The parents NBML-3053, NBML-3206 and NBML-3085 recorded positively significant *gca* effects for grain yield were the good specific combiners. Therefore these hybrids are recommended for heterosis breeding.

Estimates of heterosis, heterobeltiosis and standard heterosis were variable among crosses in desirable direction and some of them turned out to be best specific crosses. The best crosses with high standard heterosis for grain yield *viz.*, NBML-3082xNBML-3163, NBML-3027xNBML-3206, NBML-3110 x BML-15, NBML-3053x NBML - 3085 and NBML-3084 x NBML-3206 for grain yield may be further exploited in multilocation evaluation before releasing them for commercial cultivation.

Studies on heritability, correlations and path analysis emphasized the need for selection, based on plant type with greater 100-seed weight, number of kernels per row, ear girth, number of kernel rows per ear, plant height, ear length and ear height. Since, these were found to be the important direct contributors for grain yield. **M.Sc.(Ag.), 2008.**

Mapping of Regions associated with zinc content in grains of rice

Student: L. Madhuri Lalasa Major Advisor: Dr. K. Radhika

Department of Genetics and Plant Breeding

The present study was undertaken with the prime objectives of i) assessing the genetic diversity of rice germplasm using microsatellite markers derived from the genomic regions associated with Zinc metabolism and I ii) identifying specific regions of the chromosomes associated with zinc content in the grain.

A set of 83 rice genotypes with a wide variation in their zinc content in grain was screened for genetic diversity using nineteen microsatellite markers, derived from genomic regions associated with Zn metabolism.

Of the forty five markers use for parental polymorphism studies between Samba Mahsuri and

Ranbir Basmati, only sixteen markers showed polymorphism, nine markers showed monomorphism and twenty one were not amplified. Three polymorphic markers which are associated with cation uptake *viz.,* SC 129 marker based on ZIP (Zrt /Irt related protein), SC 135 marker based on ZIP (Zrt/Irt related protein) and SC 141 marker based on NRAMP (Natural Resistance - Associated Macrophage Protein), were used to assay the 24 and 22 F_2 individual plants respectively showing high and low zinc content in grains, to identify specific regions of the chromosome associated. The markers used for selective genotyping studies, amplified Ranbir Basmati specific allele in homozygous condition in more F_2 plants having high zinc content and Samba Mahsuri specific allele was found in homozygous condition in more F_2 plants with low zinc content in rice grains. This situation was very clearly noticed with respect to SC 135 marker. The linkage distance of these three markers, SC 129, SC 135 and SC 141 with their respective genes OsZIPI, OsZIP8, OsNRAMP7 on chromosomes 3,5 and 12 were found to be 47.8 cM, 15.2 cM and 44.6 cM respectively. The association could be made more effective by analyzing more F_2 population. The methodology of selective genotyping could successfully identify the chromosomal regions associated with zinc content in grains. **M.Sc.(Ag.), 2008.**

Evaluation of Genotypes for genetic divergence and fusarium wilt resistance in castor (*Ricinus communis* L.)

Student: Shaik Zareena Begum Major Advisor: Dr. Farzana Jabeen

Department of Genetics and Plant Breeding

The present investigation was carried out during *kharif* 2007-08 at Regionsal Agricultural Research Station (RARS), Palem, Mahabubnagar District, which consist of two different experiments *viz.,* Experiment-I, with fifty genotypes of castor studied for genetic divergence and Experiment-II, with other One hundred and fifty germplasm lines of castor (*Ricinus communs* L.) screened for *Fusarium* wilt resistance.

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating that the data generated from the above diverse material representing wide variability. The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the modifying effect of the environment in assiciation with the characters at genotypic level. High PCV coupled with high GCV observed for plant height, number of spikes per plant, effective spike length, number of capsules per plant. Seed yield per plant indicate the presence of wider variability for these traits in the population studied. High heritability coupled with high genetic advance as per cent of mean was observed except for days to maturity indicates preponderance of additive gene action in the inheritance of these traits and improvement in these characters is possible through simple selection.

The correlation studies indicated that number of spikes per plant, effective spike length, number of capsules per plant, 100 seed weight and oil content had significant positive association with seed yield per plant hence simultaneous improvement of these characters along with seed yield is possibile.

The path analysis indicated that capsules per plant had direct positive effect on seed yield. Direct selection through this trait for improvement of seed yield is highly effective. In case of number of spikes per plant and 100 seed weight though the associations are positive and significant, direct effects are low indirect effects through effective spike length, number of capsules per plant and plant height are to be considered to bring about improvement in seed yield.

Thus, the present study revealed that the major emphasis should be laid on selection process with more number of spikes per plant, number of capsules per plant and increased 100 seed weight for realizing higher seed yield in castor (*Ricinus communis* L.).

In Experiment - II, screening of germplasm lines for fesistance to wilt and per cent disease incidence was calculated. Amont one hundred and fity entries tested, fifteen entries *viz.,* RG-21, RG-425, RG-445, RG-453, RG-457, RG-572, RG-587, RG-625, RG-689, RG-709, RG-743, RG-788, RG-789, RG-811 and RG-819 were recorded as resistant. So these entries can be used in different crossing programmes for the development of hybrids with wilt resistance. **M.Sc.(Ag.), 2008.**

Heterosis and combining ability studies for grain yield and its components in newly bred inbred lines of maize (*Zea mays* L.)

Student: G. Sheshu

Major Advisor: Dr. Farzana Jabeen

Department of Genetics and Plant Breeding

The prsent investigation has been undertaken in maize to carry out the combining ability analysis and to estimate heterobeltiosis and standard heterosis as well as to understand nature of gene action, genetic parameters, character association of yield and yield contributing characters.

The combining ability analysis revealed importance of both additive and non-additive gene actions in governing the characters but non-additive gene action was found predominant.

Estimates of heterosis, heterobeltiosis and standard heterosis were variable among crosses in desirable direction and some of them turned out to be best specific crosses. The cross cobinations BML-10 x CM-209 and CM-210 x CM-119 for earliness and BML-15 x CM-209 and CM-209 x CM - 119, for grain yield were found to be superior to the standard check BH 1576. The hybrids BML-15 x CM-209, CM-209 x CM-119, CM-132 x CM-119, CM-132 x CM-209 and BML-15 x BML-15 x DML-10 performed well over standard check BH 1576 for grain yield.

Estimates of genetic parameters exhibited high heritability for ear height, plant height, ear length, number of kernels per row, number of kernels per row, oil content and grain yield may bring about dsired improvement in grain yield by selection for thdse characters. Character association among grain yield and yield contributing characters exhibited that 100 grain weight, number of kernels per row, number of kernel rows per ear, ea girth, ear length, plant height and ear height had significant and positive correlations with grain yield.

Path coefficient analysis showed direct relationship of number of kernels per ear, 100 grain weight, number of kernels per row, number of kernel rows per ear and ear length with grain yield. The indirect effect of these characters on grain yield influenced more by number of kernels per ear and 100 kernel weight.

The identified five superior crosses (BML-15 x CM-209, CM-209 x CM 119, CM-132 x CM-119, CM-132 x CM-209 and BML-15 x BML-10) in the present investigation, based on heterosis and combining ability, which performed well for grain yield and yield contributing characters may be used as single cross hybids after evaluation in multi location trials. **M.Sc.(Ag.), 2008.**

Statement about ownership and other particulars about
THE JOURNAL OF RESEARCH ANGRAU
Form IV (See Rule 8)

1.	Place of Publication	:	The Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030
2.	Periodicity of Publication	:	Quarterly
3.	Printer's Name	:	**Dr. V. B. Bhanu Murthy**
	Nationality	:	Indian
	Address	:	Dean of Post Graduate Studies and Editor of Journal of Research, ANGRAU Acharya N.G. Ranga Agricultural University Rajendranagar, Hyderabad.
4.	Publisher's Name	:	**Dr. V. B. Bhanu Murthy**
	Nationality	:	Indian
	Address	:	Dean of Post Graduate Studies and Editor of Journal of Research, ANGRAU Acharya N.G. Ranga Agricultural University Rajendranagar, Hyderabad.
5.	Editor's Name	:	**Dr. V. B. Bhanu Murthy**
	Nationality	:	Indian
	Address	:	Dean of Post Graduate Studies and Editor of Journal of Research, ANGRAU Acharya N.G. Ranga Agricultural University Rajendranagar, Hyderabad.
6.	Name and address of the individuals who own the newspaper & partners or share holders holding more than one per cent of the total capital	:	The Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030 (A.P.)

I, Dr. V. B. Bhanu Murthy hereby declare that the particulars given above are true to the best of my knowledge and belief.

Dated :

Signature of Publisher

THE JOURNAL OF RESEARCH ANGRAU

DECLARATION CERTIFICATE TO BE SUBMITTED BY THE AUTHOR(S)

Certified that the article entitled _____

_____

1. is based on my / our original research work / M.Sc / Ph.D thesis (strike off whichever is not applicable)
2. The article has been seen by all the authors and the order of authorship is agreed.
3. The results presented have not been published or submitted for publication else where in part or full under the same or other title
4. The names of the authors are those who made a notable contribution.
5. **No authorship is given to anyone who did not make a notable contribution.**

S.No.	Name/s	Present address	Permanent address	Signature
1.				
2.				
3.				

CERTIFICATE BY THE COMPETENT AUTHORITY

(Professor & Head of the Department/ Principal Scientist of the station/ Associate Director of Research).

Certified that the article _____

_____

authored by _____

_____ is fit for publication. It fulfills all the requirements for publication in the Journal of Research ANGRAU.

Name :

Signature :

Office seal :

Note: In case it is not possible to obtain the signature of a particular author for reasons beyond his/her reach, the reasons thereof should be explained.

SUBSCRIPTION ENROLLING FORM

I/we, herewith enclose D.D. No..... dated.....for Rs. ..... drawn in favour of Managing Editor, Journal of Research ANGRAU, Agricultural Information & Communication Centre, ARI Campus, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030 as individual annual/individual life/Institutional annual Membership for Journal of Research ANGRAU for the calendar year (January - December) .....

S.No.	**Name of the** authors	**Address for** Correspondence	**Name of the article** contributed	**Signature**
1.				
2.				
3.				
4.				

Note : The receipt of payment will be sent only if a self addressed and stamped envelope is enclosed along with your DD.

GUIDELINES FOR THE PREPARATION OF MANUSCRIPT

1. Title of the article should be short, specific, phrased to identify the content and indicate the nature of study.
2. Names should be in capitals prefixed with initials and separated by commas. For more than two authors the names should be followed by 'and' in small letters before the end of last name. Full address of the place of research in small letters should be typed below the names. Present address and E-mail ID of the author may be given as foot note.
3. The full length paper should have the titles ABSTRACT, MATERIALS AND METHODS, RESULTS AND DISCUSSION, REFERENCES-all typed in capitals and bold font - 12. The research note will have only one title REFERENCES.
4. **ABSTRACT**: The content should include the year, purpose, methodology and salient findings of the experiment in brief not exceeding 200 words. It should be so framed that the reader need not refer to the article except for details.
5. **INTRODUCTION** : Should be without title and indicate the reasons which prompted the research, objectives and the likely implication. The review of recent literature should be pertinent to the problem. The content must be brief and precise.
6. **MATERIALS AND METHODS** : Should include very clearly the experimental techniques and the statistical methods adopted. Citation of standard work is sufficient for the well known methods.
7. **RESULTS AND DISCUSSION** : Great care should be taken to highlight the important findings with support of the data well distinguished by statistical measures like CD, r, Z test etc. Too descriptive explanation for the whole data is not desirable. The treatments should be briefly expressed instead of abbreviations like T_1, T_2 etc. The discussion should be crisp and relate to the limitations or advantages of the findings in comparison with the work of others.
8. **REFERENCES :** Literature cited should be latest. References dating back to more than 10 years are not desirable. **Names of authors, their spelling and year of publication should coincide both in the text and references**. The following examples should be followed while listing the references from different sources.

Journals and Bulletins

Abdul Salam, M and Mazrooe, S.A. 2007. Water requirement of maize (*Zea mays* L.) as influenced by planting dates in Kuwait. Journal of Agrometeorology. **9** (1) : 34-41

Hu, J., Yue, B and Vick, B.A. 2007. Integration of trap makers onto a sunflower SSR marker linkage map constructed from 92 recombinant inbred lines. Helia. **30** (46) :25-36.

Books

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

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

Thesis

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

Seminars / Symposia / Workshops

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

Proceedings of Seminars / Symposia

Bind, M and Howden, M. 2004. Challenges and opportunities for cropping systems in a changing climate. Proceedings of International crop science congress. Brisbane –Australia. 26 September – 1 October 2004. pp. 52-54
(www.cropscience 2004.com 03-11-2004)

Tables and Graphs : The data in tables should not be duplicated in graphs and vice versa. Mean data for main treatment effects should be presented with appropriate SE± and CD values wherever necessary. The 2 or 3 way tables should be furnished only if the results are consistent over years and are distinguished to have consideration of significant practical value. SE± and CD values however, should be furnished in the tables for all interactions and should be explained in the results and discussion. The treatments should be mentioned atleast in short forms if they are lengthy, but not abbreviated as T_1, T_2 and T_3 etc. The weights and measures should be given in the metric system following the latest units eg. kg ha^{-1}, kg ha^{-1} cm, mg g^{-1}, ds m^{-1}, g m^{-3}, C mol kg^{-1} etc.

Typing : The article should be typed in 12 pt font on A_4 size paper leaving a margin of 5 cm on all sides. There should be a single line space between the rows in abstract and double line in rest. **Check up the manuscript thoroughly for errors before submitting it for publication.**

Note : Latest issue of the Journal may be consulted. Further details can be obtained from the book "Editors style Manual**,** edn 4. American Institute of Biological Sciences, Washington DC".

Website : www.angrau.net

ESSENTIAL REQUIREMENTS FOR CONSIDERATION OF PUBLICATION OF ARTICLES

1. Research of not less than 2 years and of high standard will be considered as full length paper. If necessary, it will be considered for short communication.
2. Research of one year should be submitted in the style and format of short communication.
3. The total number of pages should not exceed 10 for full paper and 5 pages for short communication including tables and figures. The figures should be legible.
4. Old research which terminated 5 years before the date of submission will not be considered.
5. All the authors should subscribe for the Journal
6. The manuscript should be submitted in triplicate as per the guidelines of the Journal to The Dean of Post Graduate Studies and Editor, The Journal of Research ANGRAU, Administrative Office, Rajendranagar, Hyderabad – 500 030.
7. The manuscript should accompany the declaration certificate and subscription enrolment form.
8. **The authors should accept the editorial / referees comments until the quality of the paper is improved.**
9. The revised manuscript should be submitted in duplicate along with a compact disk.

REVIEW PROCESS

The articles will be initially screened by the editors. It will be sent to an expert for peer review only if it contains adequate original information and is prepared as per the guidelines. The author, then, may also be asked to revise it if the expert desires. After getting the article suitably revised and edited, it will be placed before the editor for a final decision. The accepted article will be finally checked for language and grammar by the English editor before being sent to the press. The decision however to publish the paper lies with the editor. Any article which is not able to meet the expected standard or is not prepared in conformity with guidelines will be rejected without assigning any reason.

ANGRAU-Press/80/600/2012 Regd. No. 25487/73

Printed at ANGRAU Press, Hyderabad and Published by Dr.V.B. Bhanu Murthy, Dean of Post Graduate Studies
and Editor of Journal of Research ANGRAU, Administrative Office,
Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030
AI&CC e-mail: aicc_press@yahoo.co.in