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Gene action for grain yield and its attributes in maize (*Zea mays* L.)

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ABSTRACT
Line x tester analysis involving 10 females and 3 males from diverse origin was carried out in maize (*Zea mays* L.). Pooled analysis of variance over environments revealed mean square due to lines, testers and lines x testers was significant for all traits except due to testers for ear length. s^2sca in general were relatively greater than s^2gca for maximum traits thus indicating preponderance of non-additive variance in expression of traits under study. G x E interaction for genotypes were found to be significant for most traits. Four hybrids have been identified as desirable specific combiner for maturity traits and eleven hybrids for grain yield per plant. Among them PMI-86 x PMI-401 was detected desirable cross combination also for 100 grain weight, grain depth and ear diameter. Most of crosses showing significant sca effects involved inbred line PMI-401 as tester. The perusal of results indicated that superior crosses for different traits involved all types of combiners as parents. For grain yield per plant crosses showing high sca effects in favourable direction involved either High x High, High x Low or Low x Low general combines as parent.

Key words : Combining ability, Gene action (*Zea mays* L.), Maize, Grain yield.

INTRODUCTION
The aim of plant breeder is to identify elite inbred lines that will combine well and produce productive progenies that could be successfully exploited for synthesising promising hybrids or even synthetics, particularly when commercial exploitation of hybrid is not feasible technically and viable commercially. Since the quantitative characters are considerably influenced by the environment, a multi-environment study is likely to bring out genotype environment interaction for estimating the gene effects precisely and predicting the advance. The present study has been carried out over two locations (environments) to know the type of gene action governing grain yield and its component traits and to identify parents and crosses which could be exploited in future breeding programmes.

MATERIALS AND METHODS
Ten vigorous, diverse and advance stage inbred lines of maize viz., PMI-13, PMI-14, PMI-56, PMI-73, PMI-86, PMI-88, PMI-94, PMI-96, PMI-105 and PMI-114 coded as L_1, L_2, L_3, L_4, L_5, L_6, L_7, L_8, L_9 and L_{10} were mated with three well adapted testers of varying genetic base viz., T_1 (C-15) composite, T_2 (PS-66) synthetic and T_3 (PMI-401) inbred line respectively in line x tester mating design during rabi 2001-02 at winter Nursery Hyderabad. Thirty F_1's along with 13 parents were evaluated at two environments i.e., high altitude Maize Research Station, Pahalgam (2220 m asl). and Experimental Farm of Division of Plant Breeding and Genetics, Shalimar (1700 m asl) of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during kharif 2002 in complete randomised block design with two replication in a single row plot of 5 m length having 60 x 25 cm crop geometry. Observations were recorded on ten randomly selected plants in each plot. The combining ability analysis was conducted as per the procedure developed by (Kempthorne 1957).

RESULTS AND DISCUSSION
The pooled analysis of variance over environments (Table1) revealed that mean square due to lines, testers and lines x tester was significant for all traits except due to testers for ear length, reflecting thereby presence of adequate diversity in the genetic material chosen for study. The mean squares due to interaction of lines, testers and lines x testers with environment were ranged from significant to highly significant for all characters except ear diameters/grain depth and kernel rows per ear. Significant differences were also observed across environments for sca effects for most traits. Pooled analysis over environments showed significant gca and sca variances for most of the traits. Based on estimates, higher magnitude of σ^2sca in relation to σ^2gca imlied the greater importance of non-additive gene effects in inheritance of grain yield per plant and most of its component traits over environment. These results were in conformity with earlier finding of Vasal *et al*. (1993) and Joshi *et al*. (1998). Such results in present study favours production of hybrid cultivars and detection of

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Table 1 : Analysis of variance for combining ability pooled over environment in Lx T analysis of maize

Source	d.f.	Days to 50% anthesis	Days to 50% silking	Ear length (cm)	Kernel row/ear	Ear diameter (cm)	Grain depth (cm)	100 grain weight (g)	Grain yield /plant (g)
Environment	1	1.008	7.008	1.316	0.270**	0.075*	0.034*	0.507	5.742
Lines	9	26.597**	23.60**	4.230**	6.106**	0.218**	0.030*	14.879**	932.933**
Testers	2	12.358**	21.00**	1.167	1.278*	0.776**	0.017*	46.171**	1244.482**
Lines x testers	18	6.275**	8.859**	2.070**	1.865**	0.120*	0.013*	13.701**	703.015**
Lines x environment	9	8.263**	9.00**	3.926**	1.334*	0.066	0.015*	11.858**	722.358**
Testers x environment	2	13.125**	23.33**	3.604**	0.060	0.005	0.058*	66.406**	768.121**
Lines x testers x environment	18	10.152**	10.592**	3.457**	1.195**	0.075*	0.010	5.656*	541.484**
Pooled error	58	2.039	2.070	0.995	0.593	0.043	0.006	7.497	348.783**
α^2 lines		2.046*	1.794*	0.260	0.459*	0.014	0.002	1.155*	77.570*
α^2 testers		0.258	0.475	0.004	0.017	0.018	0.000	1.129*	31.058*
α^2 gca		0.670*	0.780	0.065	0.119*	0.019	0.000	1.135*	41.792*
α^2 gca x E		0.665*	1.084*	0.213	0.031	0.017	0.002	2.932*	57.161*
α^2sca		1.058	1.697*	0.268	0.317**	0.066**	0.001	3.173**	175.217**
α^2sca x E		4.056**	4.261**	1.228*	0.300**	0.015	0.003*	2.278**	269.670**

- significant at 5% level, ** significant at 1% level

genotypes x environment interaction for various traits emphasize multi environmental testing of genetic materials to draw valid conclusions that would help to identify cultivars for specific agro-ecological situations.

Genotypes with significant gca effects in desired direction are expected to transmit genes with desirable effects to their progenies. Two lines each for days to 50% silking and days to 50% anthesis, 100-grain weight and grain depth and one line each far grain yield per plant, prolificacy index, ear length and kernel rows per ear, five lines for grain yield per plant and three lines for ear diameter (Table 2) showed desired significant gca effect for respective traits across the environments. None of line possessed desirable gca effect for all traits. However, PMI-114 had significant positive gca effect for grain yield, 100 grain, weight, grain depth and significant negative value for maturity traits. The gca estimates for grain yield per plant indicated that among the lines PMI-114 was having highest favourable gca effect followed by PMI-94, PMI-14 and PMI-56, however, PMI-94 contributed significant to increased grain depth and ear diameter while as PMI-14 has positive gca effect for ear diameter and ear length. The lines with desirable gca for different traits could be utilized for the development either the synthetic variety or an elite breeding population by allowing though mixing among them to achieve new genetic recombination’s and then subjected them to recurrent selection. These population, could serve as source for isolation of desirable inbred lines.

In this study three crosses each for days to 50% anthesis, days to 50% silking and ear length, four each for kernel row per ear, ear diameter and grain depth, six for 100 grain weight, one for prolificacy index and eleven for grain yield per plant revealed significant sca effect for these traits in pooled analysis (Table-3). Among the crosses PMI-86 x PMI-401 was the desirable specific combination for grain yield and its components as this exhibited desired significant sca effects for maximum number of traits, with good *per se* performance and involving high x low gca parents. The cross PMI-114 x PMI-401 exhibited desired sca and gca effects, highest *per se* performance and involved good x good gca parent combination. Most crosses showing significant positive sca effects for grain yield per plant involved inbred line PMI-401 as tester. These promising crosses can be tested extensively over environments in future and good performers could be exploited in future breeding programmes.

The perusal of results indicate that superior crosses for different traits involved all types of combiners as parents. For grain yield per plant crosses showing desirable sca effect in the favourable direction involved either High x Low or Low x Low or High x High gca effect and confirmed earlier reports of Venkatesh *et al*. (2001). The

Table 2. : Best parents based on pooled analysis in respect of gca effects with *Per se* performance for yield and maturity traits in maize

Traits	Pedigree	Code	gca effect	*per se* performance
Days to 50% anthesis	PMI-56	L_3	-3.125**	86.50
	PMI-114	L_{10}	-1.292**	88.25
Days to 50% silking	PMI-56	L_3	-2.492**	90.25
	PMI-114	L_{10}	-1.242**	88.30
Ear length (cm)	PMI-14	L_2	1.178**	10.85
Kernel rows/ear	PMI-56	L_3	1.621**	12.17
Ear diameter (cm)	PMI-14	L_2	0.167*	21.90
	PMI-94	L_7	0.125*	19.42
	PMI-105	L_9	0.142*	19.95
Grain depth (cm)	PMI-94	L_7	0.074**	0.550
	PMI-114	L_{10}	0.059*	0.318
100-grain weight (g)	PMI-105	L_9	1.150**	23.85
	PMI-114	L_{10}	1.758**	21.70
Prolificacy index	PMI-14	L_2	0.075**	0.980
Grain yield/plant (g)	PMI-14	L_2	7.213**	49.87
	PMI-56	L_3	7.010**	40.81
	PMI-94	L_7	7.773**	44.97
	PMI-105	L_9	4.808*	44.28
	PMI-114	L_{10}	10.271**	32.55

- significant at 5% level, ** significant at 1% level

Table 3 : Promising hybrid combination with desired significant sca effects for yield and maturity traits together with *per se* performance and gca of parents involved in L x T analysis of maize

Traits	Best crosses	Code	Sca effects	*Per se* performance	Type of combination
Days taken to 50% anthesis	PMI-14 x C15	L_2 x T_1	-1.525*	74.25	High x Low
	PMI-73 x PS-66	L_4 x T_2	-1.417*	74.75	Average x Average
	PMI-86 x PS-66	L_5 x T_2	-1.833*	75.25	Average x Average
Days taken to 50% silking	PMI-14 x C15	L_2 x T_1	-2.667**	77.25	High x Low
	PMI-56 x PMI- 401	L_3 x T_3	-1.663*	75.50	Low x High
	PMI-73 x PS-66	L_4 x T_2	-1.783*	79.00	Average x Low
	PMI-86 x PS-66	L_5 x T_2	-2.533**	78.50	Average x Average
Ear length (cm)	PMI-56 x PS-66	L_3 x T_2	1.118*	15.33	Low x Average
	PMI-88 x C15	L_6 x T_1	1.304*	16.65	Average x Average
	PMI-105 x C15	L_9 x T_1	1.045*	16.05	Average x Average
Kernel row/ear	PMI-14 x PS-66	L_2 x T_2	0.735*	14.35	Low x Average
	PMI-94 x C15	L_7 x T_1	0.824*	15.10	Average x Average
	PMI-96 x PS-66	L_8 x T_2	1.172**	15.87	Average x Average
Ear diameter (cm)	PMI-13 x C15	L_1 x T_1	0.238*	4.22	Low x High
	PMI-14 x C15	L_2 x T_1	0.271*	4.57	High x Average
	PMI-73 x PS-66	L_4 x T_2	0.198*	4.10	Average x Average
	PMI-86 x PMI-401	L_5 x T_3	0.215*	4.12	Low x Low

Grain depth (cm)	PMI-14 x C15	L_2 x T_1	0.100**	0.96	Average x Average
	PMI-73 x PS-66	L_4 x T_2	0.069*	0.83	Average x Average
	PMI-94 x PMI-401	L_5 x T_3	0.059*	0.86	High x Average
	PMI-86 x PMI-401	L_7 x T_3	0.061*	0.94	Average x Average
100-grain weight (g)	PMI-13 x PS-66	L_1 x T_2	2.887**	28.60	Low x High
	PMI-73 x C15	L_4 x T_1	1.669**	27.42	Low x High
	PMI-86 x PMI-401	L_5 x T_3	1.643**	27.55	Average x Low
	PMI-94 x PMI-401	L_7 x T_3	1.193*	27.22	Average x Low
	PMI-88 x C15	L_6 x T_3	1.558*	27.52	Average x Low
	PMI-96 x PMI-66	L_8 x T_1	2.019**	28.62	Average x Average
Prolificacy index	PMI-86 x PMI-66	L_8 x T_2	0.098*	1.16	High x Low
Grain yield per plant (g)	PMI-105 x PS-66	L_9 x T_2	22.821**	132.74	High x Low
	PMI-88 x C15	L_6 x T_1	19.821**	119.41	Low x Low
	PMI-13 x PS-66	L_1 x T_2	18.827**	121.07	Low x Low
	PMI-114- x PMI-401	L_{10} x T_3	14.957**	141.12	High x High
	PMI-14 x C15	L_2 x T_1	13.493**	128.76	High x Low
	PMI-94 x PMI-401	L_7 x T_3	5.566**	129.23	High x High
	PMI-86 x PMI-401	L_5 x T_3	4.924**	120.35	Low x High
	PMI-56 x PMI-401	L_3 x T_3	2.635**	125.53	Average x High

- significant at 5% level, ** significant at 1% level

superiority of crosses involving High x High combiners as parents might have possibly resulted from the concentration and interaction of favourable alleles contributed by parents. The superiority of crosses involving High x Low combiners as parent could be explained on basis of interaction between positive alleles from good combiners and negative alleles from poor combiners as parent. The high yield of such crosses would be non fixable and they could be exploited for heterosis breeding. The superior cross combination involving Low x Low general combiners could result from over dominance and epistasis (Rehman *et al.*, 1981). The results of the present study suggest that high gca value of parent is no guarantee of high sca effect of their crosses and confirming the earlier report of Dubey *et al*. (2001) and thus selection of parent should be based on their specific combining ability tests.

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REFERENCES

Dubey, R.B., Joshi, V.N. and Pandiya, N.K. (2001). Heterosis and combining ability for quality, yield and maturity traits in conventional and non conventional hybrids of maize (*Zea mays* L.). *Indian. J. Genet.,* **61(4) :** 353-355.

Joshi, V.N., Pandiya, N.K. and Dubay, R.B. (1998). Heterosis and combining ability for quality and yield in early maturity single cross hybrids in maize (*Zea mays* L.). *Indian J. Genet.* **58(4) :** 519-524.

Kempthorne, O. (1957). An introduction to Genetic Statistics. John Wiley and Sons, New York pp. 458.

Rehman, M., Patway, A.K. and Miah, A.J. (1981). Combining ability in rice. *Indian J. Agri.,* **15 :** 543-46.

Vasal, S.K., Srinivasan, G., Gonzalez, C.F., Breck, D.L. and Crossa, J. (1993). Heterosis and combining ability of CIMMYT's quality protein maize germplasm II. *Subtropical Crop. Sci.,* **33(1) :** 51-57.

Venkatesh, S., Singh, N.N. and Gupta, N.P. (2001). Use of inbred tester for evaluating combining ability in modified single cross hybrid of maize. *Indian. J. Genet.,* **61(4) :** 309-313.

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