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Short Communication

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

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The aim of a pant breeder is to identify parents that will combine well and produce productive progenies. Since the quantitative characters are considerably influenced by the environment, a multi-environmental study is likely to bring out genotype-environment interaction for estimating the gene effects precisely and predicting the advance under selection. General combining ability is a good estimate of additive gene action, whereas specific combining ability is a measure of non-additive gene action [1, 2]. The present study has been carried out over three 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 programme.

Twenty diverse advanced stage inbred lines of maize were mated with 3 inbred lines (testers) in line × tester design in rabi 1998-99. The resulting 60 F_1s hybrids along with 23 parents were grown in randomized block design with three replications in a single row plot of 5 meters length having 60 × 25 cm crop geometry in *kharif* 1999 under rainfed condition at Rajasthan College of Agriculture, Udaipur, Agriculture Research Station, Banswara and Agricultural Research Sub-Station, Pratapgarh, Rajasthan. All the three environments form three diverse growing conditions of the crop. Observations were recorded on ten random plants in each plot for grain yield, plant height, days to 50% brown husk, ear size, 100 grain weight, stover yield and harvest index. The combining ability analysis for line × tester mating design was conducted as per the procedure developed by Kempthorne [3].

The pooled analysis of variance for combining ability revealed that mean squares due to lines, testers and line × tester were significant for all the traits except due to testers for plant height and days to 50% brown husk. The mean squares due to interaction of lines, testers and line × tester with the environments were significant for all the characters except for days to 50% brown husk and 100-grain weight. The higher values of σ^2 *sca* than σ^2 *gca* (pooled) for all characters in all environments indicated the importance of non-additive variances in control of all the characters studied. Environments played important role in the expression of *gca* and *sca* variances (Table 1). These results are in agreement with those of other workers [4, 5].

Table 1. Analysis of variance for combining ability pooled over environments

Source	Mean squares							
	d.f.	Grain yield	Plant height	Days to 50% brown husk	Ear size	100-grain weight	Stover yield	Harvest index
Environment (E)	2	115921.8**	219.1	0.6	16073.7**	234.7**	5175.3**	317.3*
Line (L)	19	1204.9**	295.9**	37.0**	1933.5**	45.4**	984.7**	109.5**
Tester (T)	2	1469.7**	171.0	3.2	1279.7*	50.7**	1592.6**	175.3*
L × T	38	1135.8**	330.9**	13.9*	1017.31**	41.0**	836.3**	107.1*
L × E	38	217.9**	503.1**	2.9	587.6**	7.1	198.4**	13.7*
T × E	4	302.3**	539.8*	4.4	715.8**	7.3	465.8**	15.6*
L × T × E	76	224.8**	239.9**	2.7	484.5**	5.2	186.8**	19.5*
Pooled error	354	43.2	93.9	9.5	84.2	4.9	34.4	6.0
$\sigma^2 s/\sigma^2 g$		235.4	46.0	13.9	15.1	198.5	76.0	243.5

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

Genotypes with significant *gca* effects in desired direction are expected to transmit genes with desirable effects to their progeny. One tester and 7 lines for grain yield, 6 lines for plant height, 5 lines for days to 50% brown husk, 1 tester and 5 lines for ear size, 1 tester and 8 lines for 100-grain weight, 2 testers and 7 lines for stover yield and 1 tester and 11 lines for harvest index showed desired significant *gca* effects for the respective traits in pooled analysis over the environments. Among the testers, T_1 had desired significant *gca* effects for 100-grain weight and harvest index, similarly T_2 was a poor combiner for grain yield but best combiner for ear size and stover yield. T_3 had desired significant *gca* effects for grain yield and stover yield. Among the lines L_4 and L_9 for grain yield, ear size and harvest index, L_7 and L_{10} for grain yield, plant height and days to 50% brown husk, L_5 and L_{17} for grain yield and harvest index, L_{16} and L_{18} for 100-grain weight and stover yield and L_3, L_{13}, L_{14} and L_{15} for 100-grain weight and harvest index were good general combiners for the respective traits. The performance of the parents and their *gca* effects varied in different environments which may be attributed to genotype × environment interaction.

The crosses showing desired significant *sca* effects for grain yield alongwith 3 or 4 of its component traits in pooled analysis are listed in Table 2. In this study nineteen crosses for grain yield, 17 for 100-grain weight, 14 each for harvest index and ear size, 6 for plant height and 3 for days to 50% brown husk revealed significant desired *sca* effects for these traits in pooled over the environments. Among the crosses, $L_{15} \times T_3$ and $L_{16} \times T_3$ were the best specific combinations for grain yield and its components as they exhibited desired significant *sca* effects for maximum number of traits with high yield and involving poor × good *gca* parents. The crosses $L_{14} \times T_2$, $L_6 \times T_1$, $L_{19} \times T_2$ and $L_{11} \times T_1$ gave high yield, significant positive *sca* effects for grain yield, 100-grain weight, ear size, harvest index and stover yield and involving poor × poor *gca* parents for grain yield [6]. The crosses $L_{18} \times T_3$ and $L_9 \times T_3$ exhibited desired *sca* and *gca* effects, high *per se* performance and involved good × good *gca* parent combination. Therefore, these cross combinations should be exploited in future breeding programmes for high *per se* after adequate multi-environmental testing.

Table 2. Hybrid combinations with desired significant *sca* effects for grain yield together with *per se* performance in L × T analysis in maize.

Hybrid (s)	*per se* performance (kg/ha)	*sca* effects for grain yield	*gca* effects of parents for grain yield	Type of combination
$L_{15} \times T_3$	15111	16.19**	L_{15} = –0.60 T_3 = 2.59**	poor × good
$L_{18} \times T_3$	14889	7.30**	L_{18} = 6.62** T_3 = 2.59**	good × good
$L_{17} \times T_2$	14623	16.10**	L_{17} = 1.47* T_3 = 2.59**	good × poor
$L_9 \times T_3$	14533	8.45**	L_9 = 2.80** T_3 = 2.59**	good × poor
$L_{10} \times T_1$	14325	7.01**	L_{10} = 4.80** T_1 = 0.47	good × poor
$L_{13} \times T_3$	14325	9.78**	L_{13} = –0.09 T_3 = 2.59**	poor × good
$L_{16} \times T_3$	13423	3.37**	L_{16} = –0.46 T_3 = 2.59**	poor × good
$L_{11} \times T_1$	13408	6.06**	L_{11} = – 6.34** T_1 = 0.47	poor × poor
$L_{14} \times T_2$	13023	6.44**	L_{14} = –0.86 T_2 = –3.06**	poor × poor
$L_{19} \times T_2$	12675	12.69**	L_{19} = –2.57** T_2 = –3.06**	poor × poor
$L_6 \times T_1$	11333	8.04**	L_6 = –18.68** T_1 = 0.47	poor × poor

*,**Significant at 5% and 1% level, respectively.

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