COMBINING ABILITY AND HETEROTIC POTENTIAL FOR GRAIN YIELD AND ITS RELATED TRIATS IN MAIZE (*Zea mays* L.)

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ABSTRACT

Combining ability and heterotic potential was studied in F_1 hybrids of maize inbreds with respect to grain yield and yield attributing traits using twenty one hybrids which were developed through Line × Tester mating design. The parents and their hybrids were subjected to assess the combining ability and nature of gene action governing the quantitative traits. The results revealed that the predominance of non-additive gene action was observed for all the traits. Among the parents, the overall study of *gca* effects suggested that parents UMI 1200, CML 421 and HKI 1025 were significant good general combiner for yield, these can be used to improve hybrids. Significant positive SCA effects were found for all the studied traits. Among the hybrids, CML 421 x UMI 1200 showed desirable standard heterosis percentage over the check hybrid vivek 23 along with good *sca* effects, standard heterosis and *per se* performance for grain yield and other important yield contributing traits, thus it can be used for commercial seed production programme.

Keywords: line x tester, combining ability, heterosis, maize, yield traits

INTRODUCTION

Maize (Z*ea mays* L.) is a C_4 plant that can utilize solar energy more efficiently than any other cereals. This crop can be utilized for multiple purposes like human food, poultry feed, animal fodder, and industrial raw material. Its importance has been rapidly growing in recent years in Asia, where 4% annual growth recorded as compared to other cereals. It is one of the most important crop of India having area, production and productivity of 8782 (000'ha),21759 (000't) and 2478 kg/ha respectively (Anonymous, 2014).

Maize crop is unique among the cereals on account of its amenability to diverse uses and it has huge potential in the present era of crop diversification. The success of any hybrid breeding programme depends upon the choice of parents and clear knowledge of gene action for specific traits (Venkatesh *et al.,* 2001). Combining ability is one of the most effective tool in deciding the appropriate parents for hybridization especially when a large number of parental lines are available and most promising ones are to be identified on the basis of their abilityto give superior hybrids Adelardo *et al.,* (2006). The exploitation of heterosis in maize can be accomplished through the development and identification of high *per se* performing parental lines and their subsequent evaluation for combining ability in cross combinations to identify the hybrids with high heterotic effects Kabdal *et al.,* (2003).

Heterosis, the measure of the average superiority of a hybrid over its parental inbred lines is an important consideration in the development of hybrid varieties. Diversity among inbred source populations is an important factor in determining combining ability among inbred lines and heterosis revealed by hybrids, where a more diverse combination is expected to produce more superior hybrids (Prasad and Singh 1986). Its estimation is normally specific to the material used, and the place and time of evaluation. As the L × T mating design suggested by Kempthrone (1957) is the reliable method for identifying parents and hybrids which are superior based on *gca* and *sca* respectively which also provides the nature of genes involved for expression of desirable traits.

MATERIALS AND METHODS

Seven diverse inbred lines of maize viz. CML 147, CML 150, CML 395, CML 421, HKI 209, HKI 1025 and HKI 1105 were crossed with three diverse inbred testers UMI 1200, UMI 1025 and UMI 1220 in line x tester fashion to produce twenty one hybrids during *kharif*, 2011. The F_1 seeds of all the 21 hybrids, their parents along with standard check hybrid Vivek-23 were grown in randomized block design with three replications during *kharif*, 2011 in the Plant breeding farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Chidambaram.

Usual agronomic practices were done accordingly based on the crop stage. Ten randomly competitive plants were taken for recording data on plant height (cm), days to 50% tasseling, days to 50% silking, cob length (cm), cob girth (cm), cob weight (g), number of kernel rows per cob, number of kernels per row and grain yield (g) per plant. Analysis of variance of the data was done using model suggested by Panse and Sukhatme (1984). Line x Tester analysis was carried out as per the procedure described by Kempthorne (Kempthorne (1957). The heterosis was estimated over the check (Hybrid Vivek-23) as per standard procedure.

RESULTS AND DISCUSSION

The analysis of variance revealed that mean squares due to parents (lines and testers) and crosses were highly significant for all the characters studied (Table 1). This reflected the presence of adequate genetic variability in the experimental material included under study. The knowledge of additive and non-additive gene action is essential to plant a breeder which is useful for the development of an efficient plant breeding programme. Earlier workers suggested that, if additive genetic variation is greater, then the chance of fixing superior genotype in early segregating generations would be greater. If dominant and epistatic interactions are predominant, the selection should be postponed to later generations. It is expressed as a ratio between GCA and SCA. If GCA is greater, it indicates the preponderance of additive gene action and if SCA is greater it implies the non-additive gene action which arises largely due to dominance and epistatic interactions. In the genotypes studied the ratio of components revealed that the SCA variance was higher than

GCA variance for all the characters indicating higher proportion of non-additive genes. Similar results were obtained by Premalatha, 2006; Kanagarasu *et al.*, 2010.

Mean performance was high for the lines CML 421, CML 395 and HKI 1205 for grain yield with maximum of about 81.78 for parents and the crosses CML 421 x UML 1200, CML 395 x UML 1220 and HKI 1205 x UML 1200 exhibited maximum grain yield of about 92.51 and also for majority of its component traits (Table 2). The estimates of *gca* effects showed that there was a significant different among parents revealing general combiner for all the traits in desired direction (Table 3). As the significant *gca* effects indicates the good combiner among the parents. The estimates of *gca* effects showed that the parents UMI 1200 between the three testers and CML 421, CML 395, HKI 1205 and HKI 209 among the lines possessed highly significant positive GCA effects for grain yield per plant.

The parents CML 150, CML 395 and UMI 1200 exhibited desirable significant *gca* effects for 100 kernel weight; UMI 1200, CML 421, HKI 209 and HKI 395 for number of kernels per row; UMI 1220, CML 421 and CML 395 for number of kernel rows per cob; UMI 1220, CML 150 and CML 421 for cob girth; UMI 1205, CML 421 and CML 1205 for cob length recorded significant positive *gca* effects. Similarly, for days to 50% tasseling possessed negative GCA effects byUMI 1205, CML 421, HKI 209 and CML 150 and for days to 50% silking UMI 1205, HKI 209, HKI 1205 and CML 150 exhibited negative *gca* effects. For plant height trait, UMI 1200, HKI 1105, CML 421 and CML 147 resulted with negative *gca* effects. Such kind of results are in accordance with Nagda *et al.* (1995) and Dadheech *et al.* (2007). It is evident that the tester UMI 1220 and lines CML 395, CML 421 and HKI 1205 adjudged as the best combiners for plant height and yield relating traits like cob length, 100 kernel weight, number of kernels per row and number of kernel rows per cob these might be utilized as potential parents since they possessed high *per se* performance with significant *gca* effects for the respective traits. These results indicated that there is a scope for improving combining ability of parents for attributing traits. The best general combiner for grain yield was UMI 1200, CML 421 and HKI 1205.

Specific combining ability is the indicative of heterosis for the evaluation of hybrids. The SCA was due to non-additive gene interactions (Sprague and Tatum, 1942). A perusal of the first best four hybrids based on the grain yield per plant revealed that the cross CML 421 x UMI 1200 performed best on the basis of high SCA effects, standard heterosis and *per se* performance for grain yield (Table 4). The cross was also desirable for days to 50% silking and number of kernels per row. Another cross CML 395 x UMI 1220 performed best with respect to SCA, heterosis and *per se* performance for grain yield, plant height, and cob length. The cross HKI 1205 x UMI 1200 showed best for SCA, heterosis and *per se* performance for cob length and days to 50% silking and the another one HKI 209 x UMI 1220 also resulted best for the trait number of kernels per row. Results are in conformity with Dubey *et al.*, 2001; Srivastava and Singh, 2003; Apunnu *et al.*, 2007.

It is concluded that the parents, UMI 1220, CML 421 and HKI 1025 showed good general combining ability and the hybrid CML 421 x UMI 1200 showed desirable standard heterosis percentage along with good *sca* effects and *per se* performance for grain yield and other important yield contributing traits over different locations. Therefore, this hybrid can be commercially exploited for seed production programme.

REFERENCES

Adelardo, J., De la Vega.and Scott, C.C. 2006. Multivariate analysis to display interactions between environment and general or specific combining ability in hybrid crops. *Crop Sci.*, **46**: 957-967.

Anonymous, 2014. Project Director Review. All India Coordinated Research Project on Maize, Directorate of Maize Research, New Delhi.

Apunnu, C., Satyanarayana, E. and Rao, T. N. 2007. Heterosis for grain yield and its components in maize. *J. Res. ANGRAU*, **35**(1): 124–126.

Dadheech, A and Joshi, V.N. 2007. Heterosis and combining ability for quality and yield in early maturing single crosses of maize. *Indian J. Agric. Res*., **41**(3): 210-214.

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. *Indian J. Genet.*, **61**: 353-55.

Kabdal, M.K., Verma, S.S., Kumar, A., Panwar, U.B.S. 2003. Combining ability and heterosis analysis for grain yield and its components in maize (*Zea mays* L.) *Indian J. Agr. Res.*, **37**(1): 39- 43.

Kanagarasu, S., Nallathambi, G., & Ganesan, K. (2010). Combining ability analysis for yield and its component traits in maize (Zea mays L.). *Electronic Journal of plant breeding.*, **1**(4): 915-920.

Kempthorne, O. 1957. An introduction to genetic statistics. Johan Wiley and Sons, New York, 458.

Nagda, A. K., Vyas, M. C., Dubey, R. B. and Pandiya, N.K. 1995. Heterosis and combining ability analysis for grain yield and its components in maize *Crop Res.*, **10** (3): 297–301.

Panse, V.G. and Sukhatme, P.V. (1984) Statistical methods for Agricultural workers. Indian Council of Agricultural Research, New Delhi. 145-152.

Prasad, S. K. and Singh, T. P. 1986. Heterosis in relation to genetic divergence in maize (*Zea mays* L.). *Euphytica*, **35**: 919-924.

Premalatha. (2006). Combining ability and heterosis analysis for grain yield components and quality traits in maize (*Zea mays* L.). *M.Sc Thesis*.

Srivastava, A. and Singh, I. S. 2003. Heterosis and combining ability for yield and maturity involving exotic and indigenous inbred lines of maize. *Indian J. Genet.*, **64**: 345-46.

Sprague, G. F., & Tatum, L. A. (1942). General vs. Specific Combining Ability in Single Crosses of Corn. *Agronomy Journal.*, **34**(10): 923-932.

Venkatesh, S., Singh, N.N. and Gupta, N.P. 2001. Early generation identification and utilization of potential inbred lines in modified single cross hybrids of maize (*Zea mays* L.). *Indian J. Genet.*, **61**(3): 213-217.

Table 1. Analysis of variance for yield and yield contributing traits in maize

Source of variation	df	Plant height	Days to 50% tasseling	Days to 50% silking	Cob length	Cob girth	100 kernel weight	Number of kernels per row	Number of rows per cob	Grain yield
Replication	2	23.14	0.16	0.30	0.31	0.89	3.22	1.03	0.21	2.16
Genotypes	30	2349.35*	21.83*	27.59*	19.76*	4.78*	108.24*	112.04*	3.52**	2587.23*
Parents	9	2789.54*	10.63*	16.80*	21.08*	4.04*	37.52*	44.69*	5.98**	517.95*
Lines	6	3172.41*	5.92*	9.95*	21.51*	4.92*	51.04*	107.24*	20.05*	376.68*
Testers	2	952.96*	43.26*	55.64*	24.94*	0.98*	465.96*	22.85*	4.50*	650.96*
Crosses	20	906.61*	7.26*	11.25*	9.76*	2.82*	42.41*	17.24*	2.50*	1692.23*
Error	60	9.93	0.29	0.36	1.07	0.58	3.97	1.95	0.35	0.47

Table 2. Mean performance of parents and crosses

Traits	Parents / Crosses	Mean	
		Minimum	Maximum
Plant height (cm)	P	104.98	214.61
	C	101.16	232.33
Days to 50% tasseling	P	52.67	62.45
	C	54.84	64.39
Days to 50% silking	P	56.76	65.89
	C	57.99	66.92
Cob length (cm)	P	9.32	17.65
	C	10.23	20.56
Cob girth (g)	P	9.69	14.84
	C	10.15	16.75
100 kernel weight (g)	P	16.92	40.26
	C	18.72	44.09
Number of kernels per row	P	22.67	38.23
	C	20.70	41.45
Number of rows per cob	P	11.50	14.75
	C	10.85	16.10
Grain yield (g/plant)	P	35.67	81.78
	C	33.34	92.51

Table 3. *gca* effects of parents

Lines	Plant height	Days to 50% tasseeling	Days to 50% silking	Cob length	Cob girth	100 kernel weight	Number of kernel/row	Number of kernel rows/cob	Grain yield
CML 147	-17.60*	-1.38*	-1.02*	-0.98*	-0.07*	1.32*	-0.32*	-0.25*	-6.57*
CML 150	2.45	-0.40*	-0.99*	-0.78*	0.48*	6.55*	-0.09*	-0.08*	-2.69*
CML 395	1.71	-0.81*	-1.57*	-0.96*	0.41*	2.68*	0.57*	0.75*	13.15*
UML 421	-10.69*	-0.05*	1.00*	2.58*	0.45*	-4.42*	1.28*	1.28*	21.65*
HKI 209	15.87*	-0.05*	-0.21*	0.40*	0.32*	-3.61*	0.56*	0.56*	5.38*
HKI 1205	12.57*	1.16*	-0.21*	0.48*	-0.37*	2.51*	0.38*	0.38*	20.51*
HKI 1105	-7.58*	0.16*	1.23*	0.80*	-0.38*	-0.65	-1.48*	-1.48*	1.87*
UMI 1200	-3.48	1.00*	1.29*	-0.15*	0.11*	0.63*	0.23*	0.23*	5.87*
UMI 1205	0.07	-1.21*	-1.46*	1.24*	-0.85*	0.32*	-1.30*	-1.30*	-5.83*
UMI 1220	3.23	0.21*	0.15*	-1.16*	0.83*	-0.63*	1.05*	1.05*	-0.33*
SE lines	1.06	0.17	0.20	0.34	0.26*	0.25*	0.30*	0.28*	0.40*
SE testers	0.52	0.08	0.100	0.17	0.11*	0.12*	0.20*	0.16*	0.20*

Table 4. sca and standard heterosis for best performig crosses

Trait	Effect	CML421 x UML1200	CML395 x UML1220	HKI1205 x UML1200	HKI209 x UML1200
Grain yield	sca heterosis	38.33* 43.92*	27.91* 6.71*	16.90* 11.49*	9.45* 6.76*
Plant height	sca heterosis	10.34 25.02*	14.62* 10.74*	4.68* 12.43*	-3.84* -3.21*
Days to 50% silking	sca heterosis	1.81* 6.60*	-0.73* -4.58*	-1.76* -4.12*	-1.07* -6.16*
Cob length	sca heterosis	3.45* 4.87*	6.42* 11.58*	9.23* 12.52*	4.74* 13.38*
Number of kernels per row	sca heterosis	25.83* 32.98*	18.37* 12.59*	12.23* 36.48*	19.11* 17.29*