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Short Communication

Heterosis and combining ability for yield and maturity involving exotic and indigenous inbred lines of maize (*Zea mays* L.)

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Exploitation of hybrid vigour is considered an outstanding accomplishment of plant breeding. The magnitude of heterosis shown by hybrids depends largely on the heterotic pattern and genetic divergence between parental inbred lines. Development of single cross hybrid of maize depends on the *per se* performance of inbreds and their combining ability for important characters. The information about the heterotic patterns and combining ability of parents and crosses both facilitate the breeders in the selection and development of single cross hybrids. Essentialities of diversity between two parents have been considered important for releasing high heterosis. Taking diversity into consideration the exotic and indigenous lines were involved in the present investigation to estimate the magnitude and direction of heterosis and combining ability in maize.

Eighty single crosses along with parental lines were evaluated in three environments *viz.*, Pantnagar (Uttaranchal), Bulandshahar (U.P.) and Ludhiana (Punjab) during kharif 2000, in RBD with three replications. Each entry was planted in 5 m row, 75 cm distance between rows and 25 cm between plants. All plants in a plot were taken into consideration for recording yield and days to 50% silking whereas, 5 competitive plants for 1000-kemel weight. The line × tester analysis was carried out according to Kempthome [1]. The heterosis was tested by standard procedure for individual and also for pooled data for all three characters.

Significant mean squares due to lines in pooled analysis (Table 1) indicated that significant variation existed for the traits under investigation. Significant differences were also observed across the environments for SCA effects as measured by the line × tester interaction for all characters. The mean square due to interaction of lines and lines × testers with environments were significant for all characters, while tester with environments was significant for days to 50% silking only. Higher SCA variance than the GCA variance also exhibited preponderance of non-additive gene effects resulting into more heterosis [2-5].

The estimates of GCA effects (Table 2) revealed that L_{13}, L_{17} and L_{20} were good general combiners for grain yield, 1000-kemel weight and 50% silking but only L_{13} and L_{20} had high *per se* performance. Only L_5 had significant GCA effect for grain yield and early silking [3].

Table 1. Pooled line × tester ANOVA for three characters in maize

Source of variation	df	Days to 50% silking	1000-kernel weight	Grain yield
Environment (E)	2	6860.63**	65894.66**	116266300.0**
Replication/environment	6	17.77	710.58	3397814.0
Line (L)	19	143.43**	2881.10**	5467334.0**
Tester (T)	3	129.51**	1151.70	5820522.0**
L × T	57	16.96*	1170.20*	1804015.0*
L × E	38	31.76**	1350.40*	2887846.0**
T × E	6	72.78**	1590.20	2431714.0
L × T × E	114	10.24**	813.2**	1240294.0**
Pooled error	474	4.05	223.4	510050.6
σ^2 GCA		0.72	1.75	22179.9
σ^2 SCA		2.24	118.99	187907.0

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

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Table 2. *Per se*, general combining ability, relative heterosis and specific combining ability of selected lines and crosses

Entries	Line *per se* (kg/ha)	Grain yield			Days to 50% silking			1000-kernel weight		
		Relative heterosis	SCA	GCA	Relative heterosis	SCA	GCA	Relative heterosis	SCA	GCA
Lines										
314-9-BB (L_5)	1219.44			257.71*			–1.29**			–21.84
GI 8SEQC3-7-1-2-1-1 BBB (L_7)	664.11			–45.29			–1.04**			9.07**
[Pop 147 × GM27-9-1]-219-181-2 (L_{13})	1138.89			312.68**			1.75**			8.27**
[Pop 147 × GM27-9-1]-219-307-1 (L_{14})	2019.89			168.73			1.12**			0.71
[Pop 147 × GM27-9-1]-213-246-1 (L_{15})	1034.67			132.73			0.49			10.60**
JAH 16-BB (L_{16})	660.67			–593.93**			0.93**			4.24*
P8P31DMR#1-55-2-3-2-1-B-BB-BB (L_{17})	982.67			710.57**			2.01			6.27**
89 (TL8645)/(PL753/MP781518) B-24-1-3-2-1-4-BB (L_{20})	3485.78			423.48**			1.40**			4.66*
S.E.(g_i)				101.75			0.29			2.13
Crosses										
$L_{14} \times T_2$		207.27**	704.59**		–14.18**	1.74**		5.32	–17.54**	
$L_7 \times T_4$		195.46**	824.63**		–4.58**	0.85		15.20**	–1.00	
$L_{13} \times T_3$		242.47**	452.75**		–4.14**	–0.40		8.58**	–8.29*	
$L_{15} \times T_1$		305.29**	420.44**		–9.37**	0.29		31.41**	20.70**	
$L_{15} \times T_3$		232.28**	328.89**		–3.01*	0.69		16.84**	–2.07	
$L_{16} \times T_3$		230.77**	418.59**		–5.88**	–1.69**		29.81**	5.04	
$L_{17} \times T_4$		181.48**	289.88**		–8.93**	–1.54**		18.99**	15.47**	

*,**Significant at 5% and 1% level of probability, respectively; T_1 = CM135, T_2 = CM136, T_3 = CM137 and T_4 = CM138

Among the seven selected crosses, cross $L_{17} \times T_4$ showed the highest mean along with high positive relative heterosis and SCA effect for grain yield and 1000-kemel weight. This also exhibited low mean with negative relative heterosis and SCA effect for days to 50% silking indicating early maturity. The cross $L_7 \times T_4$ was next best cross combination with high mean, positive relative heterosis and SCA effect for grain yield. Similarly the cross $L_{15} \times T_1$ exhibited the highest relative heterosis for grain yield and 1000-kernel weight and negative relative heterosis for days to 50% silking.

L_5, L_{13} and L_{20} had positive GCA effects for grain yield with high *per se* performance and these can be used as parents for high yielding single cross hybrids. All the seven crosses showed high relative heterosis and SCA effects for grain yield along with negative relative heterosis for days to 50% silking, which is desirable for developing early maturing single cross hybrids.

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