ISSN 0258-7122
Bangladesh J. Agril. Res. 33(3) : 375-379, September 2008

HETEROSIS AND COMBINING ABILITY FOR GRAIN YIELD AND ITS CONTRIBUTING CHARACTERS IN MAIZE

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Abstract

Combining ability analysis for grain yield and its contributing characters in maize were carried out in 5×5 diallel cross. The highest percentage of heterosis for grain per ear over mid parent and better parent were observed by the cross $P_2 \times P_3$. Crosses $P_1 \times P_3$ and $P_1 \times P_5$ showed significant negative heterosis for days to maturity. Significant general and specific combining ability variances were observed for all the characters except ear height. Almost equal role of additive and non-additive gene actions was observed for days to maturity. Additive genetic variance was preponderant for grains per ear and 1000-grain weight and non-additive gene action was involved in plant height, ear height, days to silking, and days to maturity. The inbred lines P_2 and P_5 were found to be best general combiner for 1000-grain weight.

Key Words: Heterosis, combining ability, grain yield, maize.

Introduction

Maize *(Zea mays* L.) is the third most important crop among the cereal crops grown in Bangladesh. Maize grain is gaining popularity in our country very quickly due to huge demand, particularly for poultry feed industry. Besides, maize has diversified uses as food and industrial raw materials. Maize acreage and production have an increasing tendency with the introduction of hybrids due to these high yield potentials. So, maize can play an important role in increasing food production of Bangladesh. At present, the farmers are cultivating some imported hybrid maize varieties, but they are very expensive. So, we have to develop hybrid maize varieties. The nature and magnitude of gene action is an important factor in developing an effective breeding programme. Combining ability analysis is useful to assess the potential inbred lines and also helps in identifying the nature of gene action involved in various quantitative characters. This information is helpful to plant breeders for formulating hybrid breeding programmes. Therefore, the present investigation with 5 × 5 diallel cross was undertaken for isolating superior inbred lines and better combining parents for suitable hybrids.

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Materials and Method

Five inbred lines of maize were mated in a diallel fashion excluding the reciprocals during the *rabi* season in 2001. The resulting 10 F_1s and their parents were grown in a randomized complete block design with three replications at Agricultural Research Station (ARS), Burirhat Farm, Rangpur during winter season (Rabi) of 2002- 2003. Each plot consisted of two rows of *5* m long. The spacing between row to row was 75 cm and plant to plant was 25 cm. One plant per hill was maintained. Observations were recorded on ten randomly selected plants from each plot for plant height, ear height, days to silking, days to maturity, grains per ear and 1000-grain weight (g).

Data were analyzed for variance for all the characters studied. General combining ability (GCA) and specific combining ability (SCA) were estimated by following Model-I, Method of Griffing (1956). The mean squares for GCA and SCA were tested against error variance desired. Mean data were used to estimate heterosis over mid parent and better parent according to Rai (1979).

Results and Discussion

Heterosis and hererobeltosis for different characters in maize are presented in Table I. For plant height, heterosis over better parent was found in the range of -10.5% to 11.33%. The crosses $P_3 \times P_4$ and $P_4 \times P_5$ showed significant and negative heterosis over better parent and mid parents and the heterosis over better parent for ear height ranged from (-) 8.33% to 10.83%. Significant negative heterosis was observed from the $P_3 \times P_4$ over better parent. The cross $P_2 \times P_3$ showed significantly positive heterosis over better parent and mid parent. For days to maturity, significant negative heterosis was observed by the cross $P_1 \times P_3$. Roy *et al.* (1998) observed a similar result for days to maturity.

Heterosis for grains per ear over better parent varied from (-)16.33% to 46.17%. Highest percentage of heterosis for grains per ear over mid parent as well as better parent was exhibited by the cross P_2 x P_3.

Analyses of variance for combining ability (GCA and SCA) are presented in Table 2. General combining ability and specific combining ability variance were highly significant for all the characters studied, which indicated that these characters were controlled by both additive and non additive gene actions. The mean squares due to SCA were much higher than GCA for plant height, ear height, and days to silking which revealed the predominance of non additive gene action for controlling these characters. The higher magnitude of GCA variance were found for days to maturity, grains per ear and 1000-grain weight, which indicated predominance of additive gene action. Akanda (1999) reported similar results for days to maturity and 1000-grain weight. Das and Islam (1994) also reported predominance of non additive gene action for grain yield.

Table 1. Heterosis and heterobeltosis *(%)* for different characters in maize.

Cross	Plant height		Ear height		D.S.		Days to maturity		GIF		100-grain weight	
	MP	HP	MP	HP	MP	HP	MP	HP	MP	HP	MP	HP
$P_1 \times P_2$	7.66*	2.16	2.00	-3.83	-0.66	-2.33**	4.16**	-0.83	16.00	10.00	7.00	-0.16
$P_1 \times P_3$	0.20	-3.33	1.00	-1.50	1.00	0.83	-1.66**	-6.83**	3.66	3.00	-9.00	-16.33**
$P_1 \times P_4$	6.16	1.58	3.00	0.67	-1.33	-2.50**	-0.83	2.66**	-8.00	-16.33	-20.33**	-26.39**
$P_1 \times P_5$	-4.33	-5.83	-1.30	-1.83	1.50	0.16	-4.83**	-7.16**	28.33**	20.39	4.00	3.16
$P_1 \times P_3$	11.00**	8.884**	11.00**	10.83**	0.34	-1.16	7.33**	7.16**	85.83**	46.17**	11.00	-3.50
$P_1 \times P_4$	12.16**	11.33**	0.50	-8.67	0.84	-1.33	6.83	3.66**	30.83**	28.50**	-7.50	-15.66**
$P_1 \times P_5$	4.16	0.17	6.16*	4.00	-4.83**	2.59**	3.33**	0.67	25.89	-0.67	7.83	1.50
$P_1 \times P_4$	-9.67**	-10.58**	-4.08	-8.33	-2.83**	-3.84	-0.16	-.50	15.50	6.50	-19.83**	-26.16**
$P_1 \times P_5$	7.50*	5.67	4.33	1.50	-2.83**	-4.33**	2.50**	-0.33	28.50	10.67	6.16	-2.00
$P_1 \times P_5$	-5.67	-8.84**	-2.50	-4.50	-3.83**	1.31	0.01	-0.580	43.50**	18.60	2.50	0.62

D.S= Days to silking, G/E= Grain per Ear. *,** indicated at 5% and 1% level of significance

GCA effects: The GCA effects of the parents are given in Table 2. Parents P_5 and P_2 exhibited significant positive GCA effects for number of grains per ear and 1000-grain weight, but parent P_4 showed negative GCA effect. The GCA effects of P_5 was significantly negative for days to silking and days to maturity. So, the estimates of GCA effects showed that the parent P_5 was the best combiner of 1000-grain weight also for both flowering and maturity. Therefore, parent P_5 could be a donor parent for yield and earliness in hybridization programme. The estimates of GCA effect showed that parent P_2 was also a good combiner for grain yield (1000-grain weight), but it was late in both days to silking and maturity. The parent P_3 showed significant negative GCA effect for days to maturity and 1000-grain weight. Debnath *et al.* (1988) found two and one inbred lines of maize, respectively, as a good general combiner for earliness in two separate experiments. Thus, the inbred lines which exhibited good general combining ability for at least one character can be used for development of early maturity and high grain yield.

Table 2. Mean squares due to general and specific combining ability (GCA and SCA) on yield and yield components of maize.

Source of variation	d.f.	Plant height	Ear height	D.S.	Days to maturity	G *I* Ear	1000-grain weight
GCA	4	172.94**	21.69**	7.21**	51.05**	6702.92**	2598.17**
SCA	10	216.30**	88.33**	18.12**	4114**	2849.94**	388 46*
Error	48	21.18	19.93	12.34	2.12	398.00	76.62
GCA:SCA	0.40	0.800	*0.245*	0.379	1.240	2.35 1	6.683

D.S=Days to silking, G/Ear= Grain per Ear. *, ** indicated at 5% and 1% level of significance

Table 3. Mean performance and general combining ability (GCA) effects for six characters in diallel cross.

Parent	Plant height	Ear height	Days to Silking	Days to maturity	Grain/Ear	1000-grain wt
P_1	1.41 (163.70)	-0.846 (57.10)	0.313 (99.03)	0.900* (152.16)	l2.l06* (459.40)	-2.386 (300.58)
P_2	1.07 (159.35)	0.353 (68.30)	0.68* (99.40)	0.866* (152.13)	0.693 (472.20)	12.51** (316.43)
P_3	3.28** (159.35)	-0.980 (56.96)	-0.486 (98.23)	-2.033 (162.70)	2.56 (474.06)	-3.986 (294.17)
P_4	-0.35 (181.15)	0.786 (58.73)	-0.388 (97.33)	0.826* (150.67)	14.l73* (453.33)	-8.753 (293.13)
P_5	5.03* (210.08	0.686 (58.63)	0.592* (98.66)	0.796* (149.23)	23.22 (494.73)	6.69** (309.53)
$SE_{(gi)}$ (%)	2.56	0.714	0.192	0.273	3.25	1.42

*,** indicated at 5% and 1% level of significance

Table 4. Mean performance and specific combining ability (SCA) effects for characters in *5* x 5 diallel cross in maize inbred lines.

Parent	Plant height	Ear height	Days to silking	Days to maturity	Grain/Ear	1000-grain wt
$P_1 \times P_2$	1.126 (160.33)	-3.95 (57.66)	-0.71 (98.33)	1.80** (139)	-1.56 (497.33)	5.78 (317.66)
$P_1 \times P_3$	-1.40 (148.00)	-0.28 (53.00)	-0.62 (99.66)	1.30* (144)	-9.29 (435.00)	-4.21 (292.00)
$P_1 \times P_4$	5.92* (156.00)	4.78 (65.66)	-0.81 (97.66)	-0.03 (143)	-13.22 (444.00)	16.44* (283.66)
$P_1 \times P_5$	-420 (145.66)	-1.62 (54.33)	2.25** (99.33)	3.06** (146)	23.04* (503.00)	2.53 (303.00)
$P_2 \times P_3$	9.4 (172.00)	6.68* (78.00)	1.25 (102.00)	2.73** (152)	4.27 (516.66)	18.05 (318.33)
$P_2 \times P_3$	6.82 (168.00)	-0.75 (54.66)	0.98 (101.60)	2.66** (158)	7.00 (455.00)	-3.39 (286.00)
$P_2 \times P_5$	-0.80 (158.00)	3.02 (56.00)	2.78** (97.00)	0.13 (142)	-10.56 (502.00)	-1.59 (324.00)
$P_3 \times P_4$	937* (131.66)	-4.58 (50.33)	1.34* (98.66)	1.60** (145)	-3.72 (445.33)	-9.68 (265.00)
$P_3 \times P_5$	7.66* (150.33)	1.84 (55.63)	-1.11 (94.61)	2.03** (141)	-1.29 (470.33)	2.78 (319.60)
$P_4 \times P_5$	-4.34 (139.54)	-1.92 (50.23)	-1.21 (94.66)	-0.03 139)	21.44** (483.66)	16.22** (290.33)
SE(ij)	2.65	2.52	0.08	0.49	9.52	5.05

*, ** indecated at 5% and 1% level of significance

SCA effect: The SCA effects of the crosses for different traits are presented in Table 3. The crosses $P_1 \times P_4$, $P_2 \times P_3$ and $P_4 \times P_5$ showed significantly positive SCA effects for 1000-grain weight. Significantly positive SCA effect was observed in $P_1 \times P_5$ and $P_4 \times P_5$ for grains per ear. Two crosses $P_2 \times P_5$ and $P_3 \times$

P_5 showed high mean performance, but did not show significant SCA effect. This indicated that high value of the crosses may not necessarily indicate their potentiality. For plant height (Table 4), the cross $P_3 \times P_4$ showed highest significant negative SCA effect. For days to silking and days to maturity, two crosses viz., $P_1 \times P_5$ and $P_3 \times P_4$ involving low x high and low x low interaction of GCA of the parents showed significant and negative SCA effects. The crosses $P_1 \times P_2$, $P_2 \times P_5$ and P_3 x P_5 although showed high mean performances, but did not show significant SCA effects for days to maturity and 1000-grain weight. This indicated that high per se value of cross may not necessarily indicate their potentiality in crosses. Moll and Stuber (1974) reported that any combination among the parents may produce hybrid vigour over the parents which might be due to dominant, over dominant or epistatic gene action. So, the crosses showing desirable SCA effects can be used in future breeding programme.

Conclusion: Considering the overall performances, the inbred lines P_2 and P_5 can be used for hybrid maize production among the different inbred lines.

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