

Original Research Article

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Estimation of Heterosis for Grain Yield and Architectural Traits in Yellow Seeded Maize (*Zea mays* L.)

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ABSTRACT

Keywords

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Tools for yield prediction are requisite to any successful heterosis breeding program. In this study, heterosis was evaluated in 10×10 half diallel along with 3 checks in RBD with 3 replications in maize for grain yield and architectural traits viz., ear length, number of grain rows per ear, 100-grain weight, grain yield per plant and harvest index etc. Significant positive mid-parent heterosis ranged from 11.11 to 27.66 per cent, 13.51 to 17.95 per cent, 7.07 to 47.66 per cent, 23.93 to 82.39 per cent and 8.84 to 25.18 per cent for ear length, number of grain rows per ear, 100-grain weight, grain yield per plant and harvest index and respectively. Out of forty five hybrids, two hybrids for ear length, one hybrid for number of grain rows per ear show positive significant better-parent heterosis. In case of grain yield per plant positive significant better-parent heterosis was exhibited by eleven hybrids with maximum magnitude of this heterosis depicted by the hybrid P1 x P2 (66.03%). Hybrid P8 x P9 (42.88 %) exhibited maximum positive significant better-parent heterosis and hybrid P4 x P10 (11.94 %) exhibited maximum positive significant economic heterosis for 100-grain weight. For harvest index, hybrid P1 x P2 (18.57%) exhibited maximum positive significant better-parent heterosis and hybrid P6 x P7 (14.63 %) obtained maximum positive significant economic heterosis. This hybrid also shows highest magnitude of positive significant economic heterosis for grain yield per plant (41.67%).

Introduction

Maize (*Zea mays* L.) is an important cereal crop belonging to the tribe Maydeae, of the grass family, Poaceae. It is a versatile crop with wider genetic variability and able to grow successfully throughout the world covering tropical, subtropical and temperate agro-climatic conditions It is used world-wide for feed, food and also serves as a source of basic raw material for a number of industries viz.,

oil, starch, protein, food, alcoholic beverages, sweeteners, cosmetics, bio- fuels etc. Maize is an extensively investigated crop for heterosis breeding and occupies the pride place in launching the first hybrid breeding programme in the country under auspicious of all India Co-ordinated Maize Improvement Project. The breeding strategy for exploitation of heterosis in maize (*Zea mays* L.) through the

cultivation of single cross hybrids is primarily dependent on the development and identification of high *per se* performing diverse, vigorous and productive inbred lines with good seed quality and their subsequent evaluation for combining ability in cross combinations to identify single crosses with high heterotic effects. The phenomenon of heterosis has provided the most important genetic tool improving yield potential of crop plants. Heterosis breeding is primary based to the identification of parents and their cross combinations capable of producing the highest level of transgressive segregates. The magnitude of heterosis depends on the extent of genetic diversity between parents and helps in choosing the parents for superior F₁ hybrids.

So, the objective of this paper is to assess heterosis, better-parent heterosis, and economic heterosis, and on the basis of the study, superior inbred lines and hybrids will be identified for grain yield and architectural traits *viz.*, ear length, number of grain rows per ear, 100-grain weight, grain yield per plant and harvest index etc.

Materials and Methods

The experimental material comprising ten S₆ inbred lines were crossed using diallel design during *Rabi* 2013-2014 and developed 45 half-diallel crosses (reciprocals excluded). These 45 hybrids with 10 parental inbred lines and three economic checks *viz.*, Prakash, PMH-5, HM-8 were evaluated in randomized block design with three replications during *Kharif* 2014 at the Instructional farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur. Each treatment was grown in single row plot of 4.0 m row length with row to row and plant to plant spacing of 60 cm. and 25 cm. respectively. Recommended package of practices of zone IV (a) of Rajasthan were used to raise a healthy crop. The data were recorded on grain

yield and architectural traits *viz.*, ear length, number of grain rows per ear, 100-grain weight, grain yield per plant and harvest index on ten randomly selected competitive plants (Table 1). Pooled magnitude of heterosis over mid parent (MP) or mid-parent heterosis, better-parent (BP) or better-parent heterosis and economic or standard-check (SC) heterosis were calculated as per economic procedure respectively Shull (1908), Fonseca and Patterson(1968), Briggles (1963).

Results and Discussion

The mean square due to genotypes, parents, crosses and parents v/s crosses were significant for all the traits, except due to parents v/s crosses for ear length, number of grain rows per ear and grain yield per plant. This indicated the existence of appreciable amount of genetic variability in the experimental material of the present investigation (Table 1).

Out of forty five hybrids, eight hybrids depicted positive significant mid-parent heterosis for ear length with range varied from 11.11 % (P2 x P8) to 27.66 % (P3 x P8); two hybrids *viz.*, P2 x P7 (17.95 %) and P2 x P7 (13.51 %) for number of grain rows per ear. In case of 100-grain weight, out of forty five hybrids, positive significant mid-parent heterosis was exhibited by twenty six hybrids and ranged from 7.07 % (P1 x P10) to 47.66 % (P8 x P9). The maximum positive significant mid-parent heterosis was depicted by hybrid P8 x P9 (47.66 %) followed by hybrid P4 x P10 (46.86 %) for 100-grain weight. For grain yield per plant, out of forty five hybrids, fourteen hybrids exhibited positive significant mid-parent heterosis. It's ranged from 23.93 % (P2 x P7) to 82.39 % (P1 x P2). The maximum positive significant mid-parent heterosis was depicted by the hybrid P1 x P2 (82.39 %) followed by hybrid P1 x P5 (78.78 %) and hybrid P1 x P8 (66.27

%) for grain yield per plant. Fifteen hybrids expressed positive significant mid-parent heterosis for harvest index with the magnitude ranged from 8.84 % (P2 x P6) to 25.18 % (P1 x P5). The study of mid-parent (MP) heterosis revealed that number of hybrids depicting positive significant mid-parent heterosis for yield and yield contributing traits ranged from 2 (number of grain rows per ear) to 15 (harvest index). Similar findings for mid

parent heterosis for grain yield per plant, 100-grain weight, harvest index, number of grains rows per ear were also obtained by Dubey *et al.*, (2009), Amanullah *et al.*, (2011), Silva *et al.*, (2011), Abuali *et al.*, (2012) Avinashe *et al.*, (2013), Gautam *et al.*, (2013), Ali *et al.*, (2014), Khan *et al.*, (2014), Ofori *et al.*, (2015) and Ruswandi *et al.*, (2015) (Tables 2 and 3).

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

Source of variance	Df	Mean Squares				
		Ear length	Number of grain rows per ear	100-grain weight	Grain yield per plant	Harvest index
Replication	2	1.519	2.206	1.673	806.297*	0.915
Genotype	54	3.7189**	2.987**	31.441**	1881.3**	11.9187**
Parent	9	3.715**	3.615**	37.128**	2184.8**	14.356**
Crosses	44	3.719**	2.909**	28.5048**	1851.45**	11.221**
Parent vs. Crosses	1	3.70647	0.775758	109.486**	463.276	20.7084**
Error	108	0.998299	1.02088	1.52982	171.217	2.24231

* and ** means Significant at 5% and 1% respectively.

Table.2 Per se Performance of inbred lines and checks for ear length (cm), number of grains rows per ear, 100 grain weight (g), grain yield per plant (g) and harvest index (%) in maize

S.No	Genotype	Ear length (cm)	Number of grains rows per Ear	100 Grain weight (g)	Grain yield per Plant (g)	Harvest Index (%)
1	P1	12.83	15.33	25.88	71.67	21
2	P2	13.47	13.33	26.71	87.33	23.33
3	P3	11.53	14.67	30.57	103.33	24.33
4	P4	15.33	14.67	24.96	123.33	25.67
5	P5	14.43	12	27.82	98	25.33
6	P6	15.13	14.67	33.13	106.67	25.67
7	P7	14	12.67	26.12	146.67	28.33
8	P8	13.53	12.67	21.58	66.67	24
9	P9	13.87	14	23.07	143.33	28
10	P10	13.2	13.33	23.25	96.67	23.67
11	Prakash	14.33	13.33	26.91	100	26.33
12	HM-8	15.2	13.33	30.17	103.33	25.67
13	PMH-5	15.13	14	31.63	120	27.33

PMH-5- Punjab Maize Hybrid-5, HM-8 - Hisar Maize-8

Table.3 Range of positive significant heterosis over mid-parent (MP), better parent (BP) and standard check (SC) and positive hybrids (in parenthesis) for ear length (cm), number of grains rows per ear, 100 grain weight (g), grain yield per plant (g) and harvest index (%) in maize

Characters	Range of Heterosis (%)			Best hybrid on the basis of highest heterosis		
	MP	BP	SC	MP	BP	SC
Ear length (cm)	11.11 % to 27.66 % (8)	16.36 % to 18.23 % (2)	-	P ₃ x P ₈ (96.20 %)	P ₃ x P ₈ (18.23 %)	-
Number of grains rows per Ear	13.51 % to 17.95 % (2)	15.00%(1)	-	P ₂ x P ₇ (17.95 %)	P ₂ x P ₇ (15.00%)	-
100 Grain weight (g)	7.07 % to 47.66 % (26)	9.32%- 42.88% (14)	11.94 % (1)	P ₈ x P ₉ (47.66 %)	P ₈ x P ₉ (42.88 %)	P ₄ x P ₁₀ (11.94 %)
Grain yield per plant(g)	23.93 % to 82.39 % (14)	15.91 % - 66.03 % (11)	20.83 % - 41.67 % (5)	P ₁ x P ₂ (82.39 %)	P ₁ x P ₂ (66.03 %)	P ₆ x P ₇ (41.67%)
Harvest index	8.84 % to 25.18 % (15)	10.39 % to 18.57% (8)	14.63 % (1)	P ₁ x P ₅ (25.18 %)	P ₁ x P ₂ (18.57%)	P ₆ x P ₇ (14.63 %)

Table.4 Superior hybrids identified on the basis of mid-parent (mp), better parent (bp) and standard check heterosis (sc) for grain yield per plant with relationship between 100-Grain weight (g) and Harvest Index (%) in maize

S. N.	Hybrids	Heterosis			<i>Per se</i> performance		
		Grain yield per plant (g)	100-Grain weight (g)	Harvest Index (%)	Grain yield per plant (g)	100-Grain weight (g)	Harvest Index (%)
Mid-parent heterosis							
1.	P ₆ x P ₇	34.21**	9.93**	16.05**	170	32.57	31.33
2.	P ₁ x P ₅	78.78**	17.26**	25.18**	151.67	31.48	29
3.	P ₄ x P ₆	27.54**	10.71**	6.49	146.67	32.16	27.33
4.	P ₁ x P ₂	82.39**	17.36**	24.81**	145	30.86	27.67
5.	P ₂ x P ₇	23.93**	10.56**	9.68*	145	29.2	28.33
6.	P ₄ x P ₁₀	12.12	46.86**	13.51**	123.33	35.4	28
Better-parent heterosis							
1.	P ₆ x P ₇	15.91*	X	10.59*	170	32.57	31.33

2.	P ₁ x P ₅	54.76**	13.17**	14.47**	151.67	31.48	29
3.	P ₄ x P ₆	18.92*	X	6.49	146.67	32.16	27.33
4.	P ₁ x P ₂	66.03**	15.52**	18.57**	145	30.86	27.67
5.	P ₂ x P ₇	X	9.32*	X	145	29.2	28.33
6.	P ₄ x P ₁₀	X	41.82**	9.09	123.33	35.4	28
Economic heterosis							
1.	P ₆ x P ₇	41.67**	2.97	14.63**	170	32.57	31.33
2.	P ₁ x P ₅	26.39**	X	6.1	151.67	31.48	29
3.	P ₄ x P ₆	22.22*	1.69	X	146.67	32.16	27.33
4.	P ₁ x P ₂	20.83*	X	1.22	145	30.86	27.67
5.	P ₂ x P ₇	20.83*	X	3.66	145	29.2	28.33
6.	P ₄ x P ₁₀	2.78	11.94**	2.44	123.33	35.4	28
Check	PMH-5				120.00	31.63	27.33

* and ** means Significant at 5% and 1% respectively; X indicate no heterosis or no value

Fourteen hybrids depicted positive significant better-parent heterosis for 100-grain weight while two hybrids for ear length and one hybrid (P₂ x P₇) for number of grain rows per ear. Better-parent heterosis for grain yield per plant was exhibited by eleven hybrids with maximum magnitude of better-parent heterosis depicted by the hybrid P₁ x P₂ (66.03%). This hybrid also exhibited significant positive better-parent heterosis for harvest index (80.03 %), whereas the number of hybrids depicting positive significant better-parent heterosis for harvest index was 8.

Heterosis over better parent for grain yield per plant, 100-grain weight was also reported by Appunu *et al.*, (2007), Gissa *et al.*, (2007), Jampatong *et al.*, (2010), Amanullah *et al.*, (2011), Bedhendi *et al.*, (2011), Silva *et al.*, (2011), Raghu *et al.*, (2012), Avinashe *et al.*, (2013), Dhairyashil *et al.*, (2013), Netravarti *et al.*, (2013), Ali *et al.*, (2014) and Khan *et al.*, (2014).

In case of economic heterosis, for grain yield per plant revealed that only five hybrids namely P₆ x P₇, P₁ x P₅, P₄ x P₆, P₁ x P₂ and P₂ x P₇ depicted positive significant economic heterosis for grain yield per plant over the best check PMH-5 (Table 4). Hybrid P₄ x P₁₀ exhibited positive significant economic heterosis for 100-grain weight (11.94 %) over the best check PMH-5. Only one hybrid namely P₆ x P₇ expressed positive significant economic heterosis for harvest index (14.63 %) over the best check PMH-5 (Table 4). Reddy *et al.*, (2011), Amiruzzaman *et al.*, (2013), Izhar and Chakraborty (2013), Netravarti *et al.*, (2013), Kage *et al.*, (2013), Kumar *et al.*, (2014) and Ruswandi *et al.*, (2015) also reported positive significant economic heterosis in maize for grain yield and its contributing traits. None of the hybrid exhibited positive significant economic heterosis for ear length and number of grain rows per ear.

In conclusion, in present study, on the basis of mean value, the inbred line P₇ exhibited

maximum mean value for grain yield per plant (146.67 g/p) and harvest index (28.33%) while the inbred line P₆ exhibited highest mean values for 100- grain weight. Hybrid P₆ X P₇ possesses positive significant economic heterosis for grain yield per plant (41.67) and harvest index (14.63).

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