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Original Research Article

Heterosis for Yield and Yield Components in Maize (*Zea mays* L.)

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A B S T R A C T

Heterosis for grain yield and yield contributing characters was studied in maize in 14 hybrids along with two standard checks Karveer and P-3501.The analysis of variance revealed that the mean squares due to genotypes were highly significant for all the characters studied indicating the presence of considerable amount of variability. The hybrid IC-541062 x GPM-230 manifested highest significant negative heterosis over best check karveer and P-3501 for days to 50% tasseling and days to 50% silking, hence were categorized as early maturing hybrid. The hybrid IC-541065 x GPM-470, IC-541064 x GPM-470, IC-541065 x GPM-230 and GPM-35 x IC-541063 exhibited significant standard heterosis over Karveer and P-3501 for yield and yield components with high *per se* performance for grain yield and also exhibited significant standard heterosis in desired direction for various traits *viz.*, Days to maturity, kernel rows number, 100-grain weight and fodder yield per plant. These crosses have immense practical value and could be exploited on commercial basis by testing on large area in multi-locational trials.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal of the world. In India, maize is the third most important cereal after rice and wheat. This maize is refers to as miracle crop and queen of cereals belongs to family Gramineae originated at South America. This crop provides food, feed, fodder and serves as a raw material for developing hundreds of industrial products. It also contains starch, protein, fats, fibres, minerals and vitamins. In maize, genotypes show wide fluctuations in their yielding ability when grown in different environments. The capacity of a crop to perform over range of environments is as important as its yielding potential. Exploitation of hybrid vigour in maize has gained much significance in view of its tremendous increase in yield levels. Maize is the highly cross pollinated crop and the scope for exploitation of hybrid vigour will depend on the direction and magnitude of heterosis and the type of gene action involved. There is continuous need to evolve new hybrids, which should exceed the existing hybrids in respect of yield.

In a recent time, more emphasis has been made for the development of superior single cross hybrids. Realizing the importance and need for such comprehensive study in maize, the present investigation was carried out to estimate standard heterosis of single cross hybrids in maize.

Materials and Method

The experimental material for the present investigation consisted of 14 experimental single cross hybrids of maize developed at Experimental Farm, Department of Agricultural Botany, College of Agriculture, Latur, along with 2 checks viz, karveer and P-3501. The details of single cross hybrids studied in the present investigation are given in Table1.

The test entries were sown under rain fed condition at three location *viz.*, Experimental Farm, Department of Agricultural Botany, College of Agriculture, Latur (E_1), Oilseed Research Sub Station, Ambajogai (E_2) and Agricultural Research Station, Udgir (E_3) in randomized block design with three replication. The plot size was 3.0 x 1.2 m^2. Recommended package of practices for maize cultivation were followed. Data were recorded on randomly selected five competitive plants from each genotype per replication for 11 character *viz*., days to 50% tasseling and silking, plant height, Ear height, ear length, Ear girth, kernel rows number, number of grains per rows, 100-grain weight, fodder yield per plant and grain yield per plant. The standard heterosis was estimated for grain yield and yield component by using method developed by Rai (1979).

Results and Discussion

The analysis of variance for yield and yield component in each environment revealed that the mean squares due to genotypes were highly significant for all characters indicating the existence of sufficient variability among the genotypes for all the traits in all environment (Table 2). Early flowering are the desirable attributes in this crop, therefore negative heterosis was considered as desirable for these trait. Among hybrids evaluated, all hybrids exhibited negative heterosis over both standard checks, karveer and P-3501 except IC 541065 X GPM 470 and GPM-35 x IC-541063. The hybrid IC-541062 x GPM-230 manifested highest significant negative heterosis over best check karveer and P-3501 for days to 50% tasseling and days to 50% silking, hence were categorized as early maturing hybrid. Similar findings were reported by Amiruzzaman *et al.,* (2013).

The hybrid IC-541067 x GPM-470 (4.97% and 5.36 %) showed highest positive standard heterosis over standard check karveer and P-3501, respectively for plant height. Present findings are in confirmation with Amiruzzaman *et al.,* (2013).

The hybrid IC-541065 x GPM-230 (5.64% and 6.96%) showed highest positive but non-significant standard heterosis over standard check karveer and P-3501 respectively for ear height. For the trait ear length the hybrid IC-541065 x GPM-230 and GPM-35 x IC-541063 showed highly significant positive standard heterosis over the checks Karveer and P-3501. The hybrid IC-541064 x GPM-470 (6.51% and 10.13%) showed positive significant standard heterosis over standard check P-3501. Similar findings were reported by Chattopadhyay and Dhiman (2005) and Devi *et al.,* (2007); None of the hybrid were found significant positive standard heterosis over the checks Karveer and P-3501 for ear girth.

The hybrid IC-541065 x GPM-230 followed by GPM-35 x IC-541063, IC-541064 x GPM-470 and IC-318781 x GPM-470 exhibited significant positive standard heterosis over the checks Karveer and P-3501 for kernel rows number, these results are in accordance with finding of Amiruzzaman *et al.,* (2011).

Table.2 Analysis of variance of single cross hybrids for eleven characters in maize

Source of variation	DF	Days to 50% Tasseling	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Kernel rows no.	No. of grains /row	100 grain weight (g)	Fodder yield/ plant (g)	Grain yield /plant (g)
		Mean sum of squares										
		LATUR (E_1)										
Genotypes	15	6.33**	9.52**	88.53**	38.726**	2.993	1.98**	1.73**	8.1591**	11.98**	130.91**	63.836**
Error	30	0.7458	0.5291	6.1388	3.1605	1.048	0.178	0.199	0.6369	0.5226	4.4893	10.2839
		AMBAJOGAI (E_2)										
Genotypes	15	5.32**	13.40**	80.33**	42.118**	3.45**	1.98**	2.01**	10.387**	6.834**	130.91**	32.280**
Error	30	1.0611	0.6208	5.6069	3.3273	0.228	0.178	0.182	0.8584	0.4529	4.4893	7.6584
		UDGIR (E_3)										
Genotypes	15	4.83**	5.911**	59.51**	39.420**	3.08**	1.15**	1.28**	8.954**	8.651**	92.354**	48.939**
Error	30	0.6055	0.6402	5.9069	2.3098	0.376	0.148	0.237	0.4876	0.3416	8.9581	2.5160

*and **, Significant at 5 and 1 per cent, respectively.

Table.3 Estimates of standard heterosis (%) of single cross hybrids in maize

Sr. No.	Genotypes	Days to 50% Tasseling		Days to 50% silking		Plant height (cm)		Ear height (cm)	
		Karveer	P-3501	Karveer	P-3501	Karveer	P-3501	Karveer	P-3501
1.	IC 541067XGPM470	-1.22	-1.64*	-1.12	-0.93	4.97	5.36	3.48	4.78
2.	IC 558707XGPM470	-2.87*	-3.28*	-3.40*	-3.22*	1.03	1.41	-3.29	-2.08
3.	IC 541065 X GPM 470	0	-0.42	-1.88	-1.70	4.39	4.78	4.44	5.75
4.	IC 318781 X GPM 470	-3.28*	-3.69*	-3.01*	-2.82*	1.49	1.87	-0.91	0.32
5.	IC 541064 X GPM 470	-2.46	-2.88*	-2.63*	-2.45*	3.77	4.15	-1.74	-0.51
6.	IC 541064 X GPM 230	-2.87*	-3.28*	-3.21*	-3.03*	1.28	1.66	-2.32	-1.09
7.	IC 541062 X GPM 230	-3.48*	-3.89*	-4.91*	-4.73*	0.62	0.99	-3.93*	-2.73
8.	IC 541065 X GPM 230	-2.67*	-3.08*	-4.15*	-3.97*	2.73	3.11	5.64	6.96
9.	IC 318781 X GPM 230	-2.67*	-3.08*	-4.15*	-3.97*	1.24	1.62	-0.67	0.57
10.	IC 558882 X GPM 230	-1.85	-1.42	-2.84	-3.03	3.23	3.61	3.56	4.86
11	GPM 35 X IC 558602	-1.22	-1.64	-3.59*	-3.40*	0.41	0.79	-1.50	-0.26
12	GPM 35 X IC 541063	0.42	0	1.32	1.51	-1.11	-0.74	4.00	5.31
13	GPM 35 X IC541068	-2.26	-2.67*	-3.96*	-3.78*	3.56	3.95	0.11	1.36
14	IC 32118 X EC558715	-0.61	-1.03	-2.82*	-2.64*	-0.29	0.08	-0.59	0.64

*and **, Significant at 5 and 1 per cent, respectively.

Contd…

Sr. No.	Genotypes	Ear length (cm)		Ear girth (cm)		Kernel rows no.		No. of grains /row	
		Karveer	P-3501	Karveer	P-3501	Karveer	P-3501	Karveer	P-3501
1.	IC 541067XGPM470	-5.62	-4.11	-0.22	-0.30	0.14	00	-2.46	-3.71
2.	IC 558707XGPM470	-8.16	-6.69	-2.91	-2.98	-1.15	-1.29	-7.39	-8.58
3.	IC 541065 X GPM 470	-0.78	0.79	3.52	3.44	2.08	1.93	5.06*	3.75
4.	IC 318781 X GPM 470	-3.02	-1.16	4.98	4.90	4.96*	4.80*	-1.23	-2.50
5.	IC 541064 X GPM 470	4.83	6.51*	7.20	2.86	5.89*	5.74*	1.43	0.13
6.	IC 541064 X GPM 230	5.67	-4.66	-6.36	-6.17	-1.94	-2.08	-6.16	-7.36
7.	IC 541062 X GPM 230	-7.01	-5.52	-3.90	-3.98	-3.88	-4.02*	-8.45	-9.62
8.	IC 541065 X GPM 230	8.40*	10.13*	6.59	6.50	7.33*	7.17*	-0.37	-1.65
9.	IC 318781 X GPM 230	-1.57	00	1.76	1.68	-7.04	-6.89	4.72*	3.37
10.	IC 558882 X GPM 230	-6.10	-4.60	0.99	0.91	-0.78	-0.93	-3.90	-5.13
11	GPM 35 X IC 558602	-1.39	0.18	-3.06	-3.13	-2.08	-2.22	1.19	-0.10
12	GPM 35 X IC 541063	6.04*	7.73*	3.98	3.90	6.68*	6.53*	4.14*	-.07
13	GPM 35 X IC541068	-0.66	0.92	-4.52	-4.59	-4.81	-4.95	-10.33	-11.48
14	IC 32118 X EC558715	-1.57	00	4.59	4.51	00	-0.14	0.27	-1.01

*and **, Significant at 5 and 1 per cent, respectively.

Contd…

Sr. No.	Genotypes	100 grain weight (g)		Fodder yield/plant (g)		Grain yield /plant (g)	
		Karveer	P-3501	Karveer	P-3501	Karveer	P-3501
1.	IC 541067XGPM470	-0.94	-3.88	-0.71	-0.51	2.05	3.44
2.	IC 558707XGPM470	-1.80	-4.71	-2.45	-2.25	-1.51	-0.18
3.	IC 541065 X GPM 470	11.35*	8.05*	3.11*	3.32*	6.25*	7.69*
4.	IC 318781 X GPM 470	1.89	-1.12	1.37	1.58	2.68	4.07
5.	IC 541064 X GPM 470	9.63*	6.38*	3.83*	4.04*	5.45*	6.88*
6.	IC 541064 X GPM 230	-6.58	-9.35	-2.50	-2.30	-1.78	-0.45
7.	IC 541062 X GPM 230	-8.30	-0.11	-5.00	-4.81	-3.39	-1.35
8.	IC 541065 X GPM 230	8.30*	5.09*	1.99*	2.20*	4.91*	6.34*
9.	IC 318781 X GPM 230	1.72	-1.29	-1.02	-0.81	3.30	4.71*
10.	IC 558882 X GPM 230	0.86	-2.12	0.35	0.56	1.60	2.98
11	GPM 35 X IC 558602	2.02	-1.00	-0.20	00	1.25	2.62
12	GPM 35 X IC 541063	9.07*	5.84*	3.98*	4.19*	4.91*	6.34*
13	GPM 35 X IC541068	-10.88	-13.52	-4.29	-4.09	-3.93	-2.62
14	IC 32118 X EC558715	1.54	-1.46	0.81	1.02	2.68	4.07

Table.1 List of hybrids and checks tested

Sr. No.	Hybrids
1	IC541067 X GPM470
2	IC558707 X GPM470
3	IC541065 X GPM470
4	IC318781 X GPM470
5	IC541064 X GPM470
6	IC541064 X GPM230
7	IC541062 X GPM230
8	IC541065 X GPM230
9	IC318781 X GPM230
10	IC558882 X GPM230
11	GPM35 X IC558602
12	GPM35 X IC541063
13	GPM35 X IC541068
14	IC32118 X EC558715
Checks :	
1.	Karveer
2.	Pioneer-3501

For number of grains per row, the hybrid IC-541065 x GPM-470, IC-318781 x GPM-230 and GPM-35 x IC-541063 expressed significant positive standard heterosis over the checks Karveer.

For 100 grains weight, the hybrid IC-541065 x GPM-470 followed by IC-541064 x GPM-470, GPM-35 x IC-541063 and IC-541065 x GPM-230 exhibited highest significant positive standard heterosis over the checks Karveer and P-3501. Sumalini and Shoba Rani (2010) reported similar findings for this trait. The hybrids viz. GPM-35 x IC-541063, IC-541064 x GPM-470, IC-541065 x GPM-470 and IC-541065 x GPM-230 showed significant and highest positive standard heterosis over the check karveer and P-3501 for fodder yield per plant. Whereas the hybrids, IC-541065 x GPM-470 followed by IC-541064 x GPM-470, IC-541065 x GPM-230 and GPM-35 x IC-541063 were found highest significant and positive standard heterosis over the check Karveer and P-3501 for grain yield per plant. These finding are in agreement with the earlier reports by Shrivastava and Singh (2003). The degree of standard heterosis varied considerably for grain yield and its component. Yield is super character build up by a number of sub components. Yield is character of economic importance for which considerable magnitude of heterosis was registered in four crosses *Viz.*, IC-541065 x GPM-470, IC-541064 x GPM-470, IC-541065 x GPM-230 and GPM-35 x IC-541063 which exhibited significant standard heterosis over the checks karveer and P-3501 for grain yield per plant and yield component traits in the desirable character. These crosses have immense practical value and could be exploited on commercial basis by testing on large area in multi-locational trials.

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