ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

HETEROTIC EFFECTS FOR GRAIN YIELD AND RELATED TRAITS IN MAIZE VARIETY AZAM

Liaqat Shah[1], Hidayat Ur Rahman[1], Asif Ali[1], Kashif Ali Shah[1] and Aaqil Khan[2]
[1]Department of Plant Breeding and Genetics, The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan
[2]Department of Agronomy, The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan
E-Mail: laqoo@yahoo.com

ABSTRACT

This research was conducted at Khyber Pakhtunkhwa (KPK) Agricultural University Peshawar, Pakistan, during 2010 (spring and summer seasons). The experimental material comprised 64 entries (40 F_1 genotypes, 20 S_2 lines, 2 testers, and 2 checks) which were sown in partially balanced lattice square design with two replications. Data were recorded on cob length, kernel rows cob^{-1}, 100 kernel weight and grain yield. Highly significant differences were observed among the testcrosses for most of the traits. Maximum mid parent and better parent heterosis for 100 grain weight was detected for TC- 45-4-1 and TC- 45-4-3-3 where Kiramat and Jalal were the testers, respectively. Positive heterosis over mid parent, better parent and positive standard heterosis over two commercial checks of grain yield were found for most of the testcrosses. These lines were having promising performance which could be used in future maize breeding programs to exploit hybrid vigour.

Keywords: Maize, Grain yield, Mid parent heterosis, Better parent heterosis, Standard heterosis.

INTRODUCTION

Maize (*Zea mays* L.) is the world leading cereal crop. It belongs to grass family, Poaceae. It is native to America and was cultivated about 8, 000 years ago. Because of the highly cross pollinated nature, maize does not survive probably in its wild form. It is monoecious i.e. the staminate and pistillate flowers are borne in isolated inflorescence on the same plant. It is grown at altitude from sea level to 3300 meters above sea level and from 50^{o}N to 40^{o}S latitude as a multi-use crop in temperate, sub tropical and tropical regions of the world (Ihsan *et al*., 2005). It is highly cross pollinated crop as about 95% of the pistillate flowers on a cob receive pollen from near by plants and about 5% of the kernels as result of self pollination. Maize plant is protoandrous in which anthesis normally begins 1-3 days before the emergence of silks and 3-4 days after the silks emergence are ready to be pollinated (Poehlman, 1977). Maize crop having desirable attributes with high yield potential and improvement in average yield per hectare can certainly be made, if stable performance and high yielding genotypes are developed. Identification of such desirable genotypes in a mixed or base population is one of the main objectives of plant breeders (Khan *et al*., 2004). Line x tester performance of experimental lines is one of the prime selection criterion in hybrid breeding programme of maize (Mihaljevic *et al*., 2005). The improvement in vigour and yield potential of inbred lines and development of better cultural practices, single crosses were adopted for commercial cultivation. The recent trend is to go for single crosses than for double crosses, as the single crosses are the highest yielder under most favorable environments, show higher uniformity than the double and three way crosses. Moreover, seed production in single crosses involves lower cost than do the double crosses. Keeping these situations in view, an attempt was made to develop single crosses through Line x Tester analysis.

MATERIALS AND METHODS

The field experiment was conducted to evaluate testcross performance of maize S_2 lines for grain yield and yield related traits in maize variety Azam, at KP Agricultural University Peshawar, Pakistan, during 2010 in spring and summer crop season. In the spring crop season (February - June) 20 best promising inbred lines of Azam variety were selected based on their performance in their S_2 generation and these selected 20 inbred lines were crossed with two different testers viz., Kiramat (hybrid) and Jalal (OPV) at two isolations. In the summer crop season (July - October), performance of the resulting testcrosses were evaluated in replicated trial along with their S_2 parents and two commercial checks viz., Babar and 30k08. The experiment comprised 64 entries (40 F_1 genotypes, 20 female lines, 2 males, and 2 checks) which were sown in partially balanced lattice square design with two replications. Each entry was raised in single row plot with a row length of 5m, having row to row and plant to plant distance of 0.75m and 0.20m, respectively. Standard cultural practices were followed to raise good crop from sowing till harvest. The data were recorded on cob length, number of kernel rows cob^{-1}, 100 kernel weight (g) and grain yield (kg ha^{-1}). At physiological maturity, the cobs were dehusked and harvested from each plot in the field and Fresh ear weight of each entry was taken with the help of weighing balance in kg. Grain yield was obtained by adjusting the grain moisture at 15% and converted to the grain yield in kgha^{-1} with the help of the following formula (Carangal *et al*., 1971).

Grain yield (kg ha^{-1}) =

$$\frac{Fresh\,ear\,weight\,(kg\ plot^{-1})\times(100-MC)\times 0.8\times 10000}{(100-15)\times Area\,harvested\,(plot\,size)}$$

Where

ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

Fresh cob weight = Fresh weight of the cob row^{-1}
0.8 = Shelling coefficient
85 = Standard value of grain moisture at 15%
MC = Moisture content (%) in grains at harvest

Statistical analysis

The data recorded was subjected to analysis of variance (ANOVA) technique appropriate for 8×8 partially balanced lattice square design using program MS-Excel package. Heterosis expressed as percent increase (+) or decrease (-) of F_1 hybrid over mid-parent (relative heterosis), better parent (heterobeltiosis) and the best commercial check (standard heterosis) were calculated for each character using the following formula (Hayes *et al.*, 1955).

a. Heterosis over mid parent (relative heterosis)

$$= \frac{F_1 - MP}{MP} \times 100$$

b. Heterosis over better parent (heterobeltiosis)

$$= \frac{F_1 - BP}{BP} \times 100$$

c. Heterosis over check (standard heterosis)

$$= \frac{F_1 - CC}{CC} \times 100$$

Where

F_1 = mean performance of F_1
MP = mean mid-parental value = $(P_1 + P_2)/2$
P_1 = mean performance of parent one
P_2 = mean performance of parent two
BP = mean performance of better parent
SD = mean performance of the best commercial check

RESULT AND DISCUSSIONS

Number of kernel rows cob^{-1}

Heterotic effects among 40 testcrosses ranged from -24.35 to 60.67% and -26.24 to 17.49% against their mid parent and better parental values, respectively. Minimum mid parent heterosis was observed for TC- 45-4-3-8, where Kiramat was the tester, while maximum mid parent heterosis was detected for TC- 45-4-3, where Jalal was the tester. Minimum better parent heterosis was observed for TC- 45-4-3-8, where Kiramat was the tester, whereas the maximum better parent heterosis was exhibited for TC- 45-4-3, where Jalal was the tester. Twenty two out of 40 testcrosses exhibited positive mid parent heterosis, while 11 out of 40 testcrosses exhibited positive better parent heterosis. Higher number of kernel rows ear^{-1} is due to high parent's combination in maize (Geetha and Jayaraman 2000). Percent heterosis over two commercial checks viz., Babar and 30K08 ranged from -20.83 to 30.54 and -33.71 to 9.32, respectively. About 23 out of 40 testcrosses exhibited positive standard heterosis over the check Babar, whereas 37 out of 40 testcrosses exhibited negative standard heterosis over the check 30K08 (Table-1).

Ear length (cm)

Heterotic effects among 40 testcrosses ranged from -18.51 to 44.36% and -26.68 to 51.34% against their mid and better parent heterosis, respectively. Minimum mid parent heterosis was observed for TC- 45-4-3-8, where Kiramat was the tester, while maximum mid parent heterosis was detected for TC- 5-1-10, where Jalal was the tester. Lowest and highest better parent heterosis was observed for TC- 9-2 and TC- 45-4-3-3, where Jalal was the tester. Almost 27 and eight testcrosses exhibited positive mid parent and better parent heterosis, respectively. Debnath (1987) reported low mid parent heterosis for cob length in maize populations. Percent heterosis over two commercial checks viz., Babar and 30K08 ranged from 5.81 to 118.41 and -26.75 to 51.20, respectively. All testcrosses exhibited positive standard heterosis over the check Babar, while eight out of 40 testcrosses exhibited positive standard heterosis over the check 30K08 (Table-1).

Table-1. Heterosis over mid-parent (MPH), better parent (BPH) and standard heterosis (SH) for kernel rows ear^{-1} and ear length of 20 testcrosses with two testers.

Line × Tester		Kernel rows ear^{-1}				Ear length			
		MPH (%)	BPH (%)	SH (%)		MPH (%)	BPH (%)	SH (%)	
				Babar	30k08			Babar	30k08
5-1-10	Jalal	41.44	17.49	30.54	9.32	44.36	11.76	61.29	11.65
	Kiramat	-8.05	-15.00	-5.56	-20.91	-4.57	-15.02	22.65	-15.10
8-2	Jalal	26.98	0.00	11.11	-6.96	4.96	-13.85	24.33	-13.93
	Kiramat	7.66	-5.13	5.42	-11.72	-18.01	-23.17	10.89	-23.24
9-2	Jalal	-0.76	-16.26	-6.96	-22.09	-5.29	-26.68	5.81	-26.75
	Kiramat	4.00	-2.50	8.33	-9.28	8.48	-3.40	39.42	-3.49
45-4-1	Jalal	13.87	-2.50	8.33	-9.28	30.94	5.94	52.89	5.84
	Kiramat	-3.96	-8.76	1.37	-15.11	4.41	-3.38	39.45	-3.47
45-4-2	Jalal	-1.46	-16.25	-6.94	-22.07	27.30	5.82	52.72	5.72
	Kiramat	-4.64	-10.01	-0.01	-16.27	-9.09	-13.85	24.33	-13.93
45-4-3	Jalal	60.67	17.49	30.54	9.32	18.13	-16.18	20.97	-16.26
	Kiramat	0.00	-17.50	-8.33	-23.24	6.98	-11.64	27.52	-11.72
45-4-3-1	Jalal	-7.91	-20.00	-11.11	-25.56	14.96	-15.02	22.65	-15.10
	Kiramat	-1.29	-5.33	5.56	-11.61	7.49	-8.03	32.73	-8.12
45-4-3-3	Jalal	14.29	-5.00	5.56	-11.61	74.50	51.34	118.41	51.20
	Kiramat	-2.72	14.27	-0.01	-16.27	-7.69	-9.20	31.05	-9.28
45-4-3-4	Jalal	32.30	5.01	16.68	-2.29	23.17	-6.87	34.41	-6.96
	Kiramat	-9.86	-20.00	-11.11	-25.56	13.42	-1.05	42.81	-1.14
45-4-3-5	Jalal	-0.72	-14.99	-5.54	-20.90	24.13	-2.46	40.78	-2.55
	Kiramat	2.63	-2.50	8.33	-9.28	5.81	-4.54	37.77	-4.63
45-4-3-7	Jalal	24.54	5.00	16.67	-2.30	13.48	-6.87	34.41	-6.96
	Kiramat	4.07	-2.50	8.33	-9.28	-16.88	-22.12	12.40	-22.19
45-4-3-8	Jalal	-2.13	-13.75	-4.17	-19.75	28.89	1.28	46.17	1.19
	Kiramat	-24.35	-26.24	-18.04	-31.37	1.81	-8.15	32.56	-8.23
45-9-1	Jalal	0.00	-17.50	-8.33	-23.24	-7.75	-23.75	10.05	-23.82
	Kiramat	-0.67	-8.74	1.40	-15.08	-18.51	-23.17	10.89	-23.24
70-4	Jalal	-20.28	-28.75	-20.83	-33.71	0.80	-19.67	15.93	-19.75
	Kiramat	-18.99	-20.00	-11.11	-25.56	1.98	-6.87	34.41	-6.96
79-1-3	Jalal	25.99	0.00	11.11	-6.96	25.18	1.28	46.17	1.19
	Kiramat	15.50	2.50	13.89	-4.63	0.64	-6.87	34.41	-6.96
120-2-1	Jalal	-4.34	-17.50	-8.33	-23.24	16.74	1.86	47.01	1.77
	Kiramat	-5.88	-10.00	0.00	-16.26	-16.42	-17.35	19.29	-17.42
120-2-2	Jalal	14.27	-10.01	-0.01	-16.27	6.94	-9.19	31.07	-9.27
	Kiramat	-4.95	-16.24	-6.93	-22.06	-3.55	-6.87	34.41	-6.96
120-2-3	Jalal	27.27	5.33	16.67	-2.30	30.53	4.77	51.21	4.68
	Kiramat	3.40	-5.00	5.56	-11.61	-11.33	-18.51	17.61	-18.59
120-2-4	Jalal	24.03	0.00	11.11	-6.96	13.66	-8.03	32.73	-8.12
	Kiramat	5.54	-5.01	5.54	-11.62	-3.14	-10.36	29.37	-10.44
120-2-5	Jalal	32.03	8.75	20.83	1.19	21.59	-11.54	27.67	-11.62
	Kiramat	3.55	-5.00	5.56	-11.61	-0.68	-16.18	20.97	-16.26

ARPN Journal of Agricultural and Biological Science

Hundred kernel weight (g)

Minimum mid parent heterosis was detected for TC- 45-4-3-3, where Jalal was the tester, while maximum mid parent heterosis was detected for TC- 45-4-1, where Kiramat was the tester. Minimum and maximum better parent heterosis was observed for TC- 45-4-3-3 and TC-45-4-3-3, where Kiramat and Jalal were testers, respectively. About 31 out of 40 testcrosses showed positive mid parent heterosis, while 33 out of 40 testcrosses exhibited negative better parent heterosis. These results are in accordance with findings of Misevic (1989) for grain weight in exotic maize population. About 34 out of 40 testcrosses exhibited positive standard heterosis over the check Babar, while 13 out of 40 testcrosses exhibited positive standard heterosis over the check 30K08 (Table-2). Mukherjee and Saha (1984) observed positive standard heterosis for 100-grain weight in intervarietal crosses of maize.

Grain yield (kg ha^{-1})

Percent heterotic effect among 40 testcrosses ranged from -20.51 to 25.92 and -24.54 to 26.1 over mid parent and better parent, respectively. Minimum and maximum mid parent heterosis was observed for TC- 8-2 and TC- 45-4-3-8, where Jalal was the tester for both testcrosses. Lowest and highest better parent heterosis was observed for TC- 45-4-3-5 and TC- 45-4-3-8, where Jalal was the tester for both testcrosses. Almost 25 out of 40 testcrosses exhibited positive mid parent heterosis, while 25 out 40 testcrosses exhibited positive better parent heterosis. Our results get support from the finding of Rosa *et al*. (2002) who reported significant positive heterosis over the mid-parental value for grain yield in the maize hybrids PP-9539 × AN-453 (11.35%) and PP-9603 × PP-9539 (11.13%). Percent heterosis over two commercial checks viz., Babar and 30K08 ranged from -33.50 to 11.16 and -20 to 32.73, respectively. About eight in all testcrosses exhibited positive standard heterosis over the check Babar, while 29 in all testcrosses exhibited positive standard heterosis over the check 30K08 (Table-2). Similar results were also presented by Verma and Singh (1980) and Larish and Brewbaker (1999) in tropical maize populations for grain yield.

VOL. 9, NO. 6, JUNE 2014 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

Table-2. Heterosis over mid-parent (MPH), better parent (BPH) and standard heterosis (SH) for 100 grain weight and grain yield of 20 testcrosses with two testers.

Line × Tester		100 kernel weight				Grain yield			
		MPH (%)	BPH (%)	SH (%)		MPH (%)	BPH (%)	SH (%)	
				Babar	30k08			Babar	30k08
5-1-10	Jalal	4.16	-4.05	18.33	2.90	24.39	14.69	1.07	20.69
	Kiramat	-1.57	-15.541	4.17	-9.42	13.69	8.61	-4.29	14.28
8-2	Jalal	9.28	-2.70	20.00	4.35	-20.51	-20.28	-29.75	-16.11
	Kiramat	11.06	-8.122	13.32	-1.46	17.96	22.23	7.71	28.62
9-2	Jalal	18.89	-1.35	21.67	5.80	-3.72	-7.07	-18.10	-2.21
	Kiramat	1.00	-22.568	-4.50	-16.96	8.47	8.30	-4.57	13.96
45-4-1	Jalal	11.78	0.70	24.20	8.00	-2.04	-1.63	-13.31	3.51
	Kiramat	26.61	6.081	30.83	13.77	9.20	13.28	-0.17	19.20
45-4-2	Jalal	15.74	2.70	26.67	10.14	11.27	6.73	-5.95	12.31
	Kiramat	0.00	-17.568	1.67	-11.59	19.31	18.41	4.34	24.60
45-4-3	Jalal	9.77	-10.01	10.98	-3.49	-14.52	-16.17	-26.13	-11.79
	Kiramat	7.14	-18.919	0.00	-13.04	11.38	12.93	-0.48	18.83
45-4-3-1	Jalal	10.18	0.00	23.33	7.25	5.67	0.50	-11.43	5.76
	Kiramat	-11.20	-25.000	-7.50	-19.57	9.76	8.04	-4.79	13.69
45-4-3-3	Jalal	20.60	9.46	35.00	17.39	16.42	16.98	3.09	23.10
	Kiramat	-13.60	-27.027	-10.00	-21.74	20.42	25.00	10.16	31.54
45-4-3-4	Jalal	17.02	-4.07	18.32	2.88	-2.49	-7.78	-18.73	-2.95
	Kiramat	3.57	-21.622	-3.33	-15.94	6.61	4.38	-8.02	9.83
45-4-3-5	Jalal	-3.70	-13.24	7.00	-6.96	-19.87	-24.54	-33.50	-20.60
	Kiramat	17.92	-1.203	21.85	5.96	-0.93	-3.41	-14.88	1.64
45-4-3-7	Jalal	-2.00	-9.46	11.67	-2.90	3.57	1.15	-10.87	6.43
	Kiramat	-6.45	-19.473	-0.68	-13.64	8.27	9.33	-3.66	15.04
45-4-3-8	Jalal	0.07	-10.14	10.83	-3.62	25.92	26.14	11.16	32.73
	Kiramat	8.76	-9.189	12.00	-2.61	-4.99	-1.67	-13.35	3.47
45-9-1	Jalal	-10.48	-18.24	0.83	-12.32	-1.85	-6.57	-17.66	-1.68
	Kiramat	3.31	-12.162	8.33	-5.80	8.22	6.61	-6.05	12.19
70-4	Jalal	8.65	-9.46	11.67	-2.90	7.21	0.52	-11.42	5.78
	Kiramat	12.28	-13.514	6.67	-7.25	10.37	7.15	-5.58	12.75
79-1-3	Jalal	-0.86	-10.01	10.98	-3.49	13.60	10.97	-2.21	16.77
	Kiramat	8.42	-8.432	12.93	-1.80	-16.32	-15.49	-25.52	-11.07
120-2-1	Jalal	14.78	7.28	32.32	15.06	15.38	14.71	1.09	20.71
	Kiramat	-7.13	-19.054	-0.17	-13.19	-3.65	-1.01	-12.77	4.16
120-2-2	Jalal	3.66	-8.11	13.33	-1.45	5.71	4.41	-7.99	9.87
	Kiramat	3.24	-14.986	4.85	-8.83	-11.04	-9.18	-19.96	-4.43
120-2-3	Jalal	23.71	8.11	33.33	15.94	20.11	14.91	1.26	20.92
	Kiramat	2.57	-16.838	2.57	-10.81	-6.87	-7.81	-18.76	-2.99
120-2-4	Jalal	7.88	-1.35	21.67	5.80	7.58	3.78	-8.54	9.21
	Kiramat	9.52	-6.757	15.00	0.00	-8.74	-8.93	-19.74	-4.17
120-2-5	Jalal	13.77	-1.35	21.67	5.80	2.56	2.22	-9.92	7.56
	Kiramat	10.92	-10.81	10.00	-4.35	-19.94	-17.94	-27.34	-13.23

REFERENCES

Carangal V.R., S.M. Ali, A.F. Koble, E.H. Rinke and J.C. Sentz. 1971. Comparison of S_1 with testcross evaluation for recurrent selection in maize. Crop Sci. 11: 658-661.

Debanth S.C. 1987. Heterosis in maize. Bangladesh J. Agric. Res. 12(3): 161-168.

Geetha K. and N. Jayaraman. 2000. Genetic analysis of yield in maize (*Zea mays* L.). Madras Agric. J. 87: 638-640.

Hayes H.K., F.R. Immer and D.C. Smith. 1955. Methods of Plant Breeding. Mc. Grow Hill Book. Co., Inc., New York, USA.

Ihsan H., I.H. Khalil, H. Rahman and M. Iqbal. 2005. Genotypic variability for morphological and reproductive traits among exotic maize hybrids. Sarhad J. Agric. 21: 599-602.

Khan, K., F. Karim, M. Iqbal, H. Sher and B. Ahmad. 2004. Response of maize varieties to environments in two agro-ecological zones of NWFP: Effects on morphological traits. Sarhad J. Agri. 20(3): 395-399.

Larish L.L.B. and J.L. Brewbaker. 1999. Diallel analyses of temperature and tropical popcorns. Maydica. 44(4): 279-284.

Misevic D. 1989. Hetrotic patterns among US Corn Belt Yugoslavian and exotic maize populations. Maydica. 34(4): 353- 363.

Mukherjee B.K. and B.C. Shah. 1984. An analysis of heterosis and manifest for yield characteristics in intervarietal crosses of maize (*Zea mays* L.). Egyptian J. Genet. and Cytology. 13: 41-52.

Poehlman J.M. 1977. Breeding Field Crops. 2nd Ed. The AVI Publishing Company, INC. Westport, Connecticut.

Verma R. K. and T.P. Singh. 1980, heterosis and combining ability studies for certain quantitative traits in popcorn. Mysore J. Agric. Sci. 14: 15-17.