J. Soils and Crops 30 (1) 118-123, June 2020

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)
NAAS Rating - 4.46
Scientific Journal Impact Factor - 7.375

USEFUL HETEROSIS FOR YIELD AND ITS COMPONENT TRAITS IN MAIZE (*Zea mays* L.)

P. B. Chavan[1], M. K. Moon[2], S. R. Kamdi[3], P. V. Shende[4] and S. H. Palkar[5]

ABSTRACT

This study was undertaken to estimate the standard heterotic effect of 30 maize hybrids obtained by diallel mating design with six parents during *rabi* 2017 at Shankar Nagar Research farm of Botany Section, College of Agriculture, Nagpur. Crossed seeds of these 30 hybrids along with 6 parents and two checks Maharaja and Rajashri were raised in randomized block design with two replications in *kharif* 2018 for evaluation. The pooled analysis of variance (diallel) revealed significant differences among genotypes for all the characters studied. The crosses exhibited significant differences, indicating varying performance of cross combination. The data were collected on randomly five plants grown on days to 50% tasseling, days to 50% silking, days to maturity, plant height (cm), cob girth (cm), cob length (cm), number of grains cob^{-1}, 100 grain weight (g), grain yield plant^{-1} (g), and grain yield plot^{-1} (kg). The data analysis were carried out through statistical analyses revealed that the four crosses *viz.,* UMI1200 X CM152, CM152 X UMI1200, UMI1200 X CM124 and CM152 X CM145 were identified as potential hybrid for grain yield plant^{-1} and other yield contributing characters over commercial hybrid check Maharaja.

(Key words: Diallel, heterosis, maize)

INTRODUCTION

Maize (*Zea mays* L.) is world's important cereal crop after rice and wheat. Maize grain is recognized worldwide as a strategic food and feed crop. It is a diploid (2n=20) crop and one of the oldest food grains in the world. Maize is one of the most important cereal crops with a high rate of photosynthetic activity leading to high grain and biomass yield potential called C_4 grain crop. Maize seed oil is also low in Linolemic acid (0.7%) and contained a high level of flavour (Rahangdale *et al.*, 2019) Maize is not only used as food, feed and foddar but also used for some industrial purposes for manufacturing viz., starch, alcohol, acetic acid, glucose, papeer, furfural, rayan, dyes, synthetic rubber and resin etc. (Pandit, *et al.,* 2019). It is grown up to 58°N to 40°S latitude and 3808 m (above mean sea level) in the areas receiving annual rainfall of 25.4-1016 cm (Hallauer and Miranda, 1998). The optimal temperatures for growth of tropical maize is between 25 °C to 33 °C, while night temperatures range between 17 °C to 23 °C (Ellis *et al.*, 1992). Exploitation of hybrid vigor and selection of parents based on combining ability has been used as an important breeding approach in crop improvement. Developing of high yielding F1s along with other favourable traits are receiving considerable attention. For developing desirable hybrids, information about combining ability of the parents and the resulting crosses is essential. The magnitude of heterosis provides information on extent of genetic diversity of parents in developing superior F1s so as to exploit hybrid vigour and has direct bearing on the breeding methodology to be adapted for varietal improvement. Hence, the present investigation was carried out to know the direction and magnitude of heterosis in maize for evolving productive hybrid(s).

MATERIALS AND METHODS

Six lines viz.,UMI1200, CM145, CM152, CM116, CM123 and CM124 crossed in diallel fashion to obtain 30 crosses during 2017. Crossed seeds of these 30 hybrids along with 6 parents and two checks Maharaja and Rajashri were raised in randomized block design with two replications in *kharif* 2018 for evaluation with a spacing 60 cm x 20 cm at Research farm of Agril.Botany Section, College of Agriculture, Nagpur. Data on days to 50% tasseling , days to 50% silking and days to maturity were recorded on whole plot basis. Five randomly selected plants were used for recording observations on plant height (cm), cob girth (cm), cob length (cm), number of grains cob^{-1}, 100 grain weight (g), grain yield plant^{-1} (g), and grain yield plot^{-1} (kg). The data were subjected to the statistical analyses suggested by Panse and Sukhatme (1954). Useful Heterosis were calculated over standard check Maharaja (CV).

1 and 5. P.G. Students, Botany section, college of Agriculture, Nagpur
2 and 4. Assoc. Professors, Botany section, college of Agriculture, Nagpur
3. Asstt. Professor, Botany section, college of Agriculture, Nagpur

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences for all the 10 quantitative traits studied which was presented in table 1. This indicates considerable variability existed among genotypes for all the characters studied.

The variation due to genotypes was further portioned into variation due to parents, crosses and parent vs crosses. The means square due to parents exhibited significant difference for all the characters. Crosses exhibited significant difference for all characters except for days to maturity and cob girth. The means square due to parent vs crosses exhibited significant difference for all the characters. This result also revealed the suitability of data for estimation of heterosis. Mir *et al.* (2015) and Karad *et al*. (2017) also reported presence of variability among the genotypes from the significant means square due to genotypes, crosses, parent vs crosses.

On the basis of mean performance and useful heterosis (Table 2) studied for grain yield plant^{-1} and yield contributing characters among 30 crosses, the crosses UMI1200 X CM152 (84.62 g)and CM152 X CM124 (79.80 g) were identified as superior crosses as it performed significantly superior over check Maharaja for grain yield plant^{-1} . Negative heterosis is desirable for days to 50% tasseling, days to 50% silking and days to maturity for determining the earliness of hybrids. Puttawar *et al*. (2018) also showed significant and negative heterosis for days to 50% flowering.

The cross CM116 X UMI1200 (-12.61 %) recorded highly significant useful heterosis in desirable direction over check Maharaja for days to 50% tasseling and 20 crosses recorded significant useful heterosis over check Maharaja Similar results reported by Amiruzzaman *et al.* (2013), Hoque *et al.* (2016) and Karad *et al.* (2018), whereas 23 crosses showed negative significant useful heterosis over the check Maharaja for days to 50 % silking with highest negative significant value expressed by cross CM116 X UMI1200 (-13.55 %). Mir *et al.* (2015) and Hoque *et al.* (2016) were also recorded useful heterosis for days to 50% silking. None of the crosses showed negative significant useful heterosis over the check Maharaja for days to maturity and similar condition was observed for plant height and cob girth. This result support the finding of Saidaiah *et al.* (2008) and Shamrka *et al.* (2015). Twenty-eight crosses exhibited significant useful heterosis over the check Maharaja for cob length and the cross UMI1200 X CM152 (78.30 %) exhibited highest positive significant useful heterosis over the check Maharaja followed by CM145 X CM116 (78.20 %). Chattopadhyay and Dhiman (2006) reported similar result. None of the cross showed positive significant useful heterosis over the checks Maharaja for number of grains cob^{-1}. The cross UMI1200 X CM152 (41.95 %) exhibited highest positive significant useful heterosis over standard check maharaja for 100 gain weight. Highest positive significant useful heterosis for grain yield plant^{-1} was recorded by the cross CM116 X CM124 (50.89 %) followed by Cross CM145 X UMI1200 (25.53 %) and CM124 X UMI1200 (31.58 %). Karad *et al.* recorded similar result for grain yield plant^{-1}.

On the basis of high mean performance, significant useful heterosis in desirable direction for yield and yield contributing traits, the potential crosses were identified for their exploitation (Table 3). The cross UMI1200 X CM152 exhibited high mean performance, significant positive heterosis over the check Maharaja for grain yield plant^{-1} (g) and also showed high mean performance and significant positive heterosis over the check Maharaja for cob length (cm) and 100 grain weight (g) and other three CM152 X UMI1200, UMI1200 X CM124 and CM152 X CM145 crosses also identified as potential crosses for grain yield plant^{-1} and yield contributing characters.

Table 3. Promising crosses for heterosis and their performance for economically important characters

Sr. No.	Crosses	Yield plant^{-1} (g)		Significant standard heterosis over both check
		Mean	Useful heterosis Maharaja	
1	UMI1200 X CM152	84.62	44.07	1,2,5,8 and 9
2	CM152 X UMI1200	82.50	9.84	1,2,5, and 8
3	UMI1200 X CM124	73.36	24.90	5,8 and 9
4	CM152 X CM145	68.40	50.89	1,2,5,8 and 9

Characters: 1) Days to 50% tasseling, 2) days to 50% silking, 3) days to maturity, 4) plant height, 5) cob length 6) cob girth, 7) number of grains cob^{-1}, 8) 100 grain weight, 9) grain yield plant^{-1} and 10) grain yield plot^{-1}.

Table 1. Analysis of variance for heterosis

Source of Variation	Mean squares										
	Degrees of freedom	Days to 50% tasseling	Days to 50% Silking	Days to maturity	Plant height (cm)	Cob length (cm)	Cob Girth (cm)	Number of grains cob^{-1}	100 grains weight (g)	Grain yield $plant^{-1}$ (g)	Grain yield $plot^{-1}$ (g)
Replication	1	0.88	5.01	00	13.13	4.52	0.06	6.94	1.00	0.013	18.10
Genotypes	35	17.57**	18.40**	38.55**	523.73**	5.92**	1.72**	11873.20**	20.96**	0.598**	786.99**
Parents	5	32.53**	41.13**	84**	357.13**	4.12**	2.98**	20660.04**	26.32**	1.565**	1131.27**
Crosses	29	9.51**	8.18**	27.33	361.29**	4.78**	1.05	6046.45**	10.06**	0.243**	416.56**
Parent Vs Crosses	1	176.4**	201**	136.9**	6067.60**	48.07**	14.66**	136914.70**	310.23**	6.032**	9807.96**
Error	**35**	**2.57**	**1.87**	**16**	**8.51**	**1.12**	**0.64**	**16.42**	**0.38**	**0.038**	**8.15**

Table 2. Performance of crosses for mean and standard heterosis (SH)

Sr.	Crosses	Days to 50% tasseling		Days to 50% silking		Days to maturity		Plant height (cm)		Cob length (cm)	
No.	Direct crosses	Mean	SH	Mean	SH	Mean	SH	Mean	SH	Mean	SH
1	UMI1200 X CM145	50.50	-9.00**	54.00	-8.47**	92.50	1.09	155.60	-9.16	15.66	55.00**
2	UMI1200 X CM152	51.50	-7.20*	54.50	-7.62**	92.00	0.54	172.60	0.75	18.01	78.30**
3	UMI1200 X CM116	56.00	0.90	58.00	-1.69	95.00	3.82	173.25	1.13	14.85	47.00**
4	UMI1200 X CM123	54.50	-1.80	56.50	-4.23	94.00	2.73	152.92	-10.74	12.70	25.70*
5	UMI1200 X CM124	53.00	-4.50*	56.00	-5.08*	89.00	-2.73	169.60	-0.99	16.86	66.90**
6	CM145 X CM152	53.00	-7.20*	55.00	-8.47**	93.00	6.01	164.60	9.38	15.82	47.00**
7	CM145 X CM116	51.00	0	55.00	-2.54	87.00	7.10	165.70	-10.39	12.69	78.20**
8	CM145 X CM123	51.00	2.70	53.50	1.69	90.50	2.18	180.30	-3.50	14.44	49.00**
9	CM145 X CM124	50.50	1.80	54.00	0	84.00	2.18	176.60	-19.38**	16.39	12.80
10	CM152 X CM116	53.00	-3.60	55.50	-5.93*	91.00	9.28*	169.90	2.68	16.46	61.30**
11	CM152 X CM123	50.00	-4.50*	53.50	-6.77**	94.00	1.63	163.40	-3.91	15.07	56.60**
12	CM152 X CM124	50.50	-8.10**	54.00	-6.77**	93.00	-4.91	150.30	-3.26	14.05	25.60*
13	CM116 X CM123	52.50	-8.10**	55.50	-9.32**	91.00	-1.09	172.40	5.25	13.86	43.00**
14	CM116 X CM124	53.50	-9.00**	56.00	-8.47**	96.50	-8.19	149.20	3.09	15.10	62.30**
15	CM123 XCM124	54.00	-8.10**	56.00	-10.16**	90.50	4.37	165.20	8.52	14.83	55.50**
	Reciprocal crosses										
16	CM145 X UMI1200	51.50	-9.90**	54.00	-11.86**	97.00	1.09	187.38	8.46	14.86	39.20**
17	CM152 X UMI1200	55.50	-9.90**	57.50	-10.16**	98.00	3.27	153.50	-0.23	18.00	49.20**
18	CM116 X UMI1200	57.00	-12.61**	60.00	-13.55**	93.50	-1.63	165.30	3.38	15.05	53.80**
19	CM123 X UMI1200	56.50	-4.50*	59.00	-5.93	93.50	-0.54	138.10	-0.81	11.41	63.00**
20	CM124 X UMI1200	53.50	-9.90**	55.50	-9.32**	100.0	2.73	175.90	-4.61	16.29	49.20**
21	CM152 X CM145	51.00	-9.00**	53.00	-8.47**	95.50	1.63	185.90	-12.29*	15.71	39.11**
22	CM116 X CM145	50.00	-4.50*	52.00	-5.08*	92.50	4.37	185.80	10.24	14.06	61.81**
23	CM123 X CM145	50.00	-10.81**	53.00	-11.01**	94.50	1.63	170.90	-1.69	15.07	56.40**
24	CM124 X CM145	48.50	-6.30*	51.00	-5.93*	90.00	1.09	177.10	-14.18*	15.53	39.93**
25	CM116 X CM 152	53.00	-5.40*	56.00	-5.93*	95.50	-0.54	188.85	0.64	16.34	37.20**
26	CM123 X CM152	49.50	-3.60	52.50	-5.08*	93.00	5.46	168.40	-12.90*	15.80	49.50**
27	CM124 X CM152	52.00	-2.70	55.50	-5.08*	92.50	13.11**	147.00	-8.17	13.86	20.16
28	CM123 X CM116	54.00	-1.80	56.00	-2.54	103.50	2.73	157.30	-13.60*	12.13	49.90**
29	CM124 X CM116	54.50	-2.70	57.50	-5.08*	94.00	-1.09	148.00	-3.56	15.14	46.80**
30	CM124 X CM123	53.00	-4.50*	56.00	-5.08*	93.00	1.63	151.00	-11.85	16.35	61.96
	S.E.(d)	1.13	**1.60**	**0.98**	**1.37**	**2.76**	**4.00**	**2.07**	**10.69**	**1.17**	**1.06**

Table cont…

Sr. No.	Crosses	Cob girth (cm)		No. of grains cob^{-1}		100 grain weight (g)		Grain yield $plant^{-1}$ (g)		Grain yield $plot^{-1}$ (kg)	
	Direct crosses	Mean	SH	Mean	SH	Mean	SH	Mean	SH	Mean	SH
1	UMI1200 X CM145	11.52	-15.11	215.40	-1.41	20.30	13.09**	45.15	-23.12	1.83	-3.68
2	UMI1200 X CM152	12.85	-5.31	364.90	-25.69**	25.48	41.95**	84.62	44.07**	2.18	14.47
3	UMI1200 X CM116	12.35	-8.99	275.00	-44.56**	19.78	10.17**	47.98	-18.31	1.28	-32.89
4	UMI1200 X CM123	11.10	-18.20*	205.17	-9.94	18.70	4.18	40.42	-31.19	1.21	-36.58
5	UMI1200 X CM124	12.95	-4.57	333.30	5.51	24.24	35.04**	73.36	24.90**	2.19	15.26
6	CM145 X CM152	11.77	-7.15	275.20	7.32	20.36	13.09**	62.57	49.81**	1.69	13.16
7	CM145 X CM116	13.09	-2.51	279.90	-16.55**	20.75	35.15**	58.71	40.47**	1.97	18.42
8	CM145 X CM123	12.76	-12.55	335.60	-48.12**	21.37	-6.78	65.71	-25.09	1.84	3.68
9	CM145 X CM124	13.74	-18.27*	350.10	-30.66**	24.58	-5.96	88.62	-50.04	2.15	-51.58
10	CM152 X CM116	12.63	-11.35	293.10	-25.64**	23.05	38.11**	64.58	12.87*	1.86	1.58
11	CM152 X CM123	12.52	-13.26	387.50	-24.37**	19.30	13.43**	71.20	6.54	2.50	-11.05
12	CM152 X CM124	12.83	-3.54	407.20	-9.32	21.33	15.60**	79.80	-0.03	2.28	3.68
13	CM116 X CM123	12.76	-5.97	328.20	-5.40	21.55	19.05**	69.10	11.88**	2.13	-3.16
14	CM116 X CM124	13.13	1.25	303.60	-12.05*	23.65	36.94**	71.85	50.89**	2.22	13.16
15	CM123 XCM124	12.71	-5.38	302.30	2.67	19.08	27.63**	62.32	16.47**	1.91	3.16
	Reciprocal crosses										
16	CM145 X UMI1200	12.60	3.76	390.50	-6.27	20.30	22.01**	87.99	40.39**	2.15	25.53**
17	CM152 X UMI1200	13.23	-11.64	397.20	-2.73	24.26	12.09**	82.50	9.84	2.25	10.53
18	CM116 X UMI1200	11.87	1.03	308.83	-20.80**	16.73	23.68**	44.00	28.54**	1.97	13.68
19	CM123 X UMI1200	11.09	-6.93	192.00	4.70	16.88	28.41**	29.34	9.96*	0.92	-2.11
20	CM124 X UMI1200	12.03	-7.74	256.60	10.02	24.79	7.52*	66.29	21.23**	1.93	31.58**
21	CM152 X CM145	12.84	-5.45	325.50	-15.19**	22.91	18.83**	68.40	35.88**	1.96	20.00
22	CM116 X CM145	14.08	-5.04	380.00	-0.05	21.90	26.50**	82.45	31.45**	2.39	15.79
23	CM123 X CM145	11.99	-2.58	346.90	-13.42*	20.12	20.33**	64.51	25.98**	2.10	1.58
24	CM124 X CM145	13.71	-11.27	360.00	-11.32*	22.20	5.85	75.49	-6.35	2.16	-17.37
25	CM116 X CM 152	12.89	-5.97	313.87	-17.96**	22.71	20.06**	77.20	17.66**	2.20	12.11
26	CM123 X CM152	13.22	-3.24	369.90	-18.31**	21.60	31.75**	73.99	22.34**	1.93	16.58
27	CM124 X CM152	12.04	-8.18	320.40	-6.00	19.00	7.19**	55.00	-4.65	1.57	-13.42
28	CM123 X CM116	12.46	-0.29	302.30	-12.40*	19.24	22.40	56.00	17.66**	1.65	-0.53
29	CM124 X CM116	13.53	-6.34	347.90	-18.18**	21.97	6.30	69.10	6.11	1.89	0.26
30	CM124 X CM123	12.52	-7.74	302.80	-1.41	22.12	23.23**	65.96	12.31**	1.98	3.95
	SE(d)	**0.56**	**0.81**	**2.83**	**19.70**	0.43	**0.61**	**2.01**	**2.85**	**0.13**	**0.19**

REFERENCES

Amiruzzaman, M., M. A. Islam, L. Hassan and M. M. Rohman, 2012. Combining ability and heterosis for yield and component characters in maize. Emir. J. Food agric. **23**(2): 132-137.

Chattopadhyaya, K. and K. R. Dhiman, 2006. Heterosis for ear parameters, crop duration and prolificacy in varietal crosses of maize (*Zea mays* L.). Indian J. Genet. **66**(1): 45-46.

Ellis, R. H., R. J. Summerfield, G. O. Edmeardes and E. H. Robert, 1992. Photoperiod, temperature and the interval from sowing to tassel initiation in diverse cultivars of maize. Crop Sci. **32**: 1225-1232.

Hallauer, A. R. and J. B. Miranda, 1988. Quantitative genetics in maize breeding. 2nd edition. Iowa State University Press, Ames, 267-294.

Hoque, M., F. Akhter, M. Kadir, H. A. Begum and S. Ahmed, 2016. Study on combining ability and heterosis for earliness and short statured plant in maize. Bangladesh J. agric. Res, **41**(2): 365-376.

Karad, G. W., M. K. Moon, S. R. Patil, Arati D. Rathod, S. R. Kamdi and Priyanka N. Taksande, 2018. Evaluation of newly developed inbred lines for heterosis for yield and its components in maize J. Soils and Crops, **28** (2):428-433.

Mir, S., D. Ahmad, G. A. Parray, G. Zaffar and S. H. Dar, 2015. Heterosis studies in single crosses of inbred lines in maize (*Zea mays* L.). Elec. J. Pl. Breed. **6**(4): 1073-1077.

Pandit, M.B., S.U. Charjan, S.R. Kamdi, S.R. Patil, P.Z. Rahangdale, M.K. Moon and D.Y. Upadhyay, 2019. Performance of double crops hybrid in maize (Zea mays L.) J. Soils and Crops **29**(1) : 146-151.

Panse, V. G. and P. V. Sukhaatme, 1954. Statistical methods for agricultural workers. ICAR, New Delhi, pp. 54-57.

Puttalwar, Megha, H.V. Kalpande, A.E. Patil and M.S. Neware, 2018. Study of heterosis for yield and yield contributing traits on CGMs based pigeonpea (*Cajanus cajan* L.) Mill spp. through hybrid. J. Soils and Crops 28(2) : 287-297.

Rahangdale, P.Z., S.R. Kamdi, S.R. Patil, R.D. Deotale, M.B. Pandit, D.Y. Upadhyay and G.A. Kankal, 2019. Generation mean analysis in maize (Zee mays L.) J. Soils and Crops, **29**(1) : 126-130.

Saidaiah, P., E. Satyanarayan and S. S. Kumar, 2008. Heterosis for yield and yield component characters in maize (*Zea mays* L.). agric. Sci. Digest, **28**(3): 201-203.

Shamarka, A., M. A. S. Ahmed and M. M. Nahas, 2015. Heterosis and combining ability for yield and its components through diallel cross analysis in maize (*Zea mays* L.). Alex. J. agric. Res. **60**(2): 87-97.

Rec. on 12.08.2019 & Acc. on 25.08.2019