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STUDY ON COMBINING ABILITY AND HETEROSIS FOR EARLINESS AND SHORT STATURED PLANT IN MAIZE

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Abstract

An experiment was carried out in 6x6 diallel crosses for combining ability analysis for grain yield, maturity and growth parameters in maize. Analysis of variance for combining ability showed that mean square value due to GCA & SCA were highly significant for all characters except SCA in days to tasseling and days to maturity indicated that all but two traits were governed by both additive and non-additive gene action. Variances due to GCA were much higher in magnitude than SCA indicated additive gene effects were much more important for all characters except cob length, thousand grain weight and ear height. The Parent P_5 was the best general combiner for yield and most of the yield contributing characters. The Parent P_1 & P_2 were best general combiner for both dwarf and earliness. The crosses showing significant SCA effects for yield involving average x average, average x low and low x low general combining parents. The crosses P_3xP_6 & P_4xP_5 showed either significantly or numerically higher heterosis than checks BHM-5, BHM-7 & BHM-9 for yield.

Keywords: Maize, GCA, SCA and heterosis.

Introduction

Maize is one of the important cereal crops in our country. The maize area and production is increasing gradually and the crop is being popular among the farmers. It is well established that hybrid maize has more yield potential than composite or synthetic varieties. Due to yield advantages and other agronomic characters growers are very much interested to cultivate hybrid maize. But maximum seeds of the hybrid maize varieties are imported from foreign countries. The imported hybrid maize is very costly and farmers are not getting seed timely. For this reason, Plant breeding division of BARI is trying to fulfill this constrain. The nature and magnitude of gene action is an important factor in developing an effective breeding program. 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 program. Therefore, the present

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investigation with 6x6 diallel cross was undertaken for isolating superior inbred lines and better combining parents for suitable hybrids.

Materials and Method

The experiment was conducted at RARS, Jamalpur during *rabi* 2012-13. Six inbred lines of maize were mated in a diallel fashion excluding the reciprocals. The resulting 15 F_1s were grown in alpha lattice design with three replications. Each plot consisted of two rows of 5m long. The spacing between row to row was 60cm and plant to plant was 20cm. One plant per hill was maintained. Fertilizers were applied @ 250, 120,120 40, 5 and 1 kg/ha of N, P_2O_5, K_2O, S, Zn and Boron, respectively.

Irrigation and other intercultural operations were done as and when necessary. Ten randomly selected plants from each plot were used for recording data of plant and ear height. Other data were collected by considering all the plants in a plot. Grain yield kg/plot was converted into grain yield t/ha. General combining ability (GCA) and specific combining ability (SCA) were estimated by following Griffing's method II, model IV. Percent heterosis was calculated by the formula as heterosis (%) =[(F_1-CV)/CV] X100. Where, F_1 and CV represented the mean performance of hybrid and standard check variety. The estimated heterosis was tested according to Singh and Singh (1994).

Results and Discussion

1. Analysis of variance

Analysis of variance for combining ability showed that mean square values due to GCA & SCA were highly significant for all characters except SCA in days to tasseling and days to maturity (Tables 1a and 1b). It indicated that all but above mentioned two traits were governed by both additive and non-additive gene action. Similar findings in maize were reported by Aguiar *et al.* (2004), Bhatnagar *et al.* (2004) and Abdel-Moneam *et al.* (2009). The additive gene action played a major role in controlling the character days to tasseling and days to maturity because of non-significant SCA of these characters. Kadir (2010) also observed non-significant SCA variance for some characters in maize.Variances due to GCA were much higher in magnitude than SCA indicated additive gene effect were much more important for all characters except cob length, thousand grain weight and ear height. This indicated predominance of additive gene action for all the characters except cob length, thousand grain weight and ear height seemed to be controlled by non additive gene action. Vacaro *et al.* (2002) and Uddin *et al.* (2006) also reported that mean sum of square for GCA effects was greater than that for SCA effects for some characters which indicating the predominance of additive effects.

Table 1a. Mean squares due to general and specific combining ability on yield and yield components of maize.

Sources	d.f	Yield (t/ha)	Cob length	Cob girth	No. of rows/ ear	No. of grains/ row	TGW (g)
Rep	2	0.28	0.01	0.17	0.07	5.43	21.51
Crosses	14	6.69**	7.08**	6.71**	14.67**	34.44**	3479.19**
GCA	5	7.79**	5.58**	13.19**	34.43**	60.04**	3355.07**
SCA	9	6.08**	7.92**	3.11**	3.70**	20.22**	3548.15**
Error	28	0.37	0.35	0.26	0.22	1.09	74.62
GCA/SCA	0.56	1.28	0.71	4.24	9.31	2.97	0.95

** indicate significant at 1% level; TGW = Thousand grain weight.

Table 1b. Mean squares due to general and specific combining ability on maturity and growth parameters of maize

Sources	d.f	Days to tasseling	Days to silking	Days to maturity	Plant height (cm)	Ear height (cm)
Rep	2	1.76	2.96	28.80	16.80	31.67
Crosses	14	9.09**	8.12**	18.61*	852.29**	233.14**
GCA	5	14.39**	12.29**	31.37*	713.30**	118.77**
SCA	9	6.14ns	5.80**	11.52ns	929.50**	296.69**
Error	28	3.21	0.91	7.97	21.59	22.17
GCA/SCA	0.56	2.34	2.12	2.72	2.16	0.40

*,** indicate significant at 5% and 1% level, respectively, ns= non-significant.

Table 2a. Mean performance of crosses for yield and yield components

Cross	Yield (t/ha)	Cob length	Cob girth	No. of rows/ ear	No. of grains/ row	TGW (g)
P_1XP_2	9.27	14.84	13.86	11.13	27.70	323.53
P_1XP_3	10.17	16.88	14.54	13.17	29.07	341.29
P_1XP_4	8.74	13.85	14.13	14.85	26.68	285.08
P_1XP_5	11.08	14.73	16.57	16.81	31.81	302.42
P_1XP_6	7.46	13.79	13.92	14.06	26.10	275.76
P_2XP_3	6.46	11.69	10.74	9.81	19.78	272.06
P_2XP_4	9.01	15.51	13.97	13.88	25.42	314.39
P_2XP_5	9.94	15.94	14.69	14.32	29.73	279.14
P_2XP_6	10.34	16.56	14.25	14.02	25.21	333.78
P_3XP_4	10.78	16.95	14.27	13.85	28.45	330.83
P_3XP_5	11.07	16.70	14.55	17.31	28.51	317.39
P_3XP_6	11.53	16.41	15.32	14.14	28.45	404.51
P_4XP_5	11.55	16.29	17.15	17.46	29.54	292.31
P_4XP_6	8.92	15.10	16.13	17.31	25.31	289.77
P_5XP_6	10.83	17.37	15.76	15.89	34.73	299.33
BHM5 (check1)	10.68	16.05	14.37	14.33	29.33	322.00
BHM7(check2)	11.38	16.23	15.20	16.57	30.29	316.00
BHM9(check3)	11.21	15.83	14.71	15.30	27.25	331.00
Mean	10.02	15.60	14.67	14.68	27.96	312.81

2. Mean performance of crosses for different characters

Eight crosses showed higher yield than overall mean (Table 2a). Two crosses namely P_3xP_6 & P_4xP_5 produced higher yield than overall mean and also higher yield than all check varieties. All tested crosses were few days earlier than all checks for days to tasseling, silking & maturity (Table 2b). Short stature plants were also observed for all crosses than all the three check varieties. So all the tested crosses were early & dwarf in stature compare to the checks.

Table 2b. Mean performance of crosses for the characters of maturity and growth parameters

Cross	Days to tasseling	Days to silking	Days to maturity	Plant height (cm)	Ear height (cm)
P_1XP_2	88.33	92.67	140.00	177.33	102.67
P_1XP_3	88.00	92.00	143.00	198.67	115.33
P_1XP_4	87.33	92.00	143.67	185.00	102.00
P_1XP_5	86.33	91.33	144.33	190.67	107.67
P_1XP_6	88.00	93.00	148.33	143.33	95.67
P_2XP_3	90.00	97.00	140.67	166.00	82.33
P_2XP_4	88.33	93.67	140.00	177.33	96.67
P_2XP_5	85.33	89.67	142.67	191.33	103.33
P_2XP_6	89.67	93.67	146.33	200.00	111.67
P_3XP_4	88.67	92.67	140.00	194.67	112.33
P_3XP_5	92.00	92.67	145.00	198.67	107.00
P_3XP_6	91.33	94.67	145.33	196.67	105.00
P_4XP_5	88.67	92.67	145.33	186.33	101.33
P_4XP_6	89.67	94.33	143.67	166.33	89.33
P_5XP_6	87.67	92.67	143.67	207.67	107.67
BHM5(check1)	96.33	99.67	147.33	214.00	125.00
BHM7(check2)	93.67	97.67	146.67	225.00	150.00
BHM9(check3)	96.33	100.00	149.67	241.33	144.67
Mean	89.76	94.00	144.09	192.24	108.70

3. General combining ability (GCA) effects

The GCA effects of the parents for different characters are presented in Tables 3a and 3b. A wide range of variability for GCA effects were observed among the parents for different traits. The GCA effects are important indicators of the values of inbreds in hybrid combinations. The parents P_5 showed highly significant positive GCA effect for grain yield. In addition to grain yield, P_5 had highly significant positive GCA for cob length, cob girth, number of grain rows/ear, number of grains/row. The Parent P_4 was good general combiner for cob girth and number of grain rows/ear. The Parent P_6 was found good general combiner for cob length, cob girth, no. of grain rows/ear and thousand grain weight. So, parent P_4, P_5 and P_6 could be used to develop high yielding maize hybrids. Alam *et al*. (2008) and Amiruzzaman (2010) also observed similar phenomenon in maize.

Table 3a. General combining ability effects for yield and yield components in 6x6 diallel cross

Parent	Yield (t/ha)	Cob length (cm)	Cob girth (cm)	No. of grain rows/ear	No.of grains/row	TGW (g)
P_1	-0.58*	-0.86**	-0.07	-0.66**	0.63	-6.44*
P_2	-1.01**	-0.75**	-1.44**	-2.38**	-2.75**	-7.74*
P_3	0.24	0.27	-0.97**	-1.10**	-1.14**	28.05**
P_4	-0.01	0.04	0.59**	1.17**	-0.86*	-10.37**
P_5	1.36**	0.87**	1.36**	2.28**	3.87**	-15.82**
P_6	0.01	0.42*	0.52*	0.69**	0.24	12.32**
SE(gi)	0.16	0.16	0.13	0.13	0.28	2.28
LSD $_{(0.05)}$	0.41	0.41	0.34	0.32	0.72	5.86
LSD $_{(0.01)}$	0.65	0.65	0.54	0.50	1.13	9.19

*,** indicate significant at 5% and 1% levels, respectively, TGW= Thousand grain weight.

Table 3b. General combining ability effects for maturity and growth parameters in 6x6 diallel cross.

Parent	Days to tasseling	Days to silking	Days to maturity	Plant height (cm)	Ear height (cm)
P_1	-1.28*	-0.97*	0.50	-7.92**	2.50
P_2	-0.36	0.44	-1.92*	-3.67*	-4.17*
P_3	1.72*	1.03**	-0.83	7.00**	2.17
P_4	-0.11	0.11	-1.17	-4.25*	-2.92
P_5	-0.78	-1.47**	0.92	12.00**	3.42*
P_6	0.81	0.86	2.5	-3.17*	-1.00
SE(gi)	0.47	0.25	0.50	1.22	1.24
LSD $_{(0.05)}$	1.21	0.64	1.29	3.14	3.19
LSD $_{(0.01)}$	1.90	1.00	2.01	4.92	4.50

*,** indicate significant at 5% and 1% levels, respectively.

For maturity and growth parameters significant negative GCA effect is desirable for dwarf and earliness in plant. The parent P_1 had significant negative GCA effect was seen for days to tasseling, days to silking and plant height.The parent P_2 had significant negative GCA effect for days to maturity, plant height and ear height. So, the parent P_1 & P_2 could be used to develop early maturing dwarf hybrid. Das and Islam (1994), Hussain *et al.* (2003) and Banik (2006) also found some inbred lines with short plant type in their studies.

4. Specific combining ability effects

The specific combing ability effects for different characters are presented in Table 4a and 4b. For yield and yield components, significant positive SCA effect is desirable. Four crosses (P_1x P_2, P_2x P_6, P_3 x P_4 and P_3 x P_6) exhibited significant positive SCA effect for grain yield involving average x average, average x low and low x low general combining parents . The cross P_3xP_6 involved average x average general combiner, exhibited the second highest significant positive SCA effects along with the second highest mean value for yield. Amiruzzaman *et al.* (2013) and Ahmed (2013) also reported significant SCA effects in some of the crosses involving the parents of average x average , average x low and low x low general combiners for grain yield in maize. The highest yielding hybrid (P_4 x P_5) could not show significant SCA value. These results showed that high general combining parent (P_5) could not show high SCA effects in hybrid combinations . Similar findings were also reported by lvy and Hawlader (2000) in maize. On the contrary, Paul and Duara (1991) reported that parents with high GCA always produce hybrids with high estimates of SCA. The cross P_1xP_6, P_2xP_3, and P_4xP_6 showed significant negative SCA effects along with their low/average GCA value for grain yield. Hoque *et al*. (2008) and Amiruzzaman *et al*. (2013) also observed similar results in some of crosses in their study in the same crop. These four crosses also showed significant SCA effects in some yield components. Significant positive SCA effects were observed in five crosses (P_1x P_2, P_1x P_3, P_1x P_5 , P_3 x P_6 and P_4x P_5) for cob girth, five crosses (P_1x P_5, P_2x P_4, P_2x P_6, P_3 x P_5 and P_4 x P_6) for number of grain rows/ear, six crosses (P_1x P_2, P_1x P_3, P_2 x P_4 ,P_3 x P_4 ,P_3 x P_6 and P_5 x P_6) for number of grains/row and six crosses (P_1x P_2, P_1x P_3, P_1x P_5 , P_2 x P_4,P_2x P_6, and P_3 x P_6) for thousand grain weight involving high, average and low general combining parents. Uddin *et al*. (2006) and Ahmed *et al*. (2008) also observed significant positive SCA effects for some crosses for the mentioned characters.

For maturity and growth parameters, significant negative SCA effect is desirable for dwarfness and earliness in plant. Significant negative SCA effect was observed in one cross (P_2x P_5)for days to tasseling, three crosses (P_1x P_3, P_2x P_5 and P_3 x P_4) in days to silking and two crosses (P_1x P_2 and P_5 x P_6) for days to maturity indicating earliness in flowering. These crosses involved high x average, high x low, average x average and average x low general combining parents which is in accordance with Uddin *et al*. (2006) and Ahmed (2013). Significant negative SCA effect was observed in five crosses (P_1x P_6, P_2x P_3, P_3x P_5 , P_4x P_5 and P_4 x P_6) for plant height indicating dwarfness of the hybrids involved high x high, high x low, average x average and low x low general combining parents. Significant and negative SCA effect was observed in 3 crosses (P_1x P_6, P_2x P_3 and P_4x P_6) for ear height indicating lower ear placement involved average x average and average x low general combining parents. Ahmed (2013) also observed significant and negative SCA effects involved high x high, high x average, high x low and low x low general combining parents in his study for plant and ear height.

Table- 4a. Specific combining ability (SCA) effects for different characters in 6x6 diallel cross for yield and yield contributing characters

Crosses	Yield (t/ha)	Cob length	Cob girth (cm)	No. of grain rows/ ear	No. of grains/ row	TGW (g)
P_1xP_2	1.05**	0.95	0.71*	-0.36	2.05**	26.95**
P_1xP_3	0.70	1.96	0.92**	0.40	1.81**	8.91*
P_1xP_4	-0.47	-0.84	-1.05**	-0.20	-0.86	-8.88*
P_1xP_5	0.49	-0.79	0.62*	0.66*	-0.46	13.91**
P_1xP_6	-1.77**	-1.28	-1.19**	-0.50*	-2.54**	-40.89**
P_2xP_3	-2.58**	-3.34	-1.50**	-1.25**	-4.10**	-59.03**
P_2xP_4	0.22	0.71	0.16	0.56*	1.26*	21.73**
P_2xP_5	-0.22	0.31	0.12	-0.12	0.84	-8.07
P_2xP_6	1.53**	1.38	0.51	1.17**	-0.05	18.42**
P_3xP_4	0.74*	1.13	-0.02	-0.76**	2.69**	2.37
P_3xP_5	-0.33	0.05	-0.50	1.59**	-1.99**	-5.62
P_3xP_6	1.47**	0.21	1.10**	0.01	1.58**	53.36**
P_4xP_5	0.40	-0.13	0.54*	-0.52*	-1.24*	7.72
P_4xP_6	-0.89**	-0.87	0.36	0.92**	-1.84**	-22.95**
P_5xP_6	-0.34	0.56	-0.78**	-1.61**	2.85**	-7.95
SE(ij)	0.27	0.26	0.23	0.21	0.47	3.86
$LSD_{(0.05)}$	0.71	0.60	0.52	0.48	1.06	8.73
$LSD_{(0.01)}$	0.82	0.86	0.75	0.69	1.53	12.54

*,** indicate significant at 5% and 1% level, respectively; TGW = Thousand grain weight.

Table 4b. Specific combining ability (SCA) effects for different characters in 6x6 diallel cross for maturity and growth parameters

Crosses	Days to tasseling	Days to silking	Days to maturity	Plant height (cm)	Ear height (cm)
P_1xP_2	1.35	0.22	-2.05*	3.58	1.67
P_1xP_3	-1.07	-1.03*	-0.13	14.25**	8.00**
P_1xP_4	0.10	-0.12	0.87	11.83**	-0.25
P_1xP_5	-0.23	0.80	-0.55	1.25	-0.92
P_1xP_6	-0.15	0.13	1.87	-30.92**	-8.50**
P_2xP_3	0.02	2.55**	-0.05	-22.67**	-18.33**
P_2xP_4	0.18	0.13	-0.38	-0.08	1.08
P_2xP_5	-2.15*	-2.28**	0.20	-2.33	1.42
P_2xP_6	0.60	-0.62	2.28*	21.50**	14.17**
P_3xP_4	-1.57	-1.45**	-1.47	6.58*	10.42**
P_3xP_5	2.43*	0.13	1.45	-5.67*	-1.25
P_3xP_6	0.18	-0.20	0.20	7.50**	1.17
P_4xP_5	0.93	1.05*	2.12*	-6.75*	-1.83
P_4xP_6	0.35	0.38	-1.13	-11.58**	-9.42**
P_5xP_6	-0.98	0.30	-3.22**	13.50**	2.58
SE(ij)	0.80	0.43	0.85	2.08	2.11
$LSD_{(0.05)}$	1.81	0.97	1.92	4.70	4.77
$LSD_{(0.01)}$	2.60	1.40	2.76	6.76	6.86

*,** indicate significant at 5% and 1% level, respectively.

5. Heterosis

The estimates of standard heterosis for different characters of 15 single cross maize hybrids is presented in the Tables 5a and 5b. The magnitude of heterosis varied widely among crosses for different characters from cross to cross for the same character.

For grain yield, only two crosses viz. P_3xP_6 and P_4xP_5 showed significant positive heterosis 7.93% and 8.18% respectively over check BHM 5.These two crosses also produced numerically higher yield than other two check variety BHM 7 & BHM 9. Rest of the characters were compared with the highest yielding check BHM 7 to calculate heterosis. The cross P_3XP_6 showed significant positive heterosis (28.01%) for thousand grain weight also. The cross P_4XP_5 showed significant positive heterosis (12.85%) for cob girth also. Significant positive heterosis was observed in one cross (P_5XP_6) for cob length, 3 crosses ($P_1XP_5,$

P_4XP_5, P_4XP_6) for cob girth, one cross (P_5XP_6) for number of grains/row and 2 crosses (P_1XP_3, P_3XP_6) for thousand grain weight (TGW). Amiruzzaman *et al*. (2013) found highest 9.71 % heterosis for grain yield than check variety in maize. Appreciable percentage of heterosis for grain yield in maize was also reported by Roy *et al*.(1998) and Uddin *et al*. (2006).

Table 5a. Percent heterosis over BHM-7 for yield and yield contributing characters

Crosses	Yield (t/ha) Over 3 check variety			Cob length (cm)	Cob girth (cm)	No. of grain rows/ ear	No. of grains/ row	TGW (g)
	BHM 5	BHM 7	BHM 9					
P_1xP_2	-13.17**	-18.51**	-17.28**	-8.54**	-8.84**	-32.83**	-8.54*	2.38
P_1xP_3	-4.81	-10.66**	-9.31*	3.98	-4.32	-20.50**	-4.04	8.00*
P_1xP_4	-18.16**	-23.20**	-22.03**	-14.66**	-7.02*	-10.40**	-11.93**	-9.78**
P_1xP_5	3.71	-2.67	-1.19	-9.22**	8.99**	1.47	5.01	-4.30
P_1xP_6	-30.15**	-34.45**	-33.45**	-15.05**	-8.42**	-15.13**	-13.83**	-12.73**
P_2xP_3	-39.54**	-43.26**	-42.40**	-27.95**	-29.32**	-40.80**	-34.69**	-13.91**
P_2xP_4	-15.67**	-20.86**	-19.66**	-4.44	-8.11**	-16.21**	-16.07**	-0.51
P_2xP_5	-6.96	-12.68**	-11.36**	-1.79	-3.36	-13.58**	-1.85	-11.66**
P_2xP_6	-3.18	-9.14*	-7.76*	2.05	-6.25*	-15.41**	-16.76**	5.63
P_3xP_4	0.91	-5.30	-3.87	4.46	-6.14*	-16.42**	-6.06	4.69
P_3xP_5	3.65	-2.72	-1.25	2.92	-4.25	4.47	-5.88	0.44
P_3xP_6	7.93*	1.29	2.82	1.13	0.77	-14.69**	-6.07	28.01**
P_4xP_5	8.18*	1.52	3.06	0.39	12.85**	5.39	-2.47	-7.50*
P_4xP_6	-16.51**	-21.65**	-20.46**	-6.94*	6.14*	4.47	-16.43**	-8.30**
P_5xP_6	1.37	-4.86	-3.42	7.00*	3.68	-4.08	14.66**	-5.28
Mean	-8.16	-13.81	-12.50	-4.44	3.57	-12.28	-8.33	-1.66
Std error	3.61	3.39	3.44	2.44	2.54	3.45	2.89	2.78
Minimum	-39.54	-43.26	-42.4	-27.95	-29.32	-40.80	-34.69	-13.91
Maximum	8.18	1.52	3.06	7.00	12.85	5.39	14.66	28.01
CD(0.05)	7.74	7.27	7.37	5.24	5.45	7.39	6.19	5.97
CD(0.01)	10.75	10.09	10.24	7.28	7.56	10.26	8.60	8.28

*,** indicate significant at 5% and 1% levels, respectively; TGW = Thousand grain weight.

Significant and negative heterosis was observed for maximum crosses in case of maturity and growth parameters which is desirable for a breeder. Out of 15 crosses all crosses showed significant negative heterosis for days to tasseling wih a range of -8.90% to -1.78%. Fourteen crosses showed significant negative heterosis for days to silking and maturity with the range of -8.19% to -0.69% and -4.55% to -0.23%, respectively. Roy *et al.* (1998) and Uddin *et al*. (2006) also observed significant and negative heterosis in some crosses for days to tasseling and silking in their studies. All the crosses showed significant negative heterosis for plant height (-36.30 to 7.70) and ear height (- 45.11 to -23.11) indicating dwarfness of the hybrids. Hoque *et al.* (2008) and Kadir (2010) also observed significant and negative heterosis in some crosses for plant height and ear height in their studies.

Table 5b.Percent heterosis over BHM-7 for maturity and growth parameters.

Cross combination	Days to tasseling	Days to silking	Days to maturity	Plant height (cm)	Ear height (cm)
P_1xP_2	-5.70**	-5.12**	-2.50**	-21.19**	-31.56**
P_1xP_3	-6.05**	-5.81**	-2.50**	-11.70**	-23.11**
P_1xP_4	-6.76**	-5.81**	-2.05**	-17.78**	-32.00**
P_1xP_5	-7.83**	-6.49**	-1.59**	-15.26**	-28.22**
P_1xP_6	-6.05**	-4.78**	-o.46	-36.30**	-36.22**
P_2xP_3	-3.92**	-0.69	-4.09**	-26.22**	-45.11**
P_2xP_4	-5.70**	-4.10**	-4.55**	-21.19**	-35.56**
P_2xP_5	-8.90**	-8.19**	-2.73**	-14.96**	-31.11**
P_2xP_6	-4.27**	-4.10**	-0.23	-11.11**	-25.56**
P_3xP_4	-5.34**	-5.12**	-4.55**	-13.48**	-25.11**
P_3xP_5	-1.78**	-5.12**	-1.14**	-11.70**	-28.67**
P_3xP_6	-2.49**	-3.07**	-0.91*	-12.59**	-30.00**
P_4xP_5	-5.34**	-5.12**	-0.91*	-17.19**	-32.44**
P_4xP_6	-4.27**	-3.42**	-2.05**	-26.07**	-40.44**
P_5xP_6	-6.41**	-5.12**	-2.05**	-7.70**	-28.22**
Mean	-5.39	-4.80	-2.24	-18.30	-31.56
Std error	0.48	0.44	0.37	1.90	1.52
Minimum	-8.90	-8.19	-4.55	-36.30	-45.11
Maximum	-.78	-0.69	-0.23	-7.70	-23.11
CD(0.05)	1.03	0.93	0.80	4.27	3.25
CD(0.01)	1.42	1.29	1.12	5.93	4.52

*,** indicate significant at 5% and 1% level, respectively.

Conclusion

From the study, it may be concluded that the parents P_5 & P_6 were good combiner for yield and the parents P_1 & P_2 were good combiner for both dwarf and earliness. The two hybrids (P_3 x P_6 & P_4 x P_5) showed good performance for yield and other desirable characters. However, for confirmation, these two hybrids would be further evaluated in wider agro-ecological zones of Bangladesh.

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