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EVALUATION OF MAIZE S_2 LINES IN TEST CROSS COMBINATIONS II: YIELD AND YIELD COMPONENTS

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Abstract

The objective of this study was to test the performance of maize S2 lines derived from maize variety Azam, using line x tester analysis. Test crosses developed from 24 S_2 lines, and crossed to three different testers were used in the study. Maximum ear length (16 cm) was observed for TC-19, using WD 2x8 as a tester, while SCA for ear length was recorded to be 0.8. Maximum ear diameter (5 cm) was observed for TC-8, using OPV lalal as tester, while SCA for ear diameter was recorded to be 0.1. Maximum kernel rows ear" (15) were observed for TC-30, using WD 2x8 as tester, while SCA was recorded to be -0.5. Maximum 100 kernel weight (34 g) was observed for TC-36, using WD 2x8 as a tester, while SCA for grain yield was 901 and 4.2 for kernel weight. Highest grain yield (6765 kg ha^1) was recorded for testcross TC-26, using WD 3x6 as a tester. Moreover, lines TC-ll, TC-8, TC-20, TC- 26, TC-9, (using WD 2x8 as a tester), TC-10, TC-7 (using WD 3x6 as a tester), TC-10, T.C-6 (using Jalal as a tester) were found good combiners. Test crosses TC-ll, using WD 2x8 as a tester, TC-26 and TC-7, using WD 3x6 as a tester had the highest SCA, GCA, and mean for important traits like grain yield, hundred kernel weight, ear diameter and ear length. These testcrosses are recommended to be included in future breeding programs for developing maize hybrids with higher yield potential accompanied with other desirable parameters of interest.

Introduction

Maize is the third important cereal after wheat and rice in Pakistan and accounts for 4.8% of the total cropped area and 3.5% of the value of agricultural output. It is planted on an estimated area of 0.9 million hectares with an annual production of 1.3 million tones. The bulk (97%) of the total production come from two major provinces, Khyber Pakhtunkhwa, accounting for 57% of the total area and 68% of total production. Punjab contributes 38% acreage with 30% of total maize grain production. Very little maize of 2-3% is produced in the province of Sindh and Balochistan. In Pakistan during the year 2005-06, maize was grown on 1024 thousand hectares, resulting in total annual production of 3109.6 thousand tones, with an average of 2984 kg per hectare (Anon., 2005-06). A considerable area of approximately more than 500,000 ha in the plains and high mountains of Khyber Pakhtunkhwa is planted with maize crop. Per hectare production of maize is considerably low in these areas compared to other countries of similar climatic conditions. Development of local inexpensive hybrids can certainly give a boost to maize crop yield per unit area.

Maize being a highly cross pollinated crop when subjected to self pollination, show considerable inbreeding depression with regard to genetic potential, however, inbred lines exhibit differential expression with regard to yield and other traits (Khan *et al*., 2008; Ahmad *et al*., 2010). For selection of inbred lines tolerant to inbreeding depression and being superior in genetic potential, early generation testing is desirable. Lines with poor combining abilities are discarded in early generations and those with good performance are advanced for further selfing (Arshad *et al*., 2003).

The objective of this study was to identify superior maize S_2 lines based on testcross performance and to test the combining ability of maize S_2 lines as potential source in the production of improved maize germplasm, adapted to the agro- climatic conditions of Peshawar.

Materials and Methods

This study was conducted during 2008 at the research farm of Khyber Pakhtunkhwa Agricultural University, Peshawar. The breeding material used comprised 24 S_2 lines developed from maize variety Azam which is a white flint genotype with medium stature and 90-110 days maturity. It is a well adapted maize composite which is used in most parts of Khyber Pakhtunkhwa. Three testers were used, comprising two single cross hybrids i.e., WD 2×8, WD 3×6 and an open pollinated variety Jalal. During spring crop season February-June 2008, 39 S_2 lines, derived from maize variety Azam were crossed with the above 3 testers in 3 isolations. At physiological maturity plants were hand harvested. Test crosses that had no or very low seed setting were discarded. During kharif season (July-0ctober 2008) test crosses along with check were evaluated in replicated yield trial using 10×10 square lattice design. Data for ear length and ear diameter were recorded on 5 randomly selected ears, with ears broken into 2 pieces to facilitate ear diameter measurement. Kernel rows of 5 randomly selected ears of each entry were counted. Kernel weight for each entry was recorded by measuring the weight of 100 grains from each plot. The grain yield recorded for each plot was converted to grain yield (kg ha^{-1}), using following relationship:

$$\text{Grain yield (kg)/hectare} = \frac{\text{Field wt. (100-moisture).10000}}{\text{85 x Plot area}} \times 0.08$$

where:

Field weight: = Weight of ears $plot^{-1}$, 0.08 = Shelling coefficient, 85 = standard value of grain moisture of 15% at storage.

Statistical analysis: Data were subjected to ANOVA appropriate for 10×10 square lattice design using computer program "MSTATC". Analysis for GCA and SCA was carried out following Singh & Chaudhary (1985).

Results

Ear length (cm): Table 1 shows significant (p>0.05) variations among the testcrosses for ear length. Maximum mean ear length (16.76 cm) was recorded for TC_19, followed by TC_20, using WD 2x8 as a tester for both testcrosses; while minimum ear length (9.83 cm) was observed for TC_7, using WD 2x8 as a tester. Mean ear length for checks was 13.78cm while 14cm for all the test crosses. About 26 out of 69 testcrosses were having greater ear length than the check. In all, 16 out of 24 testcrosses showed positive GCA effects. Highest positive GCA effect was recorded in TC_8, TC_21 and TC_12, while GCA effect was negative and maximum in case of testcrosses TC_6, TC_38 and TC_39. Similarly positive SCA effects were observed in 32 out 69 testcrosses, in which maximum SCA effect was recorded for TC_10, using WD 3x6 as a tester, followed by TC_ 20, using WD 2x8 as a tester. Highest negative SCA effect was recorded for TC_20, using WD 3x6 as a tester and TC_6, using WD 2x8 as a tester.

Table 1. Mean values, general combining ability (GCA) and specific combining ability (SCA) effects for ear length of 24 test crosses.

S_2 line	Tester						GCA
	WD2x8		WD3x6		Jalal		
	Mean(cm)	SCA	Mean(cm)	SCA	Mean(cm)	SCA	
2	12.00	-1.60	14.20	0.00	14.66	1.00	0.70
6	14.20	-2.60	12.13	-0.60	14.83	2.70	-0.70
7	9.83	-1.90	13.00	0.70	12.43	0.70	-1.10
8	15	0.50	13.76	-1.40	37.20	0.30	1.60
9	12.43	-0.80	14.53	0.70	12.70	-0.50	0.30
10	-----	-----	16.03	4.60	11.76	0.90	-2.10
11	13.33	0.40	14.06	0.60	11.33	-1.60	0.00
12	13.33	0.00	12.76	-1.20	14.00	0.60	0.50
13	15.86	0.80	15.53	-0.10	13.66	-1.40	2.10
15	13.66	-0.20	13.20	-1.30	14.86	1.00	1.00
16	12.10	-1.00	14.00	0.30	13.33	0.20	0.20
19	16.76	0.80	15.83	-0.70	15.33	-0.60	3.10
20	16.10	3.40	10.20	-3.10	11.83	-0.90	-0.20
21	12.66	-1.90	15.86	0.80	15.03	0.50	1.60
23	13.46	-0.10	13.26	-0.90	14.10	0.50	0.70
25	13.60	0.70	11.73	-1.80	13.46	0.50	0.00
26	12.03	-0.30	13.00	0.10	11.93	-0.40	-0.60
29	12.76	0.40	12.50	-0.50	11.86	-0.50	-0.50
30	12.66	-0.20	13.20	-0.30	12.76	-0.10	0.00
34	13.83	1.10	12.33	-1.00	12.00	-0.70	-0.20
35	14.86	1.10	13.43	-0.90	13.03	-0.70	0.90
36	13.43	0.70	12.66	-0.60	12.06	-0.70	-0.20
38	-----	-------	14.10	-1.00	15.03	0.50	1.70
39	------	------	12.20	-1.80	14.63	1.20	0.50

Overall mean for testcrosses = 13.78 cm, Mean value for check = 13.78 cm, $LSD_{(0.05)}$ = 8.1, $LSD_{(0.01)}$ =11

Ear diameter: The differences among the testcrosses for ear diameter were non significant (Table 2). Maximum mean ear diameter (5.4cm) was observed for TC_8, using OPV Jalal as a tester, followed by TC_34 (4.66cm), using WD 3x6 as a tester. Minimum mean ear diameter (3.23cm) was recorded for TC_2, using WD 2x8 as a tester. Mean ear diameter for check was 4.16 cm. It can be observed that 19 out of 24 testcrosses showed positive GCA effects. Highest positive GCA effect was observed for TC_8, followed by TC_34, while GCA effect was negative and maximum in case of testcross TC_10 and TC_38. Positive SCA effects were recorded in 30 out of 69 testcrosses, in which maximum SCA effect was observed for TC_38, followed by TC_ 10, using Jalal as a tester for both testcrosses. Highest negative SCA effect was recorded for TC_20, using WD 3x6 as a tester, followed by TC_2, using WD 2x6 as a tester.

Number of kernel rows ear^{-1}: Differences among the testcrosses for number of kernel rows ear^{-1} were non significant (Table 3). The highest mean number of kernel rows ear^{-1} (15.66) was observed for TC_30, using WD 2x8 as a tester, followed by TC_34 (15 kernel rows ear^{-1}), using WD 3x6 as a tester, while lowest number of kernel rows ear^{-1} was recorded for TC_11 (11), using WD 2x8 as a tester, followed by TC_8 (10 kernel row ear^{-1}), using Jalal as a tester. Mean number of kernel rows ear^{-1} of all the test crosses and check was 14.08. It is evident from the Table that 16 out of 24 testcrosses showed positive GCA effects. The highest positive GCA effect was recorded for TC_26, followed by TC_35, while GCA effect was negative and maximum in case of testcross TC_6, followed by TC_10. Positive SCA effects were observed in 27 out of 69 testcrosses, in which maximum SCA effect was recorded for TC_10, using WD 3x6 as a tester, followed by TC_10, using Jalal as a tester. The highest negative SCA effect was observed for TC_12, using Jalal as a tester, followed by TC_6, using WD 2x8 as a tester.

Table 2. Mean values, general combining ability (GCA) and specific combining ability (SCA) effects for ear diameter of 24 testcrosses.

S_2 line	Tester						GCA
	WD2x8		WD3x6		Jalal		
	Mean(cm)	SCA	Mean(cm)	SCA	Mean(cm)	SCA	
2	3.23	-0.50	4.46	0.40	3.73	-0.30	-0.10
6	3.90	-1.00	4.06	0.10	4.46	0.60	-0.20
7	4.33	0.20	4.40	-0.10	4.00	-0.40	0.30
8	4.33	0.00	4.20	-0.40	7.53	0.10	0.40
9	4.03	0.00	3.86	-0.40	4.36	0.10	0.10
10	----	------	4.06	0.70	4.06	0.70	-0.80
11	4.16	0.20	4.23	-0.10	3.06	-0.40	0.10
12	4.10	0.10	4.13	-0.10	3.90	-0.30	0.10
13	4.10	0.00	4.50	0.10	3.90	-0.50	0.20
15	3.46	-0.40	4.10	-0.10	4.30	0.20	0.00
16	4.03	0.10	4.03	-0.20	4.00	-0.20	0.10
19	4.03	0.10	4.13	-0.10	3.86	-0.30	0.10
20	4.46	0.40	3.80	-0.60	4.20	-0.10	0.20
21	4.33	0.20	4.16	-0.20	4.03	-0.30	0.20
23	4.13	-0.10	4.26	-0.20	4.46	0.00	0.30
25	3.76	-0.30	4.10	-0.20	4.50	0.20	0.20
26	4.06	-0.10	4.43	0.00	4.10	-0.30	0.20
29	4.26	0.10	4.40	-0.10	4.20	-0.30	0.30
30	3.76	-0.20	4.43	0.20	3.96	-0.30	0.10
34	3.96	-0.30	4.66	0.10	4.36	-0.20	0.40
35	4.36	0.40	3.56	-0.70	4.10	-0.10	0.10
36	4.30	0.20	4.10	-0.30	4.16	-0.20	0.20
38	----	----	3.96	0.70	4.26	1.00	-0.90
39	----	-----	3.83	0.70	4.00	0.90	-1.00

Overall mean for testcrosses = 4.16 cm, Mean value for check = 4.16 cm, $LSD_{(0.05)}$ = 0.62, $LSD_{(0.01)}$ = 0.80

Table 3. Mean values, general combining ability (GCA) and specific combining ability (SCA) effects for number of kernel rows ear^{-1} of 24 test crosses.

S_2 line	Tester						GCA
	WD2x8		WD3x6		Jalal		
	Mean (no)	SCA	Mean (no)	SCA	Mean (no)	SCA	
2	12.33	-1.80	15.33	0.40	15.00	0.40	1.30
6	12.00	-3.80	14.33	1.70	14.00	1.00	-1.10
7	14.66	0.90	13.66	-1.00	13.66	-1.00	0.90
8	13.66	-0.10	15.00	0.40	10.10	-1.30	0.90
9	13.66	0.00	14.00	-0.50	14.00	-0.50	0.80
10	-----	-------	13.33	2.10	14.33	3.10	-2.50
11	11.00	-1.00	12.66	-0.20	13.00	-12.90	-0.90
12	13.00	1.00	11.00	-1.90	13.00	-0.20	-0.90
13	13.33	0.60	13.00	-0.50	12.00	-1.20	-0.20
15	13.66	0.10	13.66	-0.70	14.00	-0.40	0.70
16	12.66	-0.60	14.33	0.30	13.00	-0.80	0.40
19	13.33	0.50	13.33	-0.30	12.00	-1.30	-0.10
20	14.33	0.50	12.66	-2.00	15.00	0.40	0.90
21	13.00	0.40	12.33	-1.10	13.00	-0.40	-0.30
23	13.66	0.20	14.33	0.00	13.00	-1.30	0.60
25	13.00	-0.90	14.33	-0.40	15.00	0.20	1.00
26	15.66	0.60	15.00	-0.90	15.00	-0.90	2.10
29	14.00	0.80	13.66	-0.40	13.00	-1.40	0.40
30	14.00	-0.50	13.66	-0.30	14.00	-0.30	0.30
34	15.00	0.40	15.66	0.30	14.00	-1.80	1.70
35	15.33	0.40	14.33	-1.40	16.00	-0.10	2.00
36	13.33	-0.10	14.33	0.00	13.00	-1.00	0.60
38	----	------	12.00	-1.30	13.00	0.00	-0.40
39	----	-------	13.00	-1.10	14.00	-0.10	0.40

Overall mean for testcrosses = 14.08 (kernel rows ears^{-1}), Mean value for check = 14 (kernel rows ears^{-1}),
$LSD_{(0.05)}$ = 11. $LSD_{(0.01)}$ = 15

100 kernel weight (g): Mean square values presented in Table 4 revealed non significant differences for 100 kernel weight among the testcrosses. Maximum mean kernel weight (34.63 g) was observed for TC_36, followed by TC_21 (30.36 g), using WD 2x8 as a tester for both testcrosses, where as minimum of (18.73g) 100 kernel weight was observed for TC_6, using Jalal as a tester and TC_6 (20.26 g), using WD 3x6 as a tester. The mean 100 kernel weight for check was 31.60 g. The overall mean of all the testcrosses was 26.91 g The highest positive GCA effect was observed for TC_8, TC_9 and TC_12, while GCA effect was negative and maximum in case of genotypes recorded in TC_6 and TC_10. Positive SCA effects were observed for 26 out of 69 testcrosses, in which maximum SCA effect was recorded for TC_36, TC_21, using WD 2x8 as a tester and TC_ 10, using WD 3x6 as a tester. The highest negative SCA effect was recorded for TC_20, using WD 2x8 as a tester followed by TC_11, using WD 3x6 as a tester.

Table 4. Mean values, general combining ability (GCA) and specific combining ability (SCA) effects for 100 kernel weight of 24 testcrosses.

S_2 line	Tester						GCA
	WD2x8		WD3x6		Jalal		
	Mean (gm)	SCA	Mean(gm)	SCA	Mean(gm)	SCA	
2	26.26	-1.40	29.43	0.80	26.36	-1. 05	1.10
6	28.36	-1.00	20.26	-0.60	18.73	-0. 60	-6.70
7	23.63	-3.10	29.93	2.20	25.46	-1.30	0.20
8	29.60	-2.50	31.40	-1.70	27.73	2.00	5.60
9	27.66	-2.00	30.46	-0.10	27.70	-0.10	3.10
10	------	------	27.86	3.80	26.20	2.60	-3.50
11	25.16	-1.30	23.23	-4.20	25.90	3.30	-0.10
12	28.96	-1.70	30.23	-1.40	29.53	0.80	4.10
13	28.13	-1.30	30.73	0.30	25.93	-1.20	2.90
15	29.73	0.70	28.36	-1.70	26.10	-1.20	2. 50
16	30.20	2.20	26.70	-2.30	23.66	-2.10	1.40
19	25.63	0.20	28.70	-3.10	24.73	0.60	-1.20
20	26.53	-25.50	28.10	-0.80	29.00	0.00	1.40
21	30.36	1.60	26.03	-3.70	26.70	-0.10	2.20
23	28.10	-1.30	27.10	-3.30	29.90	2.30	2.80
25	25.13	-0.90	28.16	1.10	24.36	-2.40	-0.50
26	26.70	-0.50	29.36	1.20	24.36	-2.90	0.60
29	28.10	-1.40	28.40	-2.10	30.26	1.30	2.90
30	25.26	-2.40	29.16	0.50	25.66	-0.20	1.10
34	26.63	0.00	28.76	1.10	23.40	-3.40	0.10
35	24.50	0.40	25.76	0.60	21.36	-3.30	-2.40
36	34.63	4.20	28.83	-2.60	27.86	-3.80	3.90
38	-----	-----	25.86	0.30	23.63	-2.30	-3.80
39	------	-------	23.93	0.20	21.56	-2.10	-3.80

Overall mean for testcrosses = 26.91gm, Mean value for check = 31gm, $LSD_{(0.05)}$ = 7.1, $LSD_{(0.01)}$ =9.3

Grain yield (Kg ha^{-1}): The analysis of variance regarding grain yield revealed highly significant variations ($P<0.05$) among the testcrosses (Table 5). Maximum mean grain yield (6765 kg ha^{-1}) was recorded for the genotype TC_26, using WD 3x6 as a tester, followed by TC_11, using WD 2x8 as a tester with mean grain yield of 6489 kg ha^{-1}. Minimum mean grain yield (622 kg ha^{-1}) was recorded for TC_2, using WD 2x8 as a tester. The overall mean grain yield for the testcrosses was 4395 kg ha^{-1} while that of the check was recorded to be 6344 kg ha^{-1}. The highest positive GCA effect was observed for TC_8, TC_9 and TC_26, while GCA effect was negative and maximum in case of testcross TC_10 and TC_6. Positive SCA effects was observed for 27 out of 69 testcrosses, in which maximum SCA effect was recorded for TC_20, TC_8 and TC_ 11, using WD 2x8 as a tester. The highest negative SCA effect was observed for TC_2, using WD 2x8 as a tester, followed by TC_11, using WD 3x6 as a tester.

Discussion

Ear length can considerably affect the final grain yield like other yield associated traits that are considered yield components for the final grain yield in maize. In our experiment, testcrosses showed significant variations for ear length. About 92.42% test crosses had greater ear length than the S_2 parental lines, while 7.5% test crosses had less ear length than the S_2 parental lines. In all, 47% test crosses showed positive SCA effects, while 53% were having negative SCA effects. Similar results were also reported by Pedro *et al*., (2008) while comparing selection methods in maize.

Ear diameter is an important yield component that contributes to the final grain yield. Our results showed non significant ($P>0.05$) variations among the test crosses for ear diameter. About 8% of test crosses showed superior mean value for ear diameter than the check. On the other hand, 33% of the test crosses had ear diameter similar to check. It is evident from the results that 79% of testcrosses showed positive GCA effect while 45% test crosses showed positive SCA effects. These results are in conformity with those of Jumbo & Caren (2007) while studying combining ability and reciprocal effects in elite maize populations.

Table 5. Mean values, general combining ability (GCA) and specific combining ability (SCA) effects for grain yield kg ha^{-1} of 24 test crosses.

S_2 line	Tester						GCA
	WD2x8		WD3x6		Jalal		
	Mean(kg)	SCA	Mean(kg)	SCA	Mean(kg)	SCA	
2	622.00	-2037.00	5557.00	1537.00	4179.00	212.00	-797.00
6	2639.00	-218.00	2228.00	-1110.00	4326.00	1040.00	-1478.00
7	3085.00	-768.00	6361.00	1149.00	4492.00	-669.00	397.00
8	5672.00	1010.00	5524.00	-499.00	4492.00	-799.00	1206.00
9	5712.00	1144.00	5516.00	-412.00	4856.00	-1020.00	1112.00
10	-----	-------	3051.00	-288.00	3313.00	25.00	-1476.00
11	6489.00	2090.00	4291.00	-1468.00	4797.00	-910.00	943.00
12	4357.00	846.00	4069.00	-802.00	4488.00	-331.00	55.00
13	3401.00	-472.00	5081.00	448.00	4918.00	-264.00	418.00
15	2785.00	-164.00	3927.00	-382.00	4517.00	259.00	-506.00
16	1842.00	-1275.00	5366.00	888.00	4525.00	99.00	-338.00
19	5644.00	1642.00	3949.00	-1413.00	4794.00	-516.00	546.00
20	5934.00	2022.00	4394.00	-879.00	3790.00	-1431.00	457.00
21	2343.00	-929.00	5294.00	662.00	4558.00	-22.00	-184.00
23	3708.00	-302.00	5380.00	10.00	5322.00	3.00	554.00
25	2301.00	-994.00	4383.00	-273.00	5584.00	979.00	-160.00
26	3620.00	-1135.00	6765.00	901.00	5506.00	-306.00	1048.00
29	2196.00	-1155.00	5247.00	535.00	4992.00	331.00	-104.00
30	2065.00	-1164.00	4756.00	167.00	5248.00	710.00	-226.00
34	3144.00	-492.00	5397.00	402.00	4746.00	-198.00	180.00
35	3595.00	-442.00	5531.00	134.00	5366.00	20.00	581.00
36	3795.00	292.00	4257.00	-607.00	4839.00	26.00	48.00
38	-----	----	4213.00	-931.00	4941.00	-151.00	327.00
39	----	-----	4444.00	-882.00	5075.00	-200.00	510.00

Overall mean for testcrosses = 4395kg ha^{-1}, Mean value for check = 6344kg ha^{-1}, $LSD_{(0.05)}$ = 2600, $LSD_{(0.01)}$ =2100

Like other yield associated traits that affects the final grain yield, number of kernel rows ear^{-1} also has an effect on the final grain yield. The test crosses showed non significant variation for number of kernel rows ear^{-1}. The highest number of kernel rows ear^{-1} was observed for TC_30, using WD 2x8 as a tester, followed by TC_34, using WD 3x6 as a tester, while lowest number of kernel rows ear^{-1} was recorded for TC_11, using WD 2x8 as a tester. It can be observed that 31.88% of the test crosses were superior than the check, while 11% had similar values. It is evident from the results that 66% test crosses showed positive GCA effect. The highest positive GCA effects was recorded in TC_26, followed by TC_35, while GCA effect was negative and maximum in case of genotypes recorded in TC_6, followed by TC_10. About 41% test crosses showed positive SCA effects. Lee *et al*., (2003) while investigating the genetic components of yield stability in maize breeding populations also reported similar observations.

Kernel weight is an important yield component that contributes to the final grain yield. Analysis of variance showed non significant variation among the test crosses for 100 kernel weight. The mean kernel weight of test crosses shows that 48.48% of the test crosses gave superior performance when compared to check, while 9.4% were having similar value. It can be observed that, 66.66% of the test crosses showed positive GCA effects, while 33.33% had negative GCA effects. About 39% test crosses showed positive SCA effects, while 61% were observed with negative SCA effects. Carena (2005) reported kernel weight as an important component for consideration in maize breeding programs while comparing improved maize population hybrids for grain yield and agronomic traits.

Grain yield is one of the most important economic factors in crop production and is given priority in maize breeding programs. The analysis of variance regarding grain yield revealed highly significant variations ($P<0.01$) among test crosses. It can be observed that 55% of the test crosses were superior to the check. On the other hand, 30% of the test crosses gave performance inferior to the check. About 62.55% test crosses showed positive GCA effects, while 37.45% test crosses had negative GCA effects. In all, 38% of the test crosses showed positive SCA effects, in which maximum SCA effect was observed for TC_20, followed by TC_ 11, using WD 2x8 as a tester. Narro etal (2003) crossed 43 S3 maize lines to two narrow based and two broad based testers (OPVS) and concluded that the synthetic developed with the S3 lines as tester yielded the highest and the one with the broad based tester yielded the lowest.

References

Ahmad, M., S. Khan, F. Ahmad, N.H. Shah and N. Akhtar. 2010. Evaluation of 99 S_1 lines of maize for inbreeding depression. *Pak. J. Agri. Sci*., 47: 209-213.

Anonymous. 2005-06. Govt. of Pakistan. Minestry of Food and Livestock. Economics Wing, Islamabad.

Arshad, M., A. Bakhash, M. Zubair and A. Ghafoor. 2003. Genetic variability and correlation studies in chickpea. *Pak. J. Bot.*, 35(4): 605-611.

Carena, M.J. 2005. Maize commercial hybrids compared to improved population hybrids for grain yield and agronomic performance. *Euphytica*, 114: 201-208.

Jumbo, M.B. and M.J. Caren. 2007. Combining ability, maternal, and reciprocal effects of elite early-maturing maize population hybrids. *Euphytica*, 162: 325-333.

Khan, H., H. Rahman, H. Ahmad, H. Ali, Inamullah and M. Alam. 2008. Magnitude of combining ability of sunflower genotypes in different environments. *Pak. J. Bot*., 40(1): 151-160.

Lee, E.A., T.K Doerksen and L.W. Kannenberg. 2003. Genetic components of yield stability in maize breeding populations. *Crop Sci*., 43: 2018-2027.

Menkir, Abebe, Ivan and Charles. 2007. Testcross performance and diversity analysis of white maize lines derived from backcrosses containing exotic germplasm. *Euphytica*, 155: 417-428.

Narro Luis, Shivaji Pandey, Crossa José, Carlos De León and Fredy Salazar. 2003. Using line x tester interaction for the formation of yellow maize synthetics tolerant to acid soils.*Crop Sci*., 43: 1718-1728.

Pedro, M.R., M. Moreira, E. P. Silas , C.V. Patto and A.R. Hallauer. 2008. Comparison of selection methods on 'Pigarro', a Portuguese improved maize population with fasciation expression. *Euphytica*, 163: 481-499.

Singh, R.K. and B.D. Chaudhary.1985. Line by tester analysis. In: *Biometrical methods in quantitative genetics*. Kalyani Publishers, New Delhi, Ludhiana(India) pp205.

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