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COMBINING ABILITY AND HETEROSIS IN GRAIN SORGHUM (*Sorghum bicolor* (L.) *Moench*)

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ABSTRACT

Thirty grain sorghum crosses were developed in 1997 growing season from three introduced cytoplasmic male sterile(CMS) and ten restorer lines at Shandaweel Agriculture Research Station Farm, Sohag, Egypt. The thirty crosses, their parents and one check; commercial hybrid Shandaweel-2; were evaluated in a randomized complete block design in two growing seasons 1998 and 1999. The genetic parameters were estimated by using line x tester analysis.

The genotypes showed highly significant differences among all studied traits. Also, the female line ATX-629 gave the earliest cross, however, ICSA-1 gave the latest one when they were crossed with the same restorer line Dorado-V-9. Grain yield showed a high estimate (71.28 %) of heterosis over the better parent in the cross (ATX-629 x22808-13). The female line ICSA-40 and the restorer lines ICSR-138, followed by ICSR-93002, Dorado-V-9 and ICSR-89037 had a positive highly significant general combining ability for grain yield. Five crosses out of thirty had positive significant specific combining ability for grain yield. Crosses, (ICSA-1 x ICSR-93002) and (ICSA-40 x ICSR-89037) had higher grain yield than the check,Shandaweel-2. Results of these two hybrids have to be confirmed on large scale tests before further recommendation for commercial release.

Key words: *combining & heterosis, sorghum bicolor.*

1. INTRODUCTION

Grain sorghum in Egypt ranks fourth among cereal crops. Seventy percent of the sorghum area is located in Upper Egypt at Assiut and Sohag Governorates. Having male sterile lines make seed production of grain sorghum hybrid less difficult. So, in order to keep down the cost of hybrid seed production, attention must be given to the yielding ability and seed quality of the female seed parent and the restorer lines. Heterosis generally increases when genetic diversity among parents increase. Estimated heterosis for grain yield was 78.3% in the cross (1258 A x PD3-1-11) by (Nandanwanker,1990). He added that, the male parents PVR-7, PVR-25 and 1235 in combination with 36A and 1258A had positive heterosis for grain yield and its components. Sankarapanadion *et al.*, (1994) studied heterosis in grain sorghum by using three male sterile and fourteen restorer lines. They reported that twenty hybrids had significant positive heterosis for grain yield and the best two hybrids were (2077-A x PV-544) and (2077-A x M-35-1). El-Menshawy (1996), Mahmoud (1997) and Amir (1999) used male sterile lines to produce their crosses and they reported that the hybrids were earlier, taller, and had high 1000-grain weight and grain yield than their better parents. On the other hand, heterosis for grain yield / plant was observed in few hybrids.

Among combining ability, Sakhare *et al.*, (1992) estimated combining ability of twelve grain sorghum lines (including four male sterile and three restorer lines) and their F_1 hybrids for seven yield components. They found that the male sterile lines 2077-A, 296-A and the restorers ,SPV-462 & SPV-346, were good general combiners for most characters including grain yield. Pillai *et al.*, (1995) reported that the lines 111-A and 205 A among the females and 89054-R, 29-R and Co-21 among the male parents, were good general combiners for yield. Among the crosses, cross (205 A x 89054-R) possessed the highest specific combining ability effects for yield. El-Menshawy (1996), Mahmoud (1997) and Amir (1999) used male sterile lines to produce their grain sorghum crosses and they found general and specific combining ability (gca & sca) for grain yield and other related components in some crosses. The present study was carried out to estimate heterosis as a criterion for developing superior hybrids. In this context the matching of flowering between the restorer and female lines and the good pollen shedding capacity of restorers are crucial for commercial hybrid seed production. Also, to estimate the general and specific combining ability effects and identify the best parental combiners for high yielding hybrids.

2. MATERIALS AND METHODS

Thirty grain sorghum crosses were developed at Shandaweel Agric. Res. Station Farm, Sohag, Egypt in 1997 season. These crosses were developed from three introduced cytoplasmic male sterile lines (A-lines) and ten restorer lines (R-lines). The heads of both parents (R-lines and A-lines) were bagged before anthesis. Pollen were collected from each restorer line and placed on the stigmas of the three male sterile lines (A-lines) to produce the thirty crosses. The origin and agronomic characteristics of the ten restorer lines (R-lines) and the three male sterile lines (A-lines) are presented in Table (1). An experiment was conducted in 1998 and 1999 growing seasons at Shandaweel Agric. Res. Station Farm, Sohag, Egypt, to evaluate the crosses, their parents and Shandaweel-2, commercial hybrid, as a check. The seeds were sown on June 15th and June 20th in 1998 and 1999 growing seasons, respectively. A randomized complete block design with three replications and one row plot was used. Rows were 4 meter long, 60 cm apart and 20 cm between hills. Three weeks after sowing, plants were thinned to two plants/hill after hoeing. All other cultural practices were done as recommended for grain sorghum production and the recommended plant protection methods were applied as necessary. The mechanical analysis of the soil showed that the soil at Shandaweel is loamy sand.

Data were recorded on days to 50 % blooming, plant height (cm),1000-grain weight and grain yield /plant with grain moisture adjusted to 14% moisture. Also, data of each season and combined over the two seasons were subjected to the analysis of variance of Data were recorded on days to 50 % blooming, plant height (cm),1000-grain weight and grain yield /plant with grain moisture adjusted to 14% moisture. Also, data of each season and combined over the two seasons were subjected to the analysis of variance of randomized complete block design (R.C.B.D.) according to Federer (1963). The genetic analysis was computed by using line x tester analysis according to Kempthorne (1957). General combining ability (gca) effects for the parental lines and specific combining ability (sca) effects for crosses were estimated according to Singh and Chaudhry (1977).

3. RESULTS AND DISCUSSION

3.1. Mean performance of the genotypes

The combined analysis of variance over the two seasons for all studied traits showed highly significant differences among the

Table (1): Origin of the parental lines and some of their agronomic Characteristics grown at Shandaweel, 1997 season.

No.	Lines	Origin	Days to 50% blooming	Plant height (cm)
I	Restorer lines			
1	Dorado-V-9	USA	76	134
2	22808	USA	75	117
3	ICSR-89037	India	73	153
4	22808-13	USA	71	116
5	MR-813	Zimbabwe	70	171
6	ICSR-93002	India	72	186
7	NEB-3175	USA	71	112
8	NEB-3245	USA	76	131
9	Kuymne	Zimbabwe	70	164
10	ICSR-138	India	77	242
II	Male sterile lines			
1	ICSA-1	India	65	130
2	ICSA-40	India	70	160
3	ATX-629	USA	69	135
III	Check			
1	Shandaweel-2	Egypt	71	198

genotypes. Differences were highly significant among years for only days to 50% blooming and significant for 1000-grain weight (Table 2). The interaction between genotypes and years was highly significant for all studied traits. Also, the data indicated that highly significant differences were detected for all studied traits among parents, crosses, their partitions (females, males and females x males) and parents vs. crosses, except for 1000-grain weight the differences were significant. Moreover, the interactions between each of the parents, crosses, their partitions and parents vs. crosses and years had highly significant differences except parent x year and parent vs. crosses x year for10-grain weight trait.

For days to 50% blooming (Table 3) the combined data over the two seasons showed that days to 50% blooming for the male parents ranged from 66.83 (NEB-3245) to 77.33 (ICSR-183) and for the crosses ranged from 66.33 (ICSA-1 x 22808- 13) to 75.33 (ICSA-

Table (2): Combined analysis of variance of the studied genotypes (without check) for four traits over two growing seasons 1998& 1999.

Source of Variation	D.F.	Days to 50% Blooming	Plant height (cm.)	1000-grain weight (g.)	Grain yield / plant (g.)
Year (Y)	1	1172.48**	18.99	16.38*	12211.72**
Reps / Year	4	17.18**	56.03	10.96*	22.47
Genotypes (G)	42	37.71**	11546.79**	129.89**	1416.70**
Parents (P)	12	43.64**	6395.48**	108.87**	930.62**
P vs. Crosses	1	330.79**	38395.76**	20.07*	7420.55**
Crosses (C)	29	25.15**	12752.54**	142.38**	1410.81**
Male (M)	9	45.78**	36422.69**	351.17**	3146.37**
Female (F)	2	11.04**	7451.76**	161.51**	791.77**
F x M	18	16.40**	1506.44**	35.87**	611.80**
G x Y	42	24.35**	2417.63**	20.90**	358.77**
P x Y	12	28.46**	945.89**	9.15	237.26**
P vs. C x Y	1	31.29**	475.38*	6.19	67.55
C x Y	29	22.41**	3093.60**	26.29**	419.07**
M x Y	9	13.10**	1051.40**	12.84**	561.70**
F x Y	2	112.71**	21345.09**	27.95**	273.15**
F x M x Y	18	17.04**	2086.75**	32.80**	363.97**
Error	168	3.49	97.78	4.16	28.17

1 x Dorado-V-9). These results indicated that lateness of last cross may be due to the genetic make up of the restorer parent Dorado-V-9.While, the average days to 50% blooming of check, Shandaweel-2, was 71.17 days. In general, most of the F_1 crosses were earlier than their parents and eight crosses out of thirty were highly significantly earlier and two were significantly earlier than the check, Shandweel-2.

For plant height the combined data of average plant height in (Table 3) for male parents ranged from 111.67 cm (NEB-3175) to 242.50 cm (ICSR-138) with an average of 152.63 cm, while for female parents it ranged from 120.00 cm (ICSA-1) to 142.50 cm.

(ICSA-40). Average plant height for the crosses ranged from 112.50 cm. (ICSA-1x NEB-3245) to 292.00 cm. (ICSA-40 x ICSR-138), while, the average plant height of the check, Shandaweel-2, was 198.33 cm. In general, some of the F_1 crosses were taller than their parents and four out of thirty were highly significantly taller than the check ,Shandaweel-2. For 1000-grain weight data over the two seasons in (Table 3) showed that average 1000-grain weight of the male parents ranged from 18.53, gm (22808) to 32.23 gm (ICSR-93002) with an average of 25.11 gm. While for female parents it ranged from 20.97 gm (ATX-629) to 23.40 gm (ICSA-40). Average 1000-grain weight for the crosses ranged from 16.83 gm (ICSA-1x NEB-3245) to 33.27gm (ATX-629 x Kuymne) while, the average 1000-grain weight of the check Shandaweel-2 was 29.63 gm. In general, only one cross (ATX-629x Kuymne) had significantly higher 1000-grain weight than the check. Some of the crosses had high 1000-grain weight compared with their parents.

For grain yield/plant, data over the two seasons (Table 3) showed that average grain yield/plant for the male parents ranged from 32.17 gm (22808-13) to 67.73gm. (ICSR-93002) with an average of 49.21gm., while for female parents it ranged from 27.07gm. (ATX-629) to 33.28 gm. (ICSA-40). Average grain yield/plant for the crosses ranged from 31.08 gm. (ICSA-1 x 22808) to 85.10 gm. (ICSA-1x ICSR-93002), while the average grain yield/plant of the check Shandaweel-2 was 77.25 gm. In general, most of the F_1 crosses had high grain yield/plant compared with their parents and also two crosses (ICSA-1 x ICSR-93002) and (ICSA-40 x ICSR-89037) produced significantly higher grain yield/plant than the check hybrid Shandaweel-2.These two crosses should be tested in a large scale for confirming their results and further recommendation. These results are in harmony with those obtained by El-Menshawy (1996) Mohmoud (1997) and Amir (1999).They concluded that most of the F_1 crosses were earlier, taller and had high 1000-grain weight and grain yield / plant than their parents.

3.2. Heterosis

Estimated heterosis for thirty F_1 crosses as a percentage of the better parent averaged over the two seasons for the studied traits are presented in Table 4 as follows:

Heterosis values for days to 50% blooming ranged from – 5.24 (ICSA-1 x 22808-13) to 7.61 % (ICSA-1 x Dorado-V-9). Most of the F_1 crosses over two seasons had negative heterosis, indicating that, these crosses were earlier than their earlier parental lines. Eight of these crosses had negative and significant heterosis and four crosses had positive and significant heterosis. Also, data indicated that the restorer line 22808-13 showed negative heterosis with ICSA-1, while Dorado- V-9 showed positive heterosis with the same A line. This result indicated that earliness or lateness of these crosses may be due to the genetic make up of the restorer parent.

On the other hand, heterosis values for plant height ranged from –14.01 (ICSA-1 x NEB-3245) to 50.05% (ATX-629 x Kuymne). Most of the F_1 crosses over two seasons had positive heterosis for plant height indicating that these crosses were taller than tall parental lines. Fourteen thirty crosses had positive and significant heterosis. Two crosses had negative and significant heterosis for plant height.

Heterosis values for 1000-grain weight ranged from –27.03 (ICSx MR-813) to 35.63% (ATX-629 x Kuymne). Five of these crosses had positive and significant heterosis for 1000-grain weight, while, ten crosses had negative and significant heterosis.

Heterosis values for grain yield/plant ranged from –25.95 (ICSA-1 x MR-813) to +71.28 % (ATX-629 x 22808-13). Most of the F_1 crosses over the two seasons had positive heterosis for grain yield/plant and this indicated that these crosses had high grain yield/plant compared with the best parent. Eighteen of these crosses had positive and significant heterosis, and three crosses had negative and significant heterosis. In general, the crosses; (ICSA-1 x Dorado-V-9), (ICSA-1x22808-13),(ICSA-1xICSR-93002), (ICSA-1 x NEB-3175), (ICSA-40xDorado-V-9), (ICSA-40x22808), (ICSA-40x ICSR-89037), (ICSA-40x22808-13),(ATX-629x22808-13) and (ATX-629xNEB-3175)gave the highest heterosis values for grain yield/plant. These results are in harmony with those obtained by Nandanwanker (1990), Sankarapanadion *et al.*, (1994) El-Menshawy (1996), Mahmoud (1997) and Amir (1999). They reported that heterosis was manifested in grain sorghum crosses for many studied traits.

Table (3): Combined means of days of 50% blooming, plant height, 1000 grain weight and grain yield / plant, over two growing seasons 1998 & 1999.

No.	Male line	Mean of male line	Mean of female lines		
			ICSA-1	ICSA-40	ATX-629
1 – Days to 50% blooming					
1	Dorado-V-9	76.17	75.33	72.00	68.50
2	22808	75.00	67.17	70.50	69.50
3	ICSR-89037	73.50	70.33	71.67	69.33
4	22808-13	71.33	66.33	70.17	69.00
5	MR-813	69.83	67.67	69.17	67.17
6	ICSR-93002	72.33	69.50	69.33	72.50
7	NEB-3175	70.67	67.50	68.67	67.67
8	NEB-3245	66.83	67.33	68.83	66.67
9	Kuymne	70.00	69.00	69.50	70.17
10	ICSR-138	77.33	72.83	70.33	72.50
Average		72.30	69.30	70.02	69.30
Female lines mean			70.00	73.50	69.00
$LSD_{0.05}$= 2.47		$LSD_{0.01}$= 3.25		Check = 71.17	
2 – Plant height (cm.)					
1	Dorado-V-9	133.83	162.67	200.50	185.00
2	22808	117.50	126.67	135.83	133.33
3	ICSR-89037	152.67	145.17	167.50	168.33
4	22808-13	115.83	137.83	137.50	168.83
5	MR-813	171.33	153.83	178.00	163.67
6	ICSR-93002	186.33	185.33	190.00	193.33
7	NEB-3175	111.67	142.17	146.67	144.17
8	NEB-3245	130.83	112.50	150.83	137.67
9	Kuymne	163.83	157.50	193.17	245.83
10	ICSR-138	242.50	286.67	292.00	272.83
Average		152.63	161.03	179.20	181.30
Female lines mean			120.00	142.50	126.17
$LSD_{0.05}$= 6.54		$LSD_{0.01}$= 8.61		Check =198.33	
3 – 1000-grain weight (g.)					
1	Dorado-V-9	29.60	29.85	29.37	29.73
2	22808	18.53	17.63	21.67	18.20
3	ICSR-89037	29.10	26.30	28.47	27.93
4	22808-13	24.67	27.13	24.47	27.97
5	MR-813	24.53	17.90	24.37	25.83
6	ICSR-93002	32.23	28.00	25.20	32.10
7	NEB-3175	19.57	20.45	19.93	23.83
8	NEB-3245	19.57	16.83	18.30	19.83
9	Kuymne	24.53	21.53	25.17	33.27
10	ICSR-138	28.77	30.50	31.87	30.67
Average		25.11	23.61	24.88	26.94
Female lines mean			21.87	23.40	20.97
$LSD_{0.05}$=3.01		$LSD_{0.01}$= 3.96		Check =29.63	
4 – Grain yield / plant (gm.).					
1	Dorado-V-9	49.47	75.50	78.25	55.62
2	22808	32.93	31.08	44.03	37.87
3	ICSR-89037	57.00	57.83	83.23	59.72
4	22808-13	32.17	44.88	42.92	55.10
5	MR-813	59.12	43.78	70.70	55.53
6	ICSR-93002	67.73	85.10	54.67	71.28
7	NEB-3175	32.95	52.20	53.77	43.83
8	NEB-3245	40.98	37.50	42.92	33.20
9	Kuymne	58.67	45.47	67.63	61.03
10	ICSR-138	61.03	77.37	71.80	69.35
Average		49.21	55.07	60.99	54.25
Female lines mean			32.87	33.28	27.07
$LSD_{0.05}$=4.88		$LSD_{0.01}$=6.43		Check =77.25	

Table (4):Estimated heterosis as a percentage of the better parent of thirty crosses over two growing seasons, 1998and 1999.

No.	Pedigree	Days of 50% blooming	Plant height (cm.)	1000-grain weight (g.)	Grain yield / plant (g.)
1	ICSA-1 x Dorado-V-9	7.61**	21.35**	0.84	52.62**
2	,, x 22808	-4.04**	5.56	-19.39**	-5.62
3	,, x ICSR-89037	0.47	-4.91	-9.62*	1.49
4	,, x 22808-13	-5.24**	14.86**	9.97*	36.54**
5	,, x MR-813	-3.09*	-10.21**	-27.03**	-25.95**
6	,, x ICSR-93002	-0.71	-0.54	-13.12**	25.65**
7	,, x NEB-3175	-3.57*	18.48**	-6.49	58.42**
8	,, x NEB-3245	-3.81*	-14.01**	-23.05**	-8.49
9	,, x Kuymne	-1.43	-3.86	-12.23*	-22.50**
10	,, x ICSR-138	4.04**	18.21**	6.01	26.77**
11	ICSA-40x Dorado-V-9	-2.04	40.70**	-0.79	58.18**
12	,, x 22808	-4.08**	-4.68	-7.39	32.30**
13	,, x ICSR-89037	-2.49	9.71**	21.67**	46.02**
14	,, x 22808-13	-1.63	-3.51	-0.81	28.97**
15	,, x MR-813	-0.95	3.89	-0.65	19.59**
16	,, x ICSR-93002	-4.15**	1.97	-21.81**	-19.28**
17	,, x NEB-3175	-2.83	2.93	-14.83**	61.57**
18	,, x NEB-3245	2.99	5.85	-21.79**	4.73
19	,, x Kuymne	-0.01	17.91**	2.61	15.27**
20	,, x ICSR-138	-4.31**	20.41**	10.78**	17.65**
21	ATX-629x Dorado-V-9	-0.72	38.24**	0.44	12.43*
22	,, x 22808	0.72	5.67	-13.21*	15.00
23	,, x ICSR-89037	0.48	10.26**	-4.02	4.77
24	,, x 22808-13	0.00	33.81**	13.38**	71.28**
25	,, x MR-813	-2.65	-4.47	5.30	-6.06
26	,, x ICSR-93002	5.07**	3.76	-0.40	5.24
27	,, x NEB-3175	-1.93	14.27**	-0.60	33.02**
28	,, x NEB-3245	-0.24	5.23	-5.44	18.98*
29	,, x Kuymne	1.70	50.05**	35.63**	4.02
30	,, x ICSR-138	5.07**	12.51**	6.60	13.63**

3.3. Combining ability

3.3.1. General combining ability General combining ability (gca) effects of the parental lines for the studied traits over two seasons are presented in Table (5).

For days to 50% blooming, the gca effects for the male lines Dorado-V-9 and ICSR-138 were positive and highly significant, indicating that these two lines had desirable gene action for lateness. The gca effects for the male lines MR-813, NEB-3175 and NEB-3245 were negative and significant, indicating that these lines had favorable gene action for earliness, these lines will be considered as good combiners for earliness.

For plant height, the gca effects of the female line ICSA-1 and seven restorer lines were negative and highly significant, indicating that these lines had favorable gene action for shortness. The gca effects of the female lines ICSA-40 & ATX629 and three restorer lines were positive and highly significant for plant height, indicating that these lines had desirable gene action for tallness.

For 1000-grain weight, the gca effects of female line ICSA-1 and four male lines were negative and highly significant, indicating that these lines had favorable gene action for decreasing grain weight. The female line ATX-629 and five male lines had positive and significant g.c.a effects for 1000-grain weight, indicating that these lines had desirable gene action to increase the grain weight and in turn attributed for increasing the total grain yield/plant.

Table (5): Estimates of general combining ability effects for four traits of three female and ten restorer lines combined over two growing seasons, 1998 &1999.

No.	Parents of crosses	Days of 50% blooming	Plant height (cm.)	1000-grain weight (g.)	Grain yield / plant (g.)
Female lines (CMS):					
1	ICSA-1	-0.222	-12.812**	-1.494**	-1.622
2	ICSA-40	0.494	5.356**	-0.262	4.161**
3	ATX-629	-0.272	7.456**	1.756**	-2.539**
Male lines (R):					
1	Dorado-V-9	2.372**	8.878**	4.517**	13.083**
2	22808	-0.517	-41.900**	-5.928**	-19.028**
3	ICSR-89037	0.872	-13.511**	2.406**	10.139**
4	22808-13	-0.906	-25.789**	1.239	-9.306**
5	MR-813	-1.572*	-8.678**	-2.372**	-0.028
6	ICSR-93002	1.039	15.711**	3.350**	13.583**
7	NEB-3175	-1.628**	-29.511**	-3.594**	-6.917**
8	NEB-3245	-1.961**	-40.178**	-6.872**	-18.917**
9	Kuymne	-0.017	24.989**	1.461*	1.306
10	ICSR-138	2.317**	109.989**	5.794**	16.083**

For grain yield/plant the female line ICSA-40 and four male lines had positive and highly significant g.c.a. effects for grain yield/plant, indicating that these lines had desirable gene action and will be considered as a good combiners for increasing grain yield/plant. On the other hand, the female line ATX-629 and other four male lines had negative and significant g.c.a. effects for grain yield. These results are in harmony with those obtained by Sakhare *et al*., (1992) El-Menshawy (1996), Mahmoud (1997) and Amir (1999). They reported that general combining ability effect differed in magnitude among male and female parents for days to 50% blooming, plant height 1000-grain weight and grain yield/plant.

3.3.2. Specific combining ability Data in Table 6 showed that specific combining ability effects for 50% blooming ranged from –3.172 (ATX-629 x Dorado-V-9) to 3.611 (ICSA-1x Dorado-V-9).These results indicated that the female line ATX-629 had favorable gene action for earliness and the female line ICSA-1 had favorable gene action for lateness. One cross out of thirty had negative and highly significant sca effect, indicating that this cross was earlier than its parents while two crosses had positive and significant sca effects, indicating that these crosses were later than, their parents.

For plant height, specific combining ability effects (sca) ranged from –28.522 (ICSA-1 x Kuymne) to 39.544 (ATX-629 x Kuymne). These results indicated that the female line ICSA-1 had favorable gene action for shortness, although the female line ATX-629 had favorable gene action for tallness. Three crosses had negative and significant sca effects, while five crosses had positive and significant sca effects for plant height.

For 1000-grain weight, the sca ranged from –3.561 (ICSA-1 x Kuymne) to 4.856 (ATX-629 x Kuymne).These results indicated that the female line ATX-629 had favorable gene action for increasing the weight of the grains. Two crosses had positive and significant sca effects and four crosses had negative and significant sca effects for 1000-grain weight.

For grain yield / plant, the sca ranged from –19.883 (ICSA-40 x ICSR-93002) to 16.400 (ICSA-1 x ICSR-93002), these results indicated that female line ICSA-1 had favorable gene action for increasing the grain yield/plant. Five crosses had positive and significant sca effects for grain yield / plant. In general , the restorer line ICSR-93002 was a good combiner with the female line ICSA-1, also the restorer line ICSR-89037 was a good combiner with the female line ICSA-40 for grain yield/plant, these two crosses were higher than the check, Shandaweel-2 and theshould be tested on a large scale to identify the best one to produce it commercially. These results are in harmony with those obtained by El-Menshawy (1996), Mahmoud (1997) and Amir (1999) reported that Specific combining ability (s.c.a.) effects were detected for grain yield and other studied traits in some crosses.

Table (6): Estimates of the specific combining ability effects for four traits of thirty crosses over two growing seasons 1998 & 1999.

No.	Pedigree	Days of 50% blooming	Plant height (cm.)	1000-grain weight (g.)	Grain yield / plant (g.)
1	ICSA-1 x Dorado-V-9	3.611**	-7.244	1.550	7.400*
2	,, x 22808	-1.667	7.533	0.161	-4.822
3	,, x ICSR-89037	0.111	-2.356	0.328	-7.489*
4	,, x 22808-13	-1.611	2.589	2.161	-1.044
5	,, x MR-813	-0.111	1.478	-3.228**	-11.322**
6	,, x ICSR-93002	-0.889	8.589	1.050	16.400**
7	,, x NEB-3175	-0.222	10.644	0.661	3.900
8	,, x NEB-3245	-0.056	-8.356	-0.061	1.400
9	,, x Kuymne	-0.333	-28.522**	-3.561**	-10.822**
10	,, x ICSR-138	1.167	15.644**	0.939	6.400*
11	ICSA-40x Dorado-V-9	-0.439	12.422*	-0.017	4.450
12	,, x 22808	0.950	-1.467	2.761*	2.061
13	,, x ICSR-89037	0.728	1.811	1.094	12.061**
14	,, x 22808-13	1.006	-15.911**	-1.739	-8.828**
15	,, x MR-813	0.672	7.478	1.872	9.894**
16	,, x ICSR-93002	-1.272	-4.911	-2.850*	-19.883**
17	,, x NEB-3175	0.228	-3.022	-1.239	-0.383
18	,, x NEB-3245	0.728	11.811*	0.206	0.783
19	,, x Kuymne	-0.550	-11.022	-1.294	5.228
20	,, x ICSR-138	-2.050	2.811	1.206	-5.383
21	ATX-629x Dorado-V-9	-3.172**	-5.178	-1.533	-11.850**
22	,, x 22808	0.717	-6.067	-2.922*	2.761
23	,, x ICSR-89037	-0.839	0.544	-1.422	-4.572
24	,, x 22808-13	0.606	13.322*	-0.422	9.872**
25	,, x MR-813	-0.562	-8.956	1.356	1.428
26	,, x ICSR-93002	2.161*	-3.678	1.800	3.483
27	,, x NEB-3175	-0.006	-7.623	0.578	-3.517
28	,, x NEB-3245	-0.672	-3.465	-0.144	-2.183
29	,, x Kuymne	0.883	39.544**	4.856**	5.594
30	,, x ICSR-138	0.883	-18.456**	-2.144	-1.017

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دراسة القدرة على الائتلاف وقوة الهجين في محصول الذرة الرفيعة للحبوب

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الملخص

تركزت هذه الدراسة في إنتاج ثلاثين هجينا من الذرة الرفيعة وذلك في موسم 1997بمزرعة محطة البحوث الزراعية بشندويل-سوهاج- وذلك من خلال التهجين بين ثلاثة سلالات عقيمة عقما ذكريا سيتوبلازميا وعشرة سلالات معيدة للخصوبة. وفى موسمي 1998 و 1999تم تقييم الثلاثين هجينا وآبائهم بالإضافة إلى هجين شندويل-2 كمقارنة فى تصميم قطاعات كاملة العشوائية وذلك في مزرعة محطة البحوث الزراعية بشندويل. وقد تم تحليل النتائج للحصول على القياسات الوراثية بإستخدام نظام تحليل السلالة X الكشاف .وقد أوضحت النتائج أن هذه الهجن كانت متباينة وعالية المعنوية فى جميع الصفات تحت الدراسة وذلك في عامي الدراسة 1998و 1999 وأيضا في التحليل المشترك للموسمين . كما وجد أن السلالة العقيمة ATX-629 أعطت أفضل هجين من حيث التبكير في التزهير .في حين أن السلالة العقيمة ICSA-1 أعطت هجينا متأخرا في التزهير وذلك عندما تم تهجينهما مع السلالة المعيدة للخصوبة Dorado-V-9 . كما أظهرت النتائج وجود قوة هجين لمحصول حبوب النبات وصلت إلى 71.28 فىالهجين (ATX-629 x22808-13).كما وجد أن السلالة العقيمة ICSA-40 والسلالات المعيدة للخصوبة ICSR-138, ICSR-93002, Dorado-V-9, ICSR89037 لها قدره عامة معنوية وموجبة بالنسبة لصفة المحصول .وهناك خمسة هجن من الثلاثين هجينا كانت لها قدرة خاصة معنوية وموجبة بالنسبة لصفة المحصول .كما أظهرت النتائج تفوق هجينين من الثلاثين هجينا على هجين المقارنة (هجين شندويل-2) والهجينين هما (ICSA-1 x ICSR-93002) و (ICSA-40 x ICSR-89037) هذا ويمكن اختبار هذين الهجينين على نطاق واسع لتحديد الأفضل منهما وانتاجه على نطاق تجاري.

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