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PERFORMANCE OF F_1 GRAIN SORGHUM HYBRIDS (*Sorghum bicolor* L. MOENCH) AND ESTIMATE COMBINING ABILITY

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ABSTRACT

Twenty-four grain sorghum hybrids, obtained by crossing each of three male sterile lines to eight restorer lines, were evaluated in a randomized complete block design at two locations, Shadwell Agric. Res. Farm - Sohag and Assiut Univ. Agric. Res. Farm, in 2001 season. Measurements for grain yield/ plant, days to 50% flowering, Plant height and 1000-grain weight were recorded. The genetic parameters were estimated by using line x tester analysis. The combined data over the two locations revealed that six crosses out-yielded significant by the check hybrid (Shandaweel-6). Heterosis for grain yield / plant was high for these six crosses and it was 59.35, 57.72, 50.41, 50.10, 48.54 and 41.13 % over the best parent for the crosses (ICSA-10288 x MR-812), (ICSA-10288 x ICSR-94005), (ICSA-10288 x ICSR-93001), (ICSA-10288 x ICSR-93021), (ICSA-10288 x ICSR-92003) and (ICSA-37 x ICSR-92003),respectively. The female lines ICSA-10288; ICSA-37 and the restorer lines MR-812, ICSR-94005 ICSR-93001, ICSR-93021 and ICSR-92003 were good combiners for grain yield. For specific combining ability (sca), the cross (ICSA-10288 x MR-812) had highly significant sca effect. The six hybrids that out-yielded than the check hybrid needs to be tested on large scale before releasing as commercial hybrids

INTRODUCTION

Grain sorghum is very important crop due to its adaptation to harsh environments. In Egypt, grain sorghum is considered the fourth crop in the rank of the cereal crops. Hybrids must express satisfactory grain yield heterosis, and be superior to current varieties. To keep down the coast of hybrid seed production, attention must be given to the yielding ability and seed quality of the female seed parents and the restorers. Heterosis generally increases with genetic diversity between parents. Swarnlata and Rana (1988) found that heritability was 32% for grain yield, 50% biological yield and 61% for HI. Estimates of σ^2_{gca} of new ms lines were higher than testers for grain yield and HI. New CMS lines will, therefore, be useful to exploit additive genetic variance for developing future hybrids.Wenzel (1988) recorded high heritability for plant height. Panicle length, days to 50% flowering and yield potential the agronomic characters all showed dominant genetic variation. The parental inbred lines SA551 was identified as best combining drought resistance with high grain yield. Jagadeshwar and Shinde (1992) concluded that the mean squares due to general and specific combining ability were highly significant in individual environments as well pooled over environments for all traits. The estimates of interaction components gca x environment and sca x environment were significant for all the traits except days to flowering. However, the interaction components due

to gca x environment variances showed higher values as compared to the sca x environment variances. Radwan *et al.* (1997) found that most hybrids were earlier, taller with heavier grain weight than their better parents. Also, they added that heterosis for panicle weight and grain yield was observed for few of the studied crosses. The highest estimates of favorable heterosis were 16.0%, 69.6%, 25.5%, 24.2% and 26.0% for earliness, plant height, panicle weight, 1000-grain weight and grain yield, respectively. Badhe and Patil (1997) revealed that the additive gene action was observed for plant height, and non-additive gene action was predominant for grain yield and other attributes. Specific combining ability variance was largely present for grain yield, which could be exploited for production of new sorghum hybrids based on male sterility–fertility restoring system. The female MS 2077A and male SPV 386 were the best combiners for almost all the traits studied, except plant height and 1000 grain weight.Changang *et al.* (1998) concluded that combining ability variance was significant for plant height, panicle length, days to 50% flowering, panicle weight, grain weight per panicle, number of grains per panicle and 1000-grain weight, and additive effects where prominent in their inheritance. General combining ability (GCA) effects were significantly higher in A2F4A than in the other four male sterile lines for eight studied traits. Among the 9 R lines, R-8643 had the highest general combining ability for plant height, panicle weight, grain weight per panicle and days to 50% flowering.El-Bakry (1998) revealed that crosses were superior to their best parents for all traits, panicle length, panicle width, 1000 grain weight, no. of grains per panicle, grain yield per plant, plant height, leaf area index, days to 50% heading and number of green leaves plant at harvesting time. Haussmann *et al.* (1998) concluded that mean hybrid superiority over the mid parent was 54% for grain yield and 35% for biomass. The highest values were found for number of seeds per head and 1000 grain weight. The average relative hybrid superiority over the best parent for grain yield was 32% and 59% under non-stress and stress conditions, respectively. Salunke and Deore (1998) showed that the hybrids 36642A x SPV 489, 36641A x RS67 and 42A x RS67 exhibited higher heterosis for physiological traits, which was reflected in heterosis for grain yield. Haussmann *et al.* (1999) reported that the mean relative hybrid superiority over the mid parental values was highest for grain yield followed by plant height. Hybrid vigour was expressed in earlier anthesis. Heterosis for the number of kernels per head and 1000 grain weight contributed most of the heterosis for grain yield.Shakoor and Qureshi (1999) stated that the additive genetic effects were important for yield per plant, head length, seeds per head, 1000 grain weight, threshing percentage, maturity index, leaves per plant, leaf area, and green leaves area/plant at 50 days after flowering. Also, dominance effects were important for yield/plant, 1000 grain weight, maturity index and green leaves area per plant at 50 days after flowering in cross protocol 1 (ICSV 107 x Pothwer 3-9) and yield per plant, maturity index, leaves per plant and green leaves area at 50 days after flowering in cross protocol 2 (ICSV 219 x Pothwer 3-9). Epistasis was not important for the desired traits in two populations. Hovny *et al.* (2001) concluded that heterosis values ranged from -5.24 to 7.61% for days to 50% blooming, -14.01 to 50.05% for plant height, -

27.03 to 35.63% for 1000 grain weight and from -25.03 to 35.63% for grain yield per plant. Some hybrids had negative and significant heterosis for 1000 grain weight and days to 50% blooming. Mostafa and El-Menshawi (2001) found that significant general (GCA) and specific (SCA) combining ability and reciprocal effects for all the studied traits. The significance of the reciprocal may indicate the presence of maternal inheritance.The estimates of general and specific combining ability variances indicated that the additive gene effect was more important than non-additive effect in the inheritance of all studied traits. Abo-Zaid (2001) reported that mean squares due to males and females in their crosses were highly significant for all studied traits, under all irrigation treatments indicating that estimates of GCA effects were significant for both parental males and females. Contribution of the variation due to females to the total variation was much greater than that due to males for all traits under all irrigation treatments. Moreover, variation due to male x female interaction was also highly significant for all studied traits, under all soil moisture conditions. He added that GCA effects for both males and females and SCA effects interacted significantly with locations at 0.01 levels for most traits under all soil moisture regimes.

MATERIALS AND METHODS

Twenty four F_1,s grain sorghum hybrids were developed from three cytoplasmic male sterile lines (CMS A-lines) and eight restorer lines, (R-lines) at Shandwell Agric. Res. St. Farm, Sohag, Egypt, in 2000 season. The origin and the agronomic characteristics of both the three CMS and the eight R-lins are presented in Table 1. The twenty-four F_1, s grain sorghum hybrids, their parents and one check (Shandweel-6) were evaluated as one experiment at two locations (Shandwell Agric. Res. St. Farm, Sohag, Egypt and Assiut Agric. Res. Farm, Assiut University) in 2001 season. The experiment was sown at Sohag and Assiut locations in June 20 and June 24, respectively. A randomized complete block design with three replications and one row/plot was used. Rows were 4 meters long and 60 cm. in width Apart with 15 cm. between hills. Three weeks after sowing, plants were thinned to two plants/hill before hoeing. All other cultural practices were performed as recommended for sorghum production and recommended plant protection measures were applied as necessary. The soil was loamy at Shandwell and clay at Assiut. Data were recorded as number of days to 50% flowering, plant height (cm), 1000-grain weight, grain yield/plant with adjusted to 14% grain moisture. The obtained data in each location and combined over the two locations were subjected to the analysis of variance of randomized complete blocks design (RCBD) according to Gomez and Gomez (1984). The genetic analysis was copied out using line x tester analysis according to Kemthorne (1957). General combining ability (GCA) effects for the female parents (3 CMS), testers (8 R-lines) and specific combining ability (SCA) effects for hybrids were estimated according to Singh and Chaudhry (1977).
Heterosis was calculated as differences of hybrids from best parent.

Table (1):Origin and agronomic traits of the parental lines and the check at Shadwell in 2000 season.

No.	Genotype	Origin	Days to 50% flowering	Plant height (cm.)	Seed index (g)	Grain Yield/plant (g)
I-Restorer lines :						
1	ICSR-92003	India	73	163	29	66
2	ZSV-14	Zimbabwe	70	160	28	66
3	ICSR-89016	India	73	213	26	71
4	ICSR-273	India	75	226	27	91
5	ICSR-93001	India	74	163	29	65
6	ICSR-93021	India	72	115	26	49
7	MR-812	Zambia	71	163	29	63
8	ICSR-94005	India	66	139	28	61
II-CMS lines :						
1	ICSA-14	India	72	142	27	69
2	ICSA-37	India	71	137	26	73
3	ICSA-10288	India	72	147	27	67
III- Check (Shandaweel-6) :						
1	Sh-6	Egypt	70	173	26	88

RESULTS AND DISCUSSION

1. Variance, performance and heterosis:

The combined analysis of variances over the two locations for all studied traits showed highly significant differences among genotypes, two traits (plant height and seed index) and among locations, (Table 2). The interaction between genotypes and locations was insignificant for all studied traits. In addition, the data indicated that highly significant differences were detected among parents, parents vs. crosses, crosses, their partitions (females, males and females x males), except for plant height, however, the females had significant differences. Moreover, the interactions between each of the parents, crosses, their partitions & parents vs. crosses and locations had insignificant differences for all studied traits except for parents vs. crosses x locations. The differences for grain yield were highly significant and significant only for plant height.

Table 3 presents data of the performance of parents and hybrids.

For days to 50% flowering, the combined data over the two locations showed that 50% flowering for the female parents were 71.17 (ICSA-37), 71.50 (ICSA-10288) and 72.17 days (ICSA-14).While, for the male parents the days to 50% flowering ranged from 65.84 (ICSR-94005) to 75.33 days (ICSR-273), the crosses ranged from 64.17 (ICSA-14 x ZSV-14) to 73.00 days (ICSA-10288 x ICSR-273). Also, 9 crosses from 24 crosses were significantly earlier than the check (Sh-6) 8 of them were highly significant (Table 3).The heterosis of the days to 50% flowering (Table 4) showed that 10 crosses out of 24 had significantly negative heterosis means which these crosses were earlier than the early parent while, 5 crosses had significantly positive heterosis means which these crosses were late.

Table (2): Combined data of analysis of variance of crosses and their parents for four studied traits over two locations in 2001 season.

Source of Variance	d.f.	Mean squares			
		Days to 50% blooming	Plant height (cm)	Seed index (g)	Grain Yield/plant (g)
Location (L)	1	27.45	6879.45**	293.55**	258.67
Rep/ Loc.	4	18.23	44.13	0.74	161.09
Genotypes (G)	34	55.30**	11761.46**	17.52**	1437.17**
Parents (P)	10	38.52**	6364.75**	7.16**	621.36**
P vs. Crosses	1	351.190**	129387.08**	135.10**	14445.92**
Crosses (C)	23	51.29**	8993.71**	16.91**	1226.28**
Female (F)	2	197.03**	450.61*	44.27**	8376.74**
Male (M)	7	22.13**	27655**	20.44**	1107.63**
F x M	14	45.06**	883.50**	11.24**	264.10**
G x L	34	1.11	33.57	1.60	30.86
P x L	10	1.31	31.39	0.65	11.56
P vs. C x L	1	0.04	339.39*	1.72	609.91**
C x L	23	1.07	21.23	2.01	35.15
F x L	2	0.20	45.67	0.32	79.18
M x L	7	1.82	12.14	2.19	35.32
F x M x L	14	0.82	22.28	2.16	28.77
Error	136	3.12	74.75	1.80	49.71

*, ** significant at 0.5 and 0.01 probability levels, respectively

For plant height, the combined data over the two locations Table 3, showed that the plant height for the female parents were 136.67 (ICSA-37), 141.67(ICSA-14) and 146.67 (ICSA-10288) cm.While for the male parents the plant height ranged from 139.17 (ICSR-94005) to 225.50 cm. (ICSR-273), the crosses ranged from 156.50 (ICSA-10288 x ICSR-94005) to 307.50 cm. (ICSA-37 x ICSR-273). Data indicated that 20 crosses from 24 crosses were significantly taller than the check (Sh-6) 18 of them were highly significant. The heterosis of the plant height Table 4 showed that 22 crosses out of 24 had significantly positive heterosis.

For seed index, the combined data over the two locations (Table 3) showed that the seed index for the female parents were 25.73 (ICSA-37), 26.99 (ICSA-10288) and 27.28 g (ICSA-14). For the male parents the seed index ranged from 26.27 (ICSR-93021) to 28.90g (MR-812), the crosses ranged from 25.28 (ICSA-14 x ICSR-94005) to 31.27g (ICSA-10288 x ICSR-94005). In addition, from Table 3 it is found that 19 crosses out of 24 had significantly heavy seed index than the check (Sh-6), 18 of them were highly significant. The heterosis of the seed index (Table 4) showed that three crosses out of 24 had significantly positive heterosis for heavy seed index.

For grain yield/plant, the combined data over the two locations (Table 3) showed that grain yield/plant for the female parents were 66.93 (ICSA-10288), 69.16 (ICSA-14) and 72.98 g (ICSA-37). For the male parents the grain yield/plant ranged from 49.49 (ICSR-93021) to 91.36g. (ICSR-273), the crosses ranged from 61.92 (ICSA-14 x ICSR-89016) to 106.66g.,(ICSA-10288 x MR-812). Also, from Table 3 it is observed that 6 crosses out of 24

had significantly higher grain yield/plant than the check (Sh-6), 5 of them were highly significant.

Table (3): Performance of the twenty four crosses, their parents and the check for four traits. Combined data over the two locations in 2001 season.

No.	Genotypes crosses	Days to 50% blooming	Plant Height (cm)	Seed index (g)	Grain Yield/plant (g)
1	ICSA 14 x ICSR 92003	71.67	229.50	30.82	77.12
2	ICSA 14 x ZSV 14	64.17	210.00	28.27	69.43
3	ICSA 14 x ICSR 89016	71.17	235.00	29.20	61.92
4	ICSA 14 x ICSR 273	65.50	293.34	29.93	65.78
5	ICSA 14 x ICSR 93001	67.50	215.00	26.47	70.59
6	ICSA 14 x ICSR 93021	64.67	179.17	27.44	84.20
7	ICSA 14 x MR 812	66.50	210.00	26.49	63.98
8	ICSA 14 x ICSR 94005	70.00	161.67	25.28	76.84
9	ICSA 37 x ICSR 92003	71.84	210.34	30.85	96.40
10	ICSA 37 x ZSV 14	71.34	192.00	29.87	76.84
11	ICSA 37 x ICSR 89016	71.84	205.83	30.60	74.55
12	ICSA 37 x ICSR 273	71.00	307.50	30.80	90.43
13	ICSA 37 x ICSR 93001	71.17	201.67	28.95	92.45
14	ICSA 37 x ICSR 93021	72.17	172.50	26.95	90.01
15	ICSA 37 x MR 812	71.17	206.67	29.07	91.52
16	ICSA 37 x ICSR 94005	70.83	190.83	29.65	94.08
17	ICSA 10288 x ICSR 92003	65.67	209.17	30.43	99.42
18	ICSA 10288 x ZSV 14	71.17	214.17	29.33	88.00
19	ICSA 10288 x ICSR 89016	69.50	228.00	28.82	82.34
20	ICSA 10288 x ICSR 273	73.00	299.17	30.29	80.59
21	ICSA 10288 x ICSR 93001	65.83	199.17	29.07	100.68
22	ICSA 10288 x ICSR 93021	65.34	188.67	29.53	100.47
23	ICSA 10288 x MR 812	70.00	218.83	29.67	106.66
24	ICSA 10288 x ICSR 94005	65.50	156.50	31.27	105.57
CMS		Days to 50% blooming	Plant Height (cm)	Seed index (g)	Grain Yield/plant (g)
1	ICSB- 14	72.17	141.67	27.28	69.16
2	ICSB-37	71.17	136.67	25.73	72.98
3	ICSB- 10288	71.50	146.67	26.99	66.93
Restorers		Days to 50% blooming	Plant Height (cm)	Seed index (g)	Grain Yield/plant (g)
1	ICSR 92003	73.34	162.67	28.67	66.10
2	ZSV 14	69.84	160.00	27.53	66.36
3	ICSR 89016	72.50	212.50	26.49	70.83
4	ICSR 273	75.33	225.50	27.37	91.36
5	ICSR 93001	74.34	162.50	28.72	64.78
6	ICSR 93021	71.84	115.33	26.27	49.49
7	MR 812	71.34	163.33	28.90	63.14
8	ICSR 94005	65.84	139.17	27.80	60.54
1	Check (Sh-6)	69.83	173.33	26.33	87.50
LSD0.05		2.00	9.78	1.52	7.98
LSD0.01		2.62	12.83	1.99	10.46

*,** significant at 0.5 and 0.01 probability levels, respectively.

The heterosis of the grain yield/plant (Table 4) showed that 14 crosses out of 24 had significantly positive heterosis for higher grain yield/plant than the best parent. These results are in harmony with those

obtained by Swarnlata and Rana (1988), Wenzel (1988), Jagadeshwar and Shinde (1992 Radwan *et al.* (1997), Badhe and Patil (1997), El-Bakry (1998), Haussmann *et al.* (1998), Salunke and Deore (1998), Haussmann *et al.* (1999), Shakoor and Qureshi (1999), Hovny *et al.*(2001), Mustafa and El-Menshawi (2001), and Abo-Zaid (2001). They cocluded that most of the crosses were earlier, taller, had heavier seed index and higher grain yield/plant compared with the check also, most of their studied crosses had positive and significantly heterosis for many of the studied traits compared with best parents.

II- Combing ability:

1-General combining ability (gca):

Among the data of general combining ability (gca) (Table 5) revealed that for days to 50% flowering the gca effect was positive and highly significant for the female line ICSA-37 and the male lines,ICSR-92003,ICSR-89016 ; ICSR-273.However, it was negative and highly significant for the female lines,ICSA-14; ICSA-10288 and the male lines, ICSR-93001; ICSR93021. Negative gca effect indicates that the lines have genes for earliness and vice versa .[So it can be expected to obtained early blooming hybrids by combining the male and female lines which have negative gca effects].

Table (4): Useful heterosis as a percentage difference of the best parents for four traits of twenty four crosses. Average data over two locations in 2001 season.

No.	Pedigree	Days to 50% blooming	Plant height (cm)	Seed index (g)	Grain Yield/plant (g)
1	ICSA 14 x ICSR 92003	-0.69	41.08**	7.50	1.67
2	ICSA 14 x ZSV 14	-8.12**	31.25**	4.49	-7.03
3	ICSA 14 x ICSR 89016	-1.38	10.59**	7.02	-12.58**
4	ICSA 14 x ICSR 273	-9.24**	30.08**	9.37	-28.00**
5	ICSA 14 x ICSR 93001	-6.46**	32.31**	-7.84	1.85
6	ICSA 14 x ICSR 93021	-9.97**	26.47**	0.55	21.51**
7	ICSA 14 x MR 812	-6.77**	28.57**	-8.36	-7.67
8	ICSA 14 x ICSR 94005	6.33**	14.12**	-9.05	15.69**
9	A 37 x ICSR 92003	0.93	29.30**	7.62	41.13**
10	A 37 x ZSV 14	2.15*	20.00**	8.48	5.29
11	A 37 x ICSR 89016	0.93	-3.14	15.54**	2.15
12	A 37 x ICSR 273	-0.24	36.36**	12.55*	-1.01
13	A 37 x ICSR 93001	-0.01	24.11**	0.82	26.68**
14	A 37 x ICSR 93021	1.40	26.10**	2.63	23.33**
15	A 37 x MR 812	0.00	26.53**	0.57	25.41**
16	A 37 x ICSR 94005	7.60**	37.12**	6.67	28.92**
17	A 10288 x ICSR 92003	-8.16**	28.58**	6.16	48.54**
18	A 10288 x ZSV 14	1.90*	33.85**	6.54	31.47**
19	A 10288 x ICSR 89016	-2.80**	7.29*	6.78	16.25**
20	A 10288 x ICSR 273	2.10*	32.67**	10.65	-11.79**
21	A 10288 x ICSR 93001	-7.92**	22.57**	1.20	50.41**
22	A 10288 x ICSR 93021	-8.62**	28.63**	9.45	50.10**
23	A 10288 x MR 812	-1.87*	33.98**	2.65	59.358**
24	A 10288 x ICSR 94005	-0.51	6.70	12.48*	57.728**

*,** significant at 0.5 and 0.01 probability levels, respectively.

With respect to plant height, the gca effect was positive and significant for the female line ICSA-14 and the male lines,ICSR-89016 ; ICSR-273.However, it was negative and significant for the female lines,ICSA-37 and the male lines, ZSV-14,ICSR-93001, ICSR93021;ICSR-94005. Negative gca effect indicates that the lines have genes for shortness and vice versa .So, it can be expected to obtain a shorter favorable grain sorghum hybrids by combining the male and female lines which have negative gca effects.

For seed index, the gca effect was positive and significant for the female line ICSA-10288 and the male lines,ICSR-92003; ICSR-273.However, it was negative and significant for the female lines,ICSA-14 and the male lines,ICSR-93001; ICSR93021.[Therefore, obtaining heavy seeds for favorable grain sorghum hybrid needs combining together the male and female lines of positive gca effects].

For grain yield/plant, the gca effect was positive and significant for the female linesICSA-37; ICSA-10288 and the male lines,ICSR-92003, ICSR-93001,ICSR-93021; ICSR-94005,.However, it was negative and significant for the female lines,ICSA-14 and the male lines,ZSV-14,ICSR-89016; ICSR-273.[Therefore, to obtain high grain yield for favorable grain sorghum hybrid needs combining together the male and female lines of positive gca effects].Similar results were obtained by Wenzel (1988), Jagadeshwar and Shinde (1992), Radwan *et al.* (1997), Badhe and Patil (1997), El-Bakry (1998), Haussmann *et al.* (1998), Salunke and Deore (1998), Haussmann *et al.* (1999), Shakoor and Qureshi (1999), Hovny *et al.*(2001), Mustafa and El-Menshawi (2001), and Abo-Zaid (2001). They reported that the general combining ability effects differed in magnitude among female and male lines for different studied traits.

Table (5): Estimates of general combining ability effects for four traits of three CMS-lines and eight restorer lines over two locations in 2001 season.

No.	Parents	Days to 50% blooming	Plant height (cm)	Seed index (g)	Grain Yield/plant (g)
	Female lines				
1	ICSA- 14	-1.457**	2.771*	-1.099**	-14.732**
2	ICSA- 37	2.312**	-3.041*	0.446	4.190**
3	ICSA -10288	-0.855**	0.270	0.652*	10.543**
	Male lines				
1	ICSR 92003	0.618**	2.395	1.555**	6.037**
2	ZSV 14	-0.217	-8.549**	0.176	-8.500**
3	ICSR 89016	1.730**	9.006**	0.390	-11.988**
4	ICSR 273	0.728**	86.061**	1.193**	-5.987**
5	ICSR 93001	-0.939**	-8.659**	-0.985*	2.983**
6	ICSR 93021	-1.715**	33.884**	-1.174**	6.636**
7	MR 812	0.120	-2.102	-0.744	2.465*
8	ICSR 94005	-0.325	-44.270**	-0.412	8.352**

*,** significant at 0.5 and 0.01 probability levels, respectively.

2-Specific combining ability(sca):

Data of specific combining ability (sca) (Table 6) revealed that for days to 50% flowering, the sca effect was positive and significant in 9 crosses out of 24 crosses. However, 10 crosses out of 24 had negative and significant sca effect. Negative sca effect indicates that the crosses will be earlier and vice versa .

For plant height, the sca effect was positive and significant in 6 crosses out of 24. Also, 6 crosses out of 24 had negative and significant sca effect. Negative sca effect indicates that the crosses will be shorter and vice versa .

For seed index, the sca effect was positive and significant in one cross (ICSA-10288 xICSR-94005) out of 24 crosses. Also, 2 crosses out of 24 had negative and significant sca effect. Positive sca effect indicates that the crosses will have heavier seeds and vice versa .

Table (6): Estimates of specific combining ability effects of the twenty-four crosses for four studied traits over two locations in 2001 season

No.	Pedigree	Days to 50% blooming	Plant Height (cm)	Seed index (g)	Grain Yield/plant (g)
1	ICSA 14 x ICSR 92003	3.40**	10.40**	1.22	-5.77**
2	ICSA 14 x ZSV 14	-3.27**	1.84	0.54	2.74
3	ICSA 14 x ICSR 89016	1.79**	9.28*	076	3.72*
4	ICSA 14 x ICSR 273	-2.88**	-9.44**	0.69	1.58
5	ICSA 14 x ICSR 93001	0.79*	6.95	-0.59	-2.59
6	ICSA 14 x ICSR 93021	-1.26**	-3.66	0.56	7.37**
7	ICSA 14 x MR 812	-1.26**	-4.60	-0.82	-8.67**
8	ICSA 14 x ICSR 94005	2.68**	-10.77**	-2.35**	1.63
9	ICSA -37 x ICSR 92003	-0.20	-2.96	-0.29	7.85**
10	ICSA -37 x ZSV 14	0.13	-10.35**	0.10	-3.77*
11	ICSA -37 x ICSR 89016	-1.31**	-14.07**	0.62	-2.58
12	ICSA -37 x ICSR 273	-1.15**	10.54**	0.02	7.31**
13	ICSA -37 x ICSR 93001	0.69*	-0.57	0.35	0.36
14	ICSA -37 x ICSR 93021	2.46**	-4.68	-1.47*	-5.74**
15	ICSA -37 x MR 812	-0.37	-2.13	0.21	-0.05
16	ICSA -37 x ICSR 94005	-0.26	24.21**	0.47	-3.38*
17	ICSA - 10288 x ICSR 92003	-3.20**	-7.44*	-0.92	-2.08
18	ICSA - 10288 x ZSV 14	3.13**	8.51*	-0.64	1.03
19	ICSA - 10288 x ICSR 89016	-0.48	4.79	-1.38	-1.14
20	ICSA - 10288 x ICSR 273	4.02**	-1.10	-0.71	-8.89**
21	ICSA -10288 x ICSR 93001	-1.48**	-6.38	0.25	2.23
22	ICSA - 10288 x ICSR 93021	-1.20**	8.34*	0.91	-1.63
23	ICSA - 10288 x MR 812	1.63**	6.73	0.61	8.73**
24	ICSA - 10288 x ICSR 94005	-2.42**	-13.44**	1.88*	1.75

*, ** significant at 0.5 and 0.01 probability levels, respectively

For grain yield/plant , the sca effect was positive and significant in 5 crosses out of 24 crosses. However, 6 crosses out of 24 had negative and significant sca effect. Positive sca effect indicates that the crosses will have high grain yield/plant and vice versa . These results are in harmony with

those obtained by Jagadeshwar and Shinde (1992), Badhe and Patil (1997), Hovny *et al.* (2001) and, Mustafa and El-Menshawi (2001). They concluded that specific combining ability (sca) effects differed in magnitude among grain sorghum genotypes (male and female lines).

In general, the combined data over the two locations revealed that five crosses had highly significant differences for grain yield and one was significant. Heterosis for grain yield/plant was high for the same six crosses and it was 59.35, 57.72, 50.41, 50.10, 48.54 and 41.13 % over the parent for the crosses(ICSA-10288 x MR-812), (ICSA-10288 x ICSR-94005), (ICSA-10288 x ICSR-93001), (ICSA-10288 x ICSR-93021), (ICSA-10288 x ICSR-92003) and (ICSA-37 x ICSR-92003),respectively. The female lines ICSA-10288, ICSA-37 and the restorer lines MR-812, ICSR-94005 ICSR-93001, ICSR-93021 and ICSR-92003 were good combiners for grain yield. For specific combining ability (sca), the cross (ICSA-10288 x MR-812) had highly significant sca effect. The six grain sorghum hybrids out yielded significantly the commercial hybrid (Sh.6) used as check. These six hybrids could be tested on large scale before releasing as commercial hybrids.

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أداء هجن F1 الذرة الرفيعة للحبوب

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أجريت دراسة عدد ٢٤ هجينا من هجن الذرة الرفيعة نتجت من التهجين بين ٣ سلالات عقيمة عقد ذكري سيتوبلازمي و ٨ سلالات معيدة للخصوبة و تم التقييم للهجن و آبائها في تصميم قطاعات كاملة العشوائية في موقعين بمزرعة محطة بحوث شندويل و مزرعة كلية الزراعة بجامعة سوهاج في موسم ٢٠٠١، و أخذت القياسات لمحصول النباتات وعدد الأيام حتى ٥٠% تزهير و طول النبات و وزن الألف حبة ، أستخدم نظام تحليل السلالة X الكشاف في تقدير القياسات السوراثية ، و تم تحليل البيانات للموقعين كتحليل مشترك و أظهرت النتائج أن هناك عدد ستة من الهجن زادت في محصول النبات زيادة معنوية عن محصول النبات لهجين شندويل – ٦ المستخدم للمقارنة و أن هذه الهجن وصلت نسبة التفوق الهجيني بها عل الاباء الأحسن بالنسبة للمحصول الي ٥٩,٣٥ و ٥٧,٧٢و ٥٠,٤١ و ٥٠,١٠ و ٤٨,٥٤ و ٤١,١٣ % لكل من (ICSA-10288 x MR-812), (ICSA-10288 x ICSR-94005), (ICSA-10288 x ICSR-93001), (ICSA-10288 x ICSR-93021), (ICSA-10288 x ICSR-92003 (ICSA-37 x ICSR-92003) علي الترتيب ، و قد وجد أن السلالتان الأميتان ICSA-10288 و ICSA-37 والسلالات المعيدة للخصوبة:- MR-812, ICSR-94005, ICSR- 93001, ICSR-93021, ICSR-92003

تتمتع بقدرة عامة علي الائتلاف و ذلك بالنسبة لمحصول النبات .أما بالنسبة للقدرة الخاصة على الائتلاف فقد وجد أن الهجين (A10288 x MR-812) يتمتع بقدرة خاصة عالية علي الائتلاف . و يمكن اختبار الهجن المتفوقة على صنف المقارنة علي نطاق واسع لاختبار جدوي انتاجها علي نطاق تجاري.