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EVALUATION OF GRAIN SORGHUM (*Sorghum bicolor* L., (MOENCH) HYBRIDS AND THIR PARENTAL LINES UNDER NORMAL AND SALINE SOIL CONDITIONS

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ABSTRACT

Twenty crosses of grain sorghum, their parents (five CMS and four restorer lines) and one commercial check hybrid (H-305) were evaluated in a randomized complete blocks design for yield and three other traits in 2022 and 2023 seasons at Arab El-Awamer Station, Assiut, Egypt under normal and salt affected soil conditions. The genetic parameters were estimated using line x tester analysis. Combined analysis across two seasons showed, highly significant differences among genotypes for all studied traits under normal and salt-affected soil conditions. The mean squares of females, males and females x males were highly significant for all studied traits under normal and salt-affected soil conditions except 1000-grain weight for males under salt-affected soil, A-line ICSA-88004, ICSA-37 and the restorer line ICSR-93002 had positive and significant general combining ability effect for grain yield under the normal and salt-affected soil across two years the four crosses (ICSA-88004 x ICSR-92003), (ICSA-88004 x ICSR-93002), (ICSA-91003 x ICSR-89022) and (ICSA-37 x ICSR-89010) had positive and significant specific combining ability effects and higher superiority relative to the check (SH-305) for grain yield/plant under normal and salt-affected soil across over two seasons. These crosses will be tested in large scale for grain yield.

Key words***: Sorghum, saline, hybrids, Heterosis, Combining ability.***

INTRODUCTION

Grain sorghum *(Sorghum bicolor* (L.) Moench), ranks fourth among cereal crops in Egypt. Following government efforts to increase the cultivated area in Upper Egypt, reclaiming desert land around Toshky and Darb El-Arbain , with limited amount of water. Grain sorghum is well adapted to semi-arid and arid regions because of its tolerance to a biotic stress such as drought and salinity (Marsalis *et al* 2010), so the grain sorghum has become a very important crop due to its adaptation to harsh environments such as hot weather, low fertility, soil texture, salinity and water stress conditions, which may characterize environments of the reclaimed areas. Increased tolerance of sorghum to salt has been related to its ability to overcome reduced uptake of K+ and Ca_2+ and /or accumulation in the leaves of toxic ions, especially Na+ and Cl^- (Lacerda *et al* 2003). In Egypt, the production of high yielding, with high grain quality sorghum hybrids has become possible with the introduction of several cytoplasmic male sterile and restorer lines. Also, sorghum can produce high levels of grain yield in harsh environments (Reddy and Reddy 2019, Ahmed *et al* 2020 and Saikiran *et al* 2022).

Several investigations have been reported on heterosis, general and specific combining ability and their effects in grain sorghum. Grain yield of some hybrids showed high heterosis over the better parent. Abd El-Halim (2003) found wide variation in heterosis among sorghum crosses, for earliness, plant height, grain weight and grain yield/plant. El-Sagheer and Zarea (2020) reported the important role of non-additive genetic variance in the inheritance of sorghum traits.

Several studies reported that there are high genetic variations in sorghum; their hybrids were earlier, taller plants, higher in number of green leaves, 1000 grain weight and grain yield per plant than the mid and the better parents, which reflecting the genotypes in response to salinity (Krishnamurthy *et al* 2007 and Netondo *et al* 2004). The means of genotypes under normal soil were higher than the means of genotypes under salt- affected soil for all traits, except for days to 50% flowering Tag El-Din *et al* (2021). These genetic variations can be monitored to search for the most salt tolerant genotypes. This monitoring analysis should be done at the most critical and sensitive stage of plant growth. Nimir *et al* (2014), Nimir *et al* (2015) and Ali *et al* (2020) reported reduction in seedling emergence by increasing salinity levels in sorghum, but the responses varied depending on the genotype. Salinity is one of the major factor which causes inhibitory effects on plant growth. The reduction in growth under saline conditions is more severe in arid and semi-arid regions due to adverse effects on metabolic and physiological processes (Krishnamurthy *et al* 2007, Rengasamy, 2006 and Bonilla *et al* 2004).

So, the objectives of this investigation were to evaluate the combining ability for grain sorghum lines and identify the superior hybrids compared to check under normal and salt-affected soil conditions.

MATERIALS AND METHODS

Twenty crosses were developed from crossing between five introduced cytoplasmic male sterile lines (ICSA-20, ICSA-88044, ICSA-91003, ICSB-37and ATX-BON 44) and four restorer lines (ICSR-89010, ICSR-89022, ICSR-92003 and ICSR-93002) using line x tester mating design during 2021 summer season at Shandweel Agric. Res. Station. The nine parents, twenty crosses and the check hybrid H-305 were evaluated in two, the first experiment under normal soil and second experiment under salt-affected soil at Arab El-Awamer Agric. Res. Station, Assiut, Egypt during 2022 and 2023 summer seasons.

A randomized complete blocks design with three replications was used for all experiments. The experimental unit was one row, four-meter- length, 0.6 m width and 20 cm between hills. Sowing date in both of the 2022 and 2023 seasons was on 21st and 25th June, respectively. After full emergence, seedlings were thinned to secure two plants /hill. The recommended cultural practices of sorghum production in the two seasons implemented.

Data were recorded on days to 50% flowering, plant height (cm), 1000 grain weight (g) and grain yield per plant (g) adjusted ate 14 % grain moisture. Combined analysis of variance for 30 genotypes across two seasons under each of normal and salt soil were done after testing the homogeneity of errors using Bartlett (1937) method according to Gomez and Gomez (1984). Line tester analysis was performed according to Kempthorne (1957). Superiority was calculated as the percentage of deviation from standard check (SC) according to the following formula by Bhatt (1971).

$$Superiorty = \frac{\overline{F}_1 - \overline{SC}}{\overline{SC}} x100$$

Where, $\overline{F}_1$and $\overline{SC}$are means for the F_1 hybrid and standard check, respectively. Some physical and chemical properties of normal and saline soil are given in Table 1 and 2. Origin of the parental lines and the check are given in Table 3.

Table 1. Physical and chemical properties of normal soil.

Chemical properties									
PH (1:1)	EC ds/m (1:1)	Soluble cations (meg/L)				Soluble anions (meg/L)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{+}HCO_3^{-}$	CL^{-}	Available phosphorus (ppm)	Total nitrogen (%)
8.37	1.33	5.83	3.24	1.36	2.75	6.85	4.21	8.31	0.009

Physical properties									
Particle size distribution (%)			Texture class	Moisture content (Volumetric %)			O.M (%)	$CaCO_3$ (%)	Bulk density
Sand	Silt	Clay		S.P	F.C	W.P.			
89.9	7.1	3.0	Sandy	23.3	10.9	4.5	0.19	30.9	1.63

Table 2. Physical and chemical properties of saline soil.

Chemical properties									
PH (1:1)	EC ds/m (1:1)	Soluble cations (meg/L)				Soluble anions (meg/L)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{+}HCO_3^{-}$	CL^{-}	Available phosphorus (ppm)	Total nitrogen (%)
8.30	7.00	22.52	18.60	12.22	15.88	37.58	28.67	7.26	0.007

Physical properties									
Particle size distribution (%)			Texture class	Moisture content (Volumetric %)			O.M (%)	$CaCO_3$ (%)	Bulk density
Sand	Silt	Clay		S.P	F.C	W.P.			
90.9	7.1	3.0	Sandy	23.1	10.2	4.3	0.18	31.2	1.64

Table 3. Name, origin of the parental lines and check.

Cytoplasmic male sterile lines (CMS lines)		Restorer lines		Check (H-305)	
Name	Origin	Name	Origin	Name	Origin
ICSA-20	India	ICSR89010	India	SH-305	Egypt
ICSA-88044	India	ICSR-89022	India		
ICSA-91003	India	ICSR-92003	India		
ICSA-37	India	ICSR-93002	India		
ATX-BON44	USA	-	-		

RESULTS AND DISCUSSION

Analysis of variance

The combined analysis of variance for 30 genotypes for Studied traits across two years (2022 and 2023) under normal and salt soil (Tables 4 and 5), respectively, Showed highly significant differences among genotypes for all the studied traits, meaning that these genotypes (G) were varied from each other for all studied traits. Meanwhile the differences between two years (Y) was signify cant for days to 50% flowering and plant height under normal salt soil. Also the mean squares due to G x Y interaction were significant for days to 50% flowering under normal and salt soil and 1000 grain weight under normal soil. These results are in agreement with Hussien (2015), Mahmoud *et al* (2013) and Tag El-Din *et al* (2021.

Table 4. Combined analysis of variance for 30 genotypes of grain sorghum for studied traits across 2022 and 2023 seasons under normal soil.

SOV	df	Mean squares			
		Days to 50% flowering	Plant height	1000-grain weight	Grain yield per plant
Years(Y).	1	35.56**	23.47**	0.24	2.20
Rep./Y	4	0.73	2.06	0.15	0.29
Genotypes(G)	29	87.40**	477.96**	19.34**	961.12**
G x Y	29	3.26**	0.37	0.71*	0.22
Error	116	1.05	1.70	0.45	0.67

***, ** Significant 0.05 and 0.01 level of probability, respectively.**

Table 5. Combined analysis of variance for 30 genotypes of grain sorghum for studied traits across 2022 and 2023 seasons under salt-affected oil.

SOV	df	Mean squares			
		Days to 50%	Plant height	1000-grain weight	Grain yield per plant
Years (Y).	1	42.92**	32.94*	0.52	7.90
Rep./Y	4	2.31	23.04	1.21	1.43
Genotypes (G)	29	15.53**	588.61**	19.50**	360.25**
G x Y	29	6.05**	3.04	1.15	0.89
Error	116	1.07	6.52	1.40	2.56

***, ** Significant at 0.05 and 0.01 level of probability, respectively.**

Means performance

The mean performance of 30 genotypes of grain sorghum for studied traits over two years under normal and salt soil are shown in Table 6. For days to 50% flowering, the parents ranged from 89.5days for (ICSR-89010) to 91.83 days for (BTX-BON44) under normal soil and from 89.33 days of (ICSB-88004) to 92.50 days of (ICSR-92003) under salt soil. The parents (ICSB-88004) and (ICSR-89010) had the best values under the two soil conditions. Meanwhile the crosses ranged from 80.50 days (ICSA-91003 x ICSR-92003) to 89.83 days for (ICSA-37 x ICSR-89010) under normal soil and ranged from 91.17 days (ICSA-88004 x ICSR-93002) to 95.33 days for (ATX-BON44 x ICSR-92003) under salt soil. The crosses (ICSA-88004 x ICSR-93002), (ICSA-37 x ICSR-89022) and (ICSA-37 x ICSR-93002) showed earliness under normal and salt soil. Those results are in harmony with these obtained by Amir (2004), Mahmoud *et al* (2013) and Roberta *et al* (2020).

Table 6. Mean performance for 30 genotypes of grain sorghum of studied traits over the two a cross under two environments (normal and salt soil).

		Genotypes	Days to 50% flowering		Plant height (cm)		1000-grain weight (g)		Grain yield per plant (g)	
			Normal	Salinity	Normal	Salinity	Normal	Salinity	Normal	Salinity
1	Hybrids	ICSA-20× ICSR-89010	84.17	92.00	131.83	121.17	27.75	24.27	55.27	43.95
2		ICSA-20× ICSR-89022	86.08	93.33	132.33	115.83	29.27	26.32	57.25	38.58
3		ICSA-20× ICSR-92003	85.17	92.67	127.00	118.00	28.83	26.33	54.23	39.67
4		ICSA-20× ICSR-93002	83.17	93.83	151.17	121.17	29.47	26.55	57.23	41.67
5		ICSA-88004× ICSR-89010	81.83	92.67	133.67	120.50	27.67	27.02	50.27	41.00
6		ICSA-88004× ICSR-89022	84.17	92.83	137.17	124.17	28.43	27.97	51.27	45.18
7		ICSA-88004× ICSR-92003	87.75	91.33	128.33	131.00	30.83	29.33	69.33	59.17
8		ICSA-88004× ICSR-93002	81.83	91.17	135.17	116.67	31.65	29.92	69.42	60.25
9		ICSA-91003× ICSR-89010	84.83	95.00	136.17	128.33	27.72	27.38	53.73	41.93
10		ICSA-91003× ICSR-89022	88.00	91.67	146.33	127.50	30.72	28.40	67.67	57.52
11		ICSA-91003× ICSR-92003	80.50	95.00	139.33	129.17	30.02	27.37	57.83	41.75
12		ICSA-91003× ICSR-93002	86.25	93.83	139.33	125.00	27.77	25.13	59.08	49.00
13		ICSA-37× ICSR-89010	89.83	92.50	138.83	130.50	29.92	29.28	67.07	55.32
14		ICSA-37× ICSR-89022	81.17	91.50	125.17	117.00	29.17	27.70	50.83	45.25
15		ICSA-37× ICSR-92003	82.08	95.00	133.33	113.33	26.43	25.75	59.00	46.83
16		ICSA-37× ICSR-93002	80.83	91.67	135.33	124.17	28.60	26.75	61.42	44.00
17		ATX-BON 44× ICSR-89010	88.67	94.67	141.33	121.17	29.32	28.05	54.80	47.33
18		ATX-BON 44× ICSR-89022	83.67	92.00	129.33	124.67	28.57	25.17	56.48	47.58
19		ATX-BON 44× ICSR-92003	82.83	95.33	136.17	129.83	29.23	28.60	55.50	45.67
20		ATX-BON 44× ICSR-93002	82.17	93.83	143.67	121.00	28.53	26.08	59.33	46.25
		Average	84.25	93.09	136.05	123.01	29.00	27.17	58.35	46.90
21	Line	ICSB-20	91.17	90.17	130.33	103.50	25.63	23.63	38.00	35.00
22		ICSB-88004	89.58	89.33	127.33	101.33	26.31	25.00	36.17	35.75
23		ICSB-91003	90.92	91.97	126.33	114.67	25.17	23.75	34.92	35.00
24		ICSB-37	91.17	90.42	126.67	112.83	26.75	24.50	38.50	37.25
25		BTX-BON 44	91.83	91.50	122.33	116.17	26.75	24.17	39.25	35.58
26	Tester	ICSR-89010	89.50	90.33	116.00	115.17	25.63	24.47	36.33	31.33
27		ICSR-89022	90.75	90.72	125.00	102.00	28.00	24.03	39.00	33.17
28		ICSR-92003	91.58	92.50	123.67	102.67	26.35	24.57	39.17	36.67
29		ICSR-93002	91.17	90.92	127.83	102.33	23.97	25.50	38.67	34.33
		Average	90.85	90.87	125.05	107.85	26.06	24.40	37.78	34.90
30		SH-305 (Check hybrid)	85.00	92.00	158.00	142.00	28.00	26.00	57.50	50.00
LSD 0.05			1.17	1.18	1.49	2.92	0.77	1.35	0.93	1.83

For plant height, the parents ranged from 116 cm for (ICSR-89010) to 130.33 cm for (ICSA-20) under normal soil and from 101.33 cm for (ICSA-88004) to 116.17 cm for (BTX-BON44) under salt soil. Meanwhile the crosses ranged from 125.17 cm (ICSA-37 x ICSR-89022) to 151.17cm (ICSA-20 x ICSR-93002) under normal soil, and from 113.33 cm (ICSA-37 x ICSR-92003) to 131.00 cm (ICSA-88004 x ICSR-92003) under salt soil. These results showed that plant height for parents and crosses under salt soil were lower than under normal soil. Similar results were obtained by Abd El- Mawgoud *et al* (2012), who reported that studied genotypes were shorter under low nitrogen level comparing with plant height of the same studied genotypes under optimum nitrogen level.

For 1000-grain weight, the parents ranged from 23.97 g for (ICSR-93002) to 28 g for (ICSR -89022) under normal soil and from 23.63 g for (ICSA-20) to 25.5 g for (ICSR-93002) under salt soil. Meanwhile the crosses ranged from 26.43 g (ICSA-37 x ICSR-92003) to 31.65 g for (ICSA-88004 x ICSR-93002) under normal soil, and from 24.27 g for (ICSA-20 x ICSR-89010) to 29.92 g for (ICSA-88004 x ICSR-93002) under salt soil. The crosses (ICSA-88004 x ICSR-92003), (ICSA-88004 x ICSR-93002), (ICSA-37 x ICSR-89010) and (BTX-BON44 x ICSR-92003) had desirable values under normal and salt soil. Also the results showed that means of parents and crosses under normal soil were higher than salt soil

For grain yield per plant, the parents ranged from 34.92 g for (ICSA-91003) to 39.25 g for (BTX-BON44) under normal soil, and from 31.33 g for (ICSR-89010) to 37.25 g for (ICSA-37) under salt soil. The parents, (ICSA-37), (BTX-BON44) and (ICSR-92003) had the highest grain yield per plant under both two soil (normal and salt). However the crosses ranged from 50.27 g (ICSA-88004 x ICSR-89010) to 69.42 g for (ICSA-88004 x ICSR-93002) under normal soil, and from 38.58 g for (ICSA-20 x ICSR-89022) to 60.25 g for (ICSA-88004 x ICSR-93002) under salt soil The crosses (ICSA-88004 x ICSR-92003), (ICSA-88004 x ICSR-93002), (ICSA-91003 x ICSR-89022) and (ICSA-37 x ICSR-89010) had the highest grain yield per plant under normal and salt soil. In general, the means of parents and crosses under normal soil were highest than under salt soil. Also, the means of crosses were higher than parents under normal and salt soil. These results are agreement with, Amir (2004), and Mahmoud *et al* and Abd El-Mawgoud *et al* (2012).

Line x Tester analysis

The mean squares of female, male, female x male and their interaction with years for four traits under normal soil are presented in Table 7. The mean squares of female (F), male (M) and their interaction Female x Male (F x M) were highly significant for all studied traits under normal soil, while the interaction between (F x Y), (M x Y) and (F x M x Y) were not significant for all studied traits, except for 1000-grain weight of (F x M x Y) was significant.

Table 7. Mean squares of Female, Male, Female x Male and their interactions with years for four traits under normal soil.

SOV	df	Mean squares			
		Days to 50% flowering	Plant height	1000-grain weight	Grain yield per plant
Female (F)	4	7.80**	210.53**	4.07**	89.04**
Male (M)	3	50.48**	382.28**	3.76**	166.03**
F ×M	12	57.29**	235.12**	12.55**	260.78**
F × Y	4	0.31	0.11	0.66	0.10
M × Y	3	0.29	0.23	0.59	0.09
F × M × Y	12	0.30	0.16	1.14*	0.39
Error	76	0.81	1.53	0.53	0.74
GCA/SCA		0.11	0.28	0.06	0.08

***, ** Significant at 0.05 and 0.01 level of probability, respectively.**

The results under salt soil, in Table (8) showed that the means squares due to (F), (M) and (F x M) interaction were highly significant for all studied traits, except for 1000-grain weight of M. Meanwhile the interactions F x Y, M x Y, and F x M x Y were not significant for all studied traits. The highly significant differences among females, males and females x males at both of types soil in over two seasons for the studied traits, indicating the importance of the additive and non-additive effects for inheritance of the studied traits.

Table 8. Mean squares of female, male, female x male and their interactions with years for four traits under salt soil.

SOV	df	Mean squares			
		Days to 50% flowering	Plant height	1000-grain weight	Grain yield per plant
Female (F)	4	15.95**	242.09**	22.29**	340.90**
Male (M)	3	16.50**	67.03**	1.79	28.51**
F ×M	12	10.64**	167.25**	14.04**	267.70**
F × Y	4	2.72	0.62	0.16	1.14
M × Y	3	2.82	3.52	0.82	1.88
F × M × Y	12	1.18	4.70	0.48	1.15
Error	76	1.53	8.50	0.78	3.33
GCA/SCA		0.31	0.21	0.19	0.15

***, ** Significant at0.05 and 0.01 level of probability, respectively.**

Significant for female, male and their interaction were reported by many researchers, (Tag El-Din *et al* 2021 and El Kady *et al* 2022).

Ratio between GCA /SCA in Table-7 and 8, showed that the non additive gene effects (SCA) were predominant than additive gene effects (GCA) for all studied traits under normal and salt soil. Similar results were reported by Hafez *et al* (2021).

General combining ability (GCA) effects

Estimates of general combining (GCA) effects of nine parents for four traits under normal and salt soil are presented in Table 9. The desirable parents in GCA effects were (ICSB-37), (ICSR-92003) and (ICSR-93002) under the normal soil and (ICSB-88004) under salt soil for earliness, (ICSB-88004), (ICSB-37), (ICSR-89022) and (ICSR-92003) under normal soil, and (ICSB-20), (ICSB-37) and (ICSB-93002) under salt soil for short plant height, (ICSB-88004) under normal and salt soil for 1000-grain weight, (ICSB-88004), (ICSB-91003), (ICSB-37), (ICSR-92003) and (ICSR-93002) under normal soil and (ICSB-88004), (ICSB-37) and (ICSR-93002) under salt soil For grain yield from above results the parents (ICSB-88004) (ICSB-37) and (ICSR-93002) had desirable values of GCA effects for most studed traits under normal and salt soil.

Table 9. General combining ability effects of parents for four traits under normal and salt soil across the two seasons.

Genotypes		Days to 50% flowering		Plant height		1000-grain weight		Grain yield per plant	
		Normal	Salinity	Normal	Salinity	Normal	Salinity	Normal	Salinity
Line	ICSB-20	0.40*	-0.35	-0.47	-3.97**	-0.16	-1.30**	-2.35**	-5.93**
	ICSB-88004	-0.35	-1.06**	-2.47**	0.07	0.65**	1.39**	1.72**	4.51**
	ICSB-91003	0.65**	0.69**	4.24**	4.49**	0.06	-0.10	1.23**	0.66
	ICSB-37	-0.77**	-0.22	-2.88**	-1.76**	-0.47**	0.20	1.23**	0.96*
	BTX-BON44	0.08	0.94**	1.57**	1.16	-0.08	-0.19	-1.82**	-0.19
LSD g_i 0.05		0.37	0.50	0.50	1.19	0.30	0.36	0.35	0.74
0.01		0.49	0.67	0.67	1.57	0.39	0.48	0.46	0.98
LSD $g_i - g_j$ 0.05		0.53	0.72	072	1.70	0.43	0.52	0.50	1.07
0.01		0.70	0.97	0.97	2.28	0.57	0.69	0.67	1.43
Tester	ICSR-89010	1.62**	0.35	0.32	1.32*	-0.52**	0.03	-2.12**	-0.99*
	ICSR-89022	0.37	0.88**	-1.98**	-1.18	0.24	-0.06	-1.65**	-0.07
	ICSR-92003	-0.58**	0.82*	-3.22**	1.26	0.08	0.31	0.83**	-0.28
	ICSR-93002	-1.40**	-0.28	4.88**	-1.41*	0.21	-0.28	2.95**	1.34**
LSD g_i 0.05		0.33	0.46	0.46	1.08	0.27	0.33	0.32	0.67
0.01		0.45	0.61	0.61	1.44	0.35	0.44	0.43	0.90
LSD $g_i - g_j$ 0.05		0.47	0.65	0.65	1.52	0.38	0.46	0.45	0.95
LSD $g_i - g_i$ 0.01		0.63	0.87	0.87	2.04	0.51	0.62	0.60	1.28

*, ** Significant at 0.05 and 0.01 levels of probability, respectively.

Specific combining ability (SCA) effects

Estimates of specific combining ability (SCA) effects of 20 crosses under two types of soil acress two seasons are presented in Table 10. For days to 50% flowering the crosses no. (1, 5, 9, 11, 14, 16, 18, 19 and 20) under normal soil and crosses no. (1, 3, 7 and 10) under salt soil had highly significant and negative specific combining ability effects, these crosses are considered the best combinations for earliness.

Table 10. Specific combining ability effects of 20 crosses for four traits under normal and salt soil across two years.

No	Genotype	Days to 50% flowering		Plant height		1000-grain weight		Grain yield per plant	
		Normal	Saline	Normal	Saline	Normal	Saline	Normal	Saline
1	ICSA-20× ICSR-89010	-2.10**	-1.18*	-4.07**	0.80	-0.56	-1.63**	1.40**	3.97**
2	ICSA-20× ICSR-89022	1.07**	1.05*	-1.27*	-2.03	0.20	0.51	2.90**	-2.31**
3	ICSA-20× ICSR-92003	1.10**	-1.15*	-5.37**	-2.30	-0.07	0.16	-2.59**	-1.02
4	ICSA-20× ICSR-93002	-0.08	1.28*	10.70**	3.53**	0.43	0.97*	-1.71**	-0.64
5	ICSA-88004× ICSR-89010	-3.68**	0.69	-0.23	-3.91**	-1.46**	-1.57**	-7.68**	-9.41**
6	ICSA-88004× ICSR-89022	-0.10	1.76**	5.57**	2.26	-1.45**	-0.53	-7.15**	-6.15**
7	ICSA-88004× ICSR-92003	4.44**	-1.77**	-2.03**	6.66**	1.11**	0.47	8.43**	8.04**
8	ICSA-88004× ICSR-93002	-0.66	-0.67	-3.30**	-5.01**	1.80**	1.64**	6.40**	7.51**
9	ICSA91003× ICSR-89010	-1.68**	0.78	-4.44**	-0.49	-0.82**	0.28	-3.72**	-4.63**
10	ICSA-91003× ICSR-89022	2.74**	-1.49**	8.03**	1.18	1.43**	1.39**	9.74**	10.04**
11	ICSA-91003× ICSR-92003	-3.81**	0.48	2.26**	0.41	0.89**	-0.01	-2.58**	-5.52**
12	ICSA-91003× ICSR-93002	2.75**	0.24	-5.84**	-1.09	-1.50**	-1.66**	-3.44**	0.11
13	ICSA-37× ICSR-89010	4.74**	-0.64	5.35**	7.93**	1.91**	1.88**	9.61**	8.46**
14	ICSA-37× ICSR-89022	-2.68**	-0.41	-6.02**	-3.07*	0.40	0.39	-7.10**	-2.53**
15	ICSA-37× ICSR-92003	-0.81	1.72**	3.38**	-9.18**	-2.17**	-1.93**	-1.41**	-0.74
16	ICSA-37× ICSR-93002	-1.25**	-0.68	-2.72**	4.33**	-0.14	-0.34	-1.11**	-5.19**
17	TX-BON44× ICSR-89010	2.72**	0.36	3.39**	-4.32**	0.93**	1.04**	0.39	1.61*
18	TX-BON44× ICSR-89022	-1.03**	-0.91	-6.31**	1.68	-0.58	-1.75**	1.60**	0.95
19	TX-BON44× ICSR-92003	-0.92*	0.73	1.76**	4.41**	0.25	1.32**	-1.86**	-0.76
20	TX-BON44× ICSR-93002	-0.77*	-0.17	1.16*	-1.76	-0.59	-0.61	-0.14	-1.80*
	LSD S_{ij} 0.05	0.74	1.02	1.02	2.41	0.60	0.73	0.71	1.51
	0.01	1.00	1.37	1.37	3.23	0.81	0.98	0.95	2.02
	LSD S_{ij}-S_{ik} 0.05	1.05	1.44	1.45	3.41	0.85	1.03	1.00	2.13
	0.01	1.41	1.93	1.94	4.56	1.14	1.38	1.34	2.86

***, ** Significant at 0.05 and 0.01 levels of probability, respectively.**

For plant height, data revealed that crosses no.(1, 2, 3, 7, 8, 9, 12, 14, 16 and 18) had highly significant and negative specific combining ability effects under normal soil, while the crosses no.(5, 8, 14, 15 and 17) under salt soil had highly significant and negative specific combining ability effects. These crosses are desirable for short plant height. For 1000-grain weight the crosses no. (7, 8, 10, 11, 13 and 17) under normal soil and crosses no. (4, 8, 10, 13, 17 and 19 under salt soil, had desirable specific combining ability effects. For grain yield / plant the crosses no. 1, 7, 8, 10 and 13 had highly significant and positive specific combining ability effects under two types of soil across two seasons, while the crosses no. 2 and 18 had highly significant and positive specific combining ability effects under normal soil, and the cross no. 17 under salt soil had highly significant and positive specific combining ability. Effects it's concluded that specific combining ability effects differed in magnitude among females and males for days to 50% flowering, plant height, 1000-grain weight and grain yield / plant. These results are in line with those reported by Mahmoud (2007), Amir (2008), Mahmoud *et al* (2013), Tag El-Din (2015) and El-Sagheer (2019).

Superiority relative to check.

Estimates of superiority of 20 F_1 crosses was calculated as the percentage relative to SH-305 under two types of soil acress two seasons are presented in Table(11) For days to 50% flowering, the superiority% for crosses ranged from -5.29% (ICSA-91003 x ICSR-92003) to 5.69% (ICSA-37x ICSR-89010) under normal soil and ranged from -0.91 (ICSA-88004 x ICSR-93002) to 3.62% (ATX-BON44 x ICSR-92003) under salt soil. Ten crosses showed superiority for earliness than check under normal soil, the best crosses from them no.(11, 14 and 16) For plant height the superiority% for crosses ranged from, -20.78 (ICSA-37x ICSR-89022) to -4.32% (ICSA-20 x ICSR-93002) under normal and from -20.19 (ICSA-37 x ICSR-92003) to -7.75% (ICSA-88004 x ICSR-92003) under salt soil. All, F_1 crosses under two types of soil were significantly supers ion to the check SH-305 for short plant height for 1000-grain weight, the superiority% for crosses ranged from -5.60 (ICSA-37 x ICSR-92003) to 13.04% (ICSA-88004 x ICSR-93002) under normal soil, and ranged from -6.67(ICSA-20 x ICSR-89010) to 15.06% (ICSA-88004 x ICSR-93002) under salt soil aeress two seasons.

Table 11. Superiority percentage of 20 crosses relative to the check hybrid for four traits under normal and saline soil across two seasons.

No	Genotype	Days to 50% flowering		Plant height		1000-grain weight		Grain yield per plant	
		Normal	Saline	Normal	Saline	Normal	Saline	Normal	Salinie
1	ICSB-20× ICSR-89010	-0.98	0.00	-16.56**	-14.67**	-0.89	-6.67**	-3.88**	-12.10**
2	ICSB-20× ICSR-89022	1.27*	1.45*	-16.24**	-18.43**	4.52**	1.22	-0.43	-22.83**
3	ICSB-20× ICSR-92003	0.20	0.72	-19.62**	-16.90**	2.98	1.28	-5.68**	-20.67**
4	ICSB-20× ICSR-93002	-2.16**	1.99**	-4.32**	-14.67**	5.24**	2.12	-0.46	-16.67**
5	ICSA-88004× ICSR-89010	-3.73**	0.72	-15.40**	-15.14**	-1.19	3.91*	-12.58**	-18.00**
6	ICSA-88004× ICSR-89022	-0.98	0.91	-13.19**	-12.56**	1.55	7.56**	-10.84**	-9.63**
7	ICSA-88004× ICSR-92003	3.24**	-0.72	-18.78**	-7.75**	10.12**	12.82**	20.58**	18.33**
8	ICSA-88004× ICSR-93002	-3.73**	-0.91	-14.45**	-17.84**	13.04**	15.06**	20.72**	20.50**
9	ICSA-91003× ICSR-89010	-0.20	3.26**	-13.82**	-9.62**	-1.01	5.32**	-6.55**	-16.13**
10	ICSA-91003× ICSR-89022	3.53**	-0.36	-7.38**	-10.21**	9.70**	9.23**	17.68**	15.03**
11	ICSA-91003× ICSR-92003	-5.29**	3.26**	-11.81**	-9.04**	7.20**	5.26**	0.58	-16.50**
12	ICSA-91003× ICSR-93002	1.47*	1.99**	-11.81**	-11.97**	-0.83	-3.33	2.75**	-2.00
13	ICSA-37× ICSR-89010	5.69**	0.54	-12.13**	-8.10**	6.85**	12.63**	16.64**	10.63**
14	ICSA-37× ICSR-89022	-4.51**	-0.54	-20.78**	-17.61**	4.17**	6.54**	-11.59**	-9.50**
15	ICSA-37× ICSR-92003	-3.43**	3.26**	-15.61**	-20.19**	-5.60**	-0.96	2.61**	-6.33**
16	ICSA-37× ICSR-93002	-4.90**	-0.36	-14.35**	-12.56**	2.14	2.88	6.81**	-12.00**
17	TX-BON44× ICSR-89010	4.31**	2.90**	-10.55**	-14.67**	4.70**	7.88**	-4.70**	-5.33*
18	TX-BON44× ICSR-89022	-1.57*	0.00	-18.14**	-12.21**	2.02	-3.21	-1.77*	-4.83*
19	TX-BON44× ICSR-92003	-2.55**	3.62**	-13.82**	-8.57**	4.40**	10.00**	-3.48**	-8.67**
20	TX-BON44× ICSR-93002	-3.33**	1.99**	-9.07**	-14.79**	1.90	0.32	3.19**	-7.50*

***, ** Significant at 0.05 and 0.01 levels of probability, respectively.**

Eight crosses had highly significant and positive for superiority% relative to check SH-305 for1000-grain weight under two types of soil. For grain yield/plant, the superiority of crosses relative to the check SH-305 ranged from -11.59 (ICSA-37 x ICSR-89022) to 20.72% (ICSA-88004 x ICSR-93002) under the normal soil, and ranged from -22.83 (ICSA-20 x ICSR-89022) to 20.50% (ICSA-88004 x ICSR-93002) under salt soil. Four F_1 crosses ,(ICSA-88004 x ICSR-92003, ICSA-88004 x ICSR-93002, ICSA-91003 x ICSR-89022 and ICSA-37 x ICSR-89010) showed significant superiority for grain yield plant over the check SH-305 under normal and salt. soil These crosses will be used in breeding program. These results are in harmony with those seported by Hoveny *et al* (2001), Mahmoud (2002), Abd El-Halim (2003), Tag El-Din (2015) and El-Sagheer (2019).

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تقبيم هجن وسلالات من الذرة الرفعة للحبوب تحت ظروف التربة العادية والملحية

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تم تقييم عدد ٢٠ هجينا من الذرة الرفيعة للحبوب و أبائهم (٥ سلالات عقيمة ذكريا و ٤ سلالات معيدة للخصوبة) ,الهجين التجاري شندويل – ٣٠٥ فى قطاعات كاملة العشوائية وذلك لصفة محصول الحبوب وثلاثة صفات أخري في محطة عرب العوامر بأسيوط خلال موسمي٢٠٢٢ و ٢٠٢٣ م تحت ظروف التربة العادية والتربة الملحية. وقد تم تحليل النتائج للحصول باستخدام تحليل السلالة X الكشاف. أوضحت نتائج التحليل المشترك للموسمين معا تحت التربة العادية التربة الملحية وجود اختلافات عالية المعنوية بين التراكيب الوراثية لكل الصفات المدروسة. كان التباين للسلالات العقيمة ذكريا والسلالات المعيدة للخصوبة وهجن السلالات العقيمة ذكريا × السلالات المعيدة للخصوبة عالي المعنوية لجميع الصفات المدروسة تحت التربة العادية والملحية ما عدا وزن ١٠٠٠ حبة للسلالات المعيدة للخصوبة تحت التربة الملحية، السلالات العقيمة ذكريا ICSB-8٨٠٠٤ وICSA-37 والسلالة المعيدة للخصوبة ICSR-93002 كان لها قدرة عامة على الائتلاف عالية لصفة محصول الحبوب للنبات تحت التربة العادية والملحية كان لها أظهرت اربعة هجن قدرة خاصة على الائتلاف كذلك كان لها تفوقا على الهجين القياسى لصفة محصول حبوب النبات تحت ظروف التربة العادية والملحية خلال الموسمين وهى (ICSA-88004 x ICSR-92003) , (ICSA-88004 x ICSR-93002), (ICSA-91003 x ICSR-89022) و (ICSA-37 x ICSR-89010). سيتم اختبار هذه الهجن على نطاق أوسع للاستفادة منها فى الحصول على هجن عالي المحصول .