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Estimate of Combining Ability In 9x9 Diallel Crosses of Maize at Two Locations

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Abstract

An 9x9 half diallel cross was evaluated at two different locations (Moshtohor (L1) and Sids (L2)) for nine quantitative characters. Locations and hybrids mean squares (Ms) were significant for all studied characters. Significant crosses x location mean squares were detected for all studied characters, except, days to 50% tasseling. General (GCA) and specific (SCA) combing ability Ms were significant for days to 50% tasseling at Sids (L2) experiment and days to 50% silking at Moshtohor (L1), SCA mean square for shelling% at Sids location (L2). High ratios of GCA/ SCA exceeded the unity were found for tassling date at L1 and L2, silking date and plant height at L2, ear height and shelling% at L2 and combined analysis, No. of kerenel/ row at L1 and combined analysis and no of rows / ear at both and across locations, indicating that additive and additive by additive gene action participate a large portion total genetic variability for these traits. Regarding, the other studied cases, the large portion of the total genetic variability for these traits was due to non-additive gene action because, the GCA/SCA values were less than unity. The parental inbred lines No. 1, 2, 6 and 9 gave positive and significant ($\hat{g}_i$) effects for grain yield/ plant and one or more of its components. The parental combination P_1xP_3, P_1xP_4, P_1xP_5, P_2xP_4, P_2xP_7, P_2xP_9, P_3xP_4, P_3xP_5, P_3xP_6, P_4xP_6, P_5xP_6, P_6xP_7, P_6xP_9, P_7xP_8, P_7xP_9 and P_8xP_9 for grain yield/plant exhibited significant positive $\hat{S}_{ij}$ effects. The cross 1x3 out yielded the check hybrid SC10 at both and across environments.

Key words: Maize, heterosis, Combining ability, Locations, Genotype x Env.

Introduction

Maize (*Zea mays* L.) is one of main cereal crops in the world and Egypt. Maize ranked the third cereal crop in the world, after wheat and rice. It is essential for animal fedding and human. Beside, its utilize in industrial purposes such as manufacturing cooking oils and starch. In 2019 maize grown area in Egypt was 1.13 Million hectares (2.7 million feddan) with an annual grain production of 8.72 Million metric tons and an average productivity of 7.71 ton ha^{-1} (23.15 ardab/feddan). (One feddan; fed =4200 m^2 and one ardab; ard = 140 Kg). (National maize program (NMP), Egypt. Expanding maize creation, relies chiefly upon improving high yielding maize to cover the mounting utilization. This relies for the most part upon the produce new F1 of maize across breeding programs. To complete an effective breeding program, the raiser required to have sufficient information about the sort and relative measure of hereditary change parts and their interactions by climate for various traits (El Hosary and El-Akkad 2015, Sidi *et al* 2019, El Hosary *et al* 2018 and El Hosary 2020 a &b).

Diallel cross is a valuable instrument to improve promising F1 and consolidating capacity assists with distinguishing the most fitting hybrids and give adequate hereditary data on the legacy of characteristics. In such manner, estimate of both types of combining ability general (GCA) and specific (SCA) impacts prompting high heterosis were attained by **Shafey *et al* (2003),** Girma *et al* (2015) and Sedhom *et al.* (2021).

The quantitative characters are greatly influenced by the climate change, and the measure of such impact increments with the increment in the quantity of dominating qualities. Consequently, articulation of a particular person which constrained by a few loci were show more noteworthy genotype x environment (GxE). (Singh 1973 and 1979 , Wani *et al* 2017 , El-Hosary *et al*., 2018 and El Hosary 2020 a &b).

Diallel mating design using consolidating capacity examinations are enormously utilized in maize breeding projects to find the joining capacity types. Besides, the size of hereditary parts for a SCA would rely essentially on the ecological flection under which the hybrids materials will be tried. Subsequently, contrasts because of GCA and SCA are related with the sort of combining ability activity implicated.

The fundamental targets of this examination are to: 1) determine hybrid performance for the studied parental combination. 2) To assess the amount of relative superiority over than the che-ck hybrid SC 10 and 3) To establish the magnitude of GCA and SCA effects and their interaction with two locations.

Materials And Methods

Nine white maize parents were utilized in this study as parents in this concern. Maize inbred lines Moshtohor P1 (153), P2 (17), P3 (28), P4 (374-4), P5 (357), P6 (344), P7 (55-b), P8 (101-1) and P9 (391-A) were developed by Prof. Dr. A.A.A. El-Hosary - Benha Univ. In summer 2019 the 9 parents were sown in 13th, 20th and 27th of May to match variation in the time of matching and to gain much crosses seed. All potential mixes in half diallel were scored among the 9 parents by hand technique to producing 36 crosses. In the subsequent season 2020, two trials were directed at the two locations. In each trial the 36 F1 and check hybrid SC 10 were filled in a complete randomize block design with three replications. Each plot comprised of two rows of 70 cm width and 5 m length. Hills were spaced by 25 cm. The dry technique for planting was utilized. All agronomic field operation was adopted as usual in ordinary field maize cultivation. Irregular 10 guarded plants in each row were collected to measure; days to 50% tasseling and silking, plant and ear height (cm), No. of kernels/row, No. of rows/ear, 100-grain weight, grain yield/plant and shelling%.

The collected data were analyzed for ANOVA. Then, General (GCA) and specific (SCA) combining ability were determined following **Griffing's (1956)** method 4 model I for each location. Combined across the two trials was made after test of homogeneity of error variances **(Snedecor and Cochran 1980)**. Heterosis over check cross expressed as the % deviation of the mean performance of F_1 than S.C. 10.

Results and Discussion

The ANOVA table in both and across experiments for all studied traits is given in Table (1). The locations mean squares (MS) for all studied characters were significant or highly significant, with mean values in Moshtohor location (L1) being higher than those in Sids location (L2) for all studied traits (data not showed). It could be concluded that Moshtohor location showed positive effect on the previous traits on maize.

The high performance of traits at L1 may be due to soil and the prevailing favorable temperature leading to great growth and high yield of maize plants. Therefore, the first location seemed to be favorable environment. These finds agreed with those obtained by Nawar *et al* (2002), Amer (2005), El-Hosary et al (2006), El Hosary (2015), El Hosary et al (2018) and Sedhom et al (2021).

The crosses mean squares were significant for all traits at each and across locations, except shelling% at the second location (Sids) (Table 1), revealing that, there were a variation among crossess used in this study. Significant crosses x location mean squares were obtained for all traits except days to 50% tasseling. The mention results showed that, these crosses influenced from Moshtohor location to Sids location.

Table (2) presented the mean performances of F_1 crosses and S.C. 10. It is useful to produce F1 were flowering early to enhance early maturity crosses. Consequences, escape damage by environmental adverse conditions or insects like borers.

The earliness crosses for days to 50% tasseling and silking compared to SC 10 were 1x3, 1x7, 1x8, 2x4, 2x5, 2x7, 2x8, 3x6, 4x5, 4x7, 5x9 and 7x9. From the point of view for the breeder the highest plant gave high biomass is vital for high production on the same time the low ear position is important for resistance to stem lodging. The cross 7x8 was differ significantly relative to SC 10 for high plant and low ear heights. Meanwhile, the crosses 6x9 exhibited differ significantly relative to SC 10 for lowest plant and ear highs.

The four crosses 2x6, 2x8, 3x6 and 4x7 exhibited the highest mean value of No of grains/ row. Regarding, No of rows/ ear the cross 7x9 showed significant difference over SC 10. For 100-grain weight, the cross 1x3 increased significantly over SC 10. The parent combinations 1x2, 1x3, 2x8, 3x6, 3x7, 4x7, 6x8 and 6x9 in Moshtohor location, 1x3, 2x8, 3x6 and 4x6 at Sids location and 1x2, 1x3, 2x8, 3x6, 4x7 and 6x9 in the combined across location showed the highest significant mean value of grain yield/ plant. Also, the mention crosses exhibited significant superiority relative to SC 10.

Relative superiority**:**

Relative superiority over SC 10 estimated as the % deviation of F_1 as mean from S.C. 10 for grain yield/plant is shown in Table (2). Regarding grain yield/plant the parent combinations 1x3, 2x8, 3x6, 3x7, 6x8 and 6x9 at Moshtohor and 1x3 at Sids location and 1x3 and 2x8 at combined analysis out yielded the check hybrid. Meanwhile the cross 1x3 out yielded the check hybrid SC10 at both and across environments. Therefore, these crosses display possibility for enhancing grain yield in maize. Many researchers reported high superiority for yield of maize; i.e. **Singh *et al*., (2004), El-Hosary *et al*., (2006), El-Hosary (2015)** , **EL-Hosary and EL-Fiki (2015), El-Hosary and El-Akkad (2015), Turkey *et al.* (2018), El-Hosary *et al*., (2018)**, **El Hosary (2020 a &b) , Turk et al. (2020) and Sedhom et al. (2021) .**

ANOVA for combining ability

The combining ability analysis of variance at each and across location for all the studied characters is presented in Table (1). The variance of GCA included the additive and additive x additive genetic portion. Meanwhile, SCA represent the non-additive genetic portion of the total variance arising largely from dominance and epistatic deviations. The mean squares due to general and specific combing ability were highly significant for all traits except GCA mean squares for days to 50% tasseling at Sids (L2) experiment , days to 50% silking at Moshtohor

(L1) and SCA mean square for shelling% at Sids location (L2).

If both general and specific combining ability mean squares are significant, one may ask which type and or types of gene action are important in determining the performance of single- cross progeny. To overcome such situation the size of mean squares can be used to assume the relative importance of both types of combining ability. Hence, GCA/SCA ratio was used as measure to reveal the nature of genetic variance involved.

High ratios which largely exceeded the unity were obtained for tasseling date at Moshtohor and Sids location, silking date and plant height at Sids location, ear height and shelling% at Sids and combined analysis, no of kerenel/ row at Moshtohor and combined analysis and no of rows / ear at both and across locations. This result indicated that large part of the total genetic variability associated with these traits was additive and additive by additive gene action. **Mosa (2003), El-Hosary and El-Badawy (2005), Motawei (2005), El-Hosary *et al.* (2006) , Kahtimi *et al* (2006), Abd El-Aal and Abdallah (2006) and** Sedhom et al. (2021)**.**

Remain cases in separate location as well as the combined analyses, gave GCA/SCA ratios below unity. Hence, the large portions of the total genetic variability refer to non-additive gene action. The largest magnitude of hybrid vigor scored by the mention traits as the deviation of each cross than check hybrid S.C. 10 mean performances, revealing that non-additive gene effects is useful in inheritance these characters.

MS of location x GCA and location x SCA were significant for days to 50% tasseling, plant and ear heights, ear weight, No of kernel/ row, grain yield/ plant and shelling%. These, results demonstrated that the magnitude of gene action types influenced from location to other. The ratio for GCA x L/GCA was higher over SCA x L/SCA ratio for plant height, ear weight, no of kernels/ row, 100-grain weight and grain yield/ plant. This result showed that additive gene effects were more changed by change in location than non- additive effects. The genetic variance was previously reported to be mostly due to non-additive for plant and ear heights by **Dubey et al (2001), Amer (2003) and Shafey *et al.* (2003)**; No. of kernels/row by **El-Hosary *et al.* (2006)** and grain yield/plant by **El-Hosary *et al.* (2006) and El- Badawy et al (2010) .** On the other hand, the additive genetic variance was previously reported to be the most prevalent for earliness by **Dubey *et al.* (2001); Turk et al. (2020)**; No. of rows/ear by **Turk et al. (2020)**;100-grain weight by **Chun et al (2005) and Turk et al. (2020).**

For the other traits the ratio of SCA x L/SCA was even significant or higher than GCA x L/GCA. This result showed that non-additive effects were more changed by locations change over additive genetic effects for this character.

This finding confirms those obtained above from the ordinary analysis of variance. These results are in the same line of **Amer (2003), El-Hosary and El-Badawy (2005), El-Hosary *et al.* (2006), Sedhom *et al* (2007) and Yonan (2009).**

General combining ability ($\hat{g}_i$) effects:

Estimations of ($\hat{g}_i$) effects for each parent for individual trait in the combined across location are given in Table (3). ($\hat{g}_i$) estimated herein differ significantly from zero. High positive ($\hat{g}_i$) values is desirable for all traits in question except days to earliness traits and plant & ear heights, where, negative ($\hat{g}_i$) effects would be favorable from the breeder's point of view.

The parent No. 1 showed significant negative ($\hat{g}_i$) effects for; plant height. On the other hand, significant positive ($\hat{g}_i$) effects were obtained for grain yield/ plant.

The parent No. 2 showed significant positive ($\hat{g}_i$) effects for plant height, No of rows/ ear, 100-grain weight and grain yield/ plant. Also, it gave significant negative ($\hat{g}_i$) effects (undesirable) for other cases.

The parent No. 3 showed significant desirable ($\hat{g}_i$) effects for plant height (high and positive), ear height, No of rows/ ear, and shelling%., indicating that this inbred line could be considered as good combiner for developing tallest genotypes, in the same times, resistance to lodging. Also, it gave significant negative ($\hat{g}_i$) effects (undesirable) for other cases.

The parent No. 4 showed significant negative ($\hat{g}_i$) ear height. Meanwile, it gave significant positive ($\hat{g}_i$) effects for plant height, no of rows/ ear. However, it gave undesirable ($\hat{g}_i$) effects for other cases.

The parent No. 6 seemed to be best combiner for plant , No of rows/ ear, No of kernels/ row and Grain yield/ plant. On the contrary, it expressed either undesirable significant or non-appreciable ($\hat{g}_i$) values for the other traits.

The parent No. 7 appeared to be the best combiner for; earliness traits, plant height, no of kernels/ row and grain yield/ plant On the contrary, it expressed either significant desirable or insignificant ($\hat{g}_i$) effects for other traits.

Earliness of inflorescence is required for developing early maturing season to escape corn pest.

The parent No. 8 appeared to be desirable combiner for; days to 50% silking, plant height, ear height, grain yield/ plant and shelling%. On the contrary, it expressed either significant desirable or insignificant ($\hat{g}_i$) effects for other traits. The parental inbred line No. 9 showed significant negative ($\hat{g}_i$) effects only for plant height.

It is worth nothing that the parent which had high ($\hat{g}_i$) effects for grain yield / plant exhibited a similar impact for one or more of the characters adding to grain yield.

In many characters, the values of $\hat{g}_i$ effects mostly varied from location to another. This mentioned results matched with that reached above where GCA by environment MS were obtained to be significant (Table 1).

The mentioned result referred that the parent P7 appeared to be the best $\hat{g}_i$ for earliness traits, high yield/plant and portion of its components in combined analyses across locations.

Specific (SCA) combining ability effect ($\hat{S}_{ij}$):

Estimation of SCA effects in 36 parent combinations for the studied characters across the two locations are showed in table (4). The most desirable inter and intra allelic interactions were presented by P_2xP_4, and P_4xP_5 for days to 50% tasseling date, P_1xP_3, P_1xP_7 , P_2xP_4, P_2xP_5 and P_5xP_9 for days to 50% silking; P_1xP_6, P_1xP_8 , P_2xP_5, P_2xP_9, P_3xP_4, P_4xP_7 and P_6xP_9 for short plant and low ear heights; P_3xP_8 and P_4xP_5 for tall plant and low ear heights; P_1xP_5, P_1xP_9, P_2xP_3, P_2xP_8, P_3xP_5 and P_7xP_8 for no of rows/ ear, P_1xP_9 and P_5xP_7 for No of kernels/ row; P_2xP_6, and P_3xP_5 for 100-grain weight. The parental combination P_1xP_3, P_1xP_4, P_1xP_5, P_2xP_4, P_2xP_7, P_2xP_9, P_3xP_4, P_3xP_5, P_3xP_6, P_4xP_6, P_5xP_6, P_6xP_7, P_6xP_9, P_7xP_8, P_7xP_9 and P_8xP_9 for grain yield/plant; P_4xP_5 and P_8xP_9 for shelling% exhibited significant positive $\hat{S}_{ij}$ effects. These parental combinations may be play an important role in breeding programmers either towards synthetic varieties composed or hybrid maize production of crosses which contaned the excellent combiners for the characters in view.

Table 1. Ordinary and combining ability mean squares analysis for the studied characters in both and across locations.

SOV	df		days to 50% tasseling			days to 50% silking			plant height		
	S.	C	L1	L2	C	L1	L2	C	L1	L2	C
Location (L)		**1**			100.04**			124.52**			42785.19**
Rep/L.	**2**	**4**	2.23	1.15	1.69	0.73	0.84	0.79	6.48	0.93	3.7
Crosses	**35**	**35**	4.00**	2.25*	4.83**	3.70**	5.79**	6.93**	586.96**	839.66**	921.43**
Crosses x L		**35**			1.42			2.56**			505.19**
Error.	**70**	**140**	1.21	1.28	1.25	0.91	1.08	1.00	8.39	9.5	8.94
GCA	**8**	**8**	1.86**	0.31	1.39**	0.44	2.21**	1.71**	179.94**	290.12**	268.85**
SCA	**27**	**27**	1.18**	0.88**	1.68**	1.47**	1.85**	2.49**	200.31**	276.85**	318.49**
GCA x L		**8**			0.79			0.94**			201.21**
SCA x L		**27**			0.38			0.83**			158.67**
Error	**70**	**140**	0.4	0.43	0.42	0.3	0.36	0.33	2.8	3.17	2.98
GCA/SCA			1.58	--	0.83	--	1.2	0.69	0.9	1.05	0.84
GCA x L /GCA					--			0.54			**0.74**
SCA x L/SCA					--			0.33			**0.49**
SOV	**df**		**Ear height**			**No of rows/ ear**			**No of kernels/row**		
	S.	**C**	**L1**	**L2**	**C**	**L1**	**L2**	**C**	**L1**	**L2**	**C**
Location		**1**			20416.6			13.20**			876.69*

(L)					7**						*
Rep/L.	**2**	**4**	62.04	12.04	37.04	0.29	1.04	0.66	0.25	15.86*	8.05
Crosses	**35**	**35**	294.26**	291.08**	286.77**	3.69**	2.54**	4.78**	69.38**	52.46**	96.57**
Crosses x L		**35**			298.57**			1.46**			25.28**
Error.	**70**	**140**	24.89	24.42	24.66	0.92	0.56	0.74	3.62	3.76	3.69
GCA	**8**	**8**	72.53**	127.82**	129.92**	1.74**	1.41**	2.91**	34.92**	15.29**	41.88**
SCA	**27**	**27**	105.66**	87.90**	85.42**	1.08**	0.68**	1.20**	19.63**	18.14**	29.32**
GCA x L		**8**			70.44**			0.24			8.32**
SCA x L		**27**			108.14**			0.56**			8.46**
Error	**70**	**140**	8.3	8.14	8.22	0.31	0.19	0.25	1.21	1.25	1.23
GCA/SCA			0.69	1.45	1.52	1.61	2.06	2.42	1.78	0.84	1.43
GCA x L /GCA					**0.54**			0.08			0.2
SCA x L/SCA					**1.27**			0.46			0.14

SOV	**df**		**100-grain weight**			**grain yield/ plant**			**Shelling%**		
	S.	**C**	**L1**	**L2**	**C**	**L1**	**L2**	**C**	**L1**	**L2**	**C**
Location (L)		**1**			71.41**			23405.18**			932.55**
Rep/L.	**2**	**4**	4.06	0.32	2.19	146.46	435.21	290.84	10.42	10.93	10.67
Crosses	**35**	**35**	8.64**	10.20**	11.92**	2904.32**	1003.22**	3416.55**	126.98**	24.62	87.15*
Crosses x L		**35**			6.92*			490.99**			64.46**
Error.	**70**	**140**	3.75	3.95	3.85	83.475	36.566	60.2	17.14	16.32	16.73
GCA	**8**	**8**	1.48	3.04*	2.5	161.78**	55.49**	160.03**	41.72**	14.67*	32.87**
SCA	**27**	**27**	3.29**	3.51**	4.41**	1207.02**	417.05**	1428.87**	42.51*	6.29	27.92**
GCA x L		**8**			2.02			57.24**			23.51**
SCA x L		**27**			2.39**			195.20**			20.88**
Error	**70**	**140**	1.25	1.32	1.28	27.825	12.189	20.007	5.71	5.44	5.58
GCA/SCA			0.45	0.87	0.57	0.13	0.13	0.11	0.98	2.33	1.18
GCA x L /GCA				0.29	0.81			0.36			0.72
SCA x L/SCA					0.54			0.14			0.75

* , **, L1,L2 and C refers to significant $p< 0.05$, $p< 0.01$, Moshtohor, Sids and combined across locations,

Table 2. Mean performance of the parental combinations and SC 10 for all studied characters across environments, grain yield plant^{-1} and superiority relative to check hybrid SC10 at Moshtohor, Sids and across locations.

cross	Days to 50% tasseling	Days to 50% silking	plant height (cm)	ear height (cm)	No of rows/ ear	No of kernels/ row	100-grain weight (g)	shelling%
1x2	62.50	66.50	305.00	146.67	13.47	38.47	35.47	72.07
1x3	61.50	62.50	320.00	133.33	11.93	51.68	43.68	87.68
1x4	62.50	64.17	293.34	135.00	12.78	31.02	28.02	70.42
1x5	63.50	65.33	300.00	151.67	11.95	34.81	31.81	61.77
1x6	63.17	63.50	278.33	130.00	13.07	32.30	29.30	67.42
1x7	61.17	62.50	280.00	136.67	12.70	34.33	31.33	71.36
1x8	61.67	63.33	271.67	126.67	12.73	31.30	28.30	69.80
1x9	61.33	64.83	286.67	135.00	14.19	34.25	31.25	69.30
2x3	61.33	65.00	296.67	135.00	14.07	36.90	33.90	77.95
2x4	60.50	63.50	308.34	135.00	13.37	34.43	31.44	61.80
2x5	61.67	63.67	290.00	121.67	13.93	32.43	29.44	67.45
2x6	63.17	65.17	301.67	131.67	13.18	41.67	38.67	81.33
2x7	61.67	64.33	303.34	138.33	13.00	30.20	27.20	79.51
2x8	61.17	63.50	293.34	130.00	13.20	42.07	39.07	86.63
2x9	62.17	66.00	275.00	126.67	11.73	30.77	27.77	73.51
3x4	62.83	63.83	300.00	120.00	14.40	31.30	28.30	74.20
3x5	62.33	65.00	306.67	130.00	13.52	38.48	35.49	86.58
3x6	61.67	63.33	280.00	130.00	14.80	39.73	36.74	85.71
3x7	62.50	63.50	290.00	130.00	14.00	37.70	34.70	76.87
3x8	63.17	64.83	305.00	121.67	13.83	33.37	30.37	77.76
3x9	61.00	65.33	313.34	125.00	14.00	34.60	31.60	76.79
4x5	61.17	63.00	290.00	118.33	14.13	34.20	31.20	70.13
4x6	62.67	65.00	313.34	131.67	14.67	38.13	35.14	84.97
4x7	61.67	63.00	290.00	121.67	14.20	41.35	38.35	81.07
4x8	63.00	64.50	285.00	138.33	11.95	32.68	29.68	68.59
4x9	63.67	67.17	295.00	126.67	12.98	33.78	30.78	78.43
5x6	62.17	64.17	290.00	135.00	13.32	39.10	36.10	78.65
5x7	63.00	65.50	295.00	128.33	13.80	29.20	26.20	63.82
5x8	62.50	64.17	293.34	131.67	13.93	35.06	32.06	69.56
5x9	60.67	63.67	290.00	130.00	12.67	35.01	32.01	73.94
6x7	63.17	65.33	295.00	126.67	14.60	38.80	35.80	81.30
6x8	62.00	63.83	280.00	126.67	13.33	36.28	33.28	71.27
6x9	62.17	64.17	280.00	120.00	12.98	34.83	31.84	71.39
7x8	62.00	63.67	310.00	125.00	12.27	38.43	35.43	77.24
7x9	59.83	63.50	320.00	130.00	10.93	33.54	30.54	71.44
8x9	62.00	63.67	285.00	128.33	11.82	31.58	28.58	69.16
Check SC10	64.50	65.67	291.90	130.19	10.10	34.69	37.16	76.53
LSD 5%	1.26	1.13	3.38	5.62	0.97	2.17	2.22	4.63
LSD 1%	1.70	1.52	4.54	7.54	1.31	2.92	2.98	6.21

Table (2). Cont.

Cross	Grain yield/ plant (g)			Relative superiority over SC 10		
	L1	L2	Comb.	L1	L2	Comb.
1x2	183.58	151.5	167.54	11.99	-7.58	2.2
1x3	251.22	208.66	229.94	53.24**	27.28**	40.26**
1x4	108.69	97.28	102.99	-33.70**	-40.66**	-37.18**
1x5	122.82	99.73	111.28	-25.08**	-39.17**	-32.12**
1x6	121.57	100.99	111.28	-25.84**	-38.39**	-32.12**
1x7	125.15	113.54	119.34	-23.66**	-30.74**	-27.20**
1x8	136.68	75.62	106.15	-16.62**	-53.87**	-35.25**
1x9	155.14	134.16	144.65	-5.36	-18.16**	-11.76*
2x3	154.62	146.87	150.74	-5.68	-10.41*	-8.05
2x4	155.65	112.54	134.1	-5.05	-31.35**	-18.20**
2x5	130.31	110.5	120.4	-20.51**	-32.60**	-26.55**
2x6	129.01	103.38	116.19	-21.31**	-36.94**	-29.12**
2x7	121.99	103.03	112.51	-25.59**	-37.15**	-31.37**
2x8	198.68	170.51	184.6	21.19**	4.01	12.60**
2x9	109.26	83.35	96.3	-33.35**	-49.16**	-41.26**
3x4	149.62	108.27	128.95	-8.73	-33.96**	-21.34**
3x5	175	132.27	153.64	6.75	-19.31**	-6.28
3x6	186.84	157.92	172.38	13.97**	-3.67	5.15
3x7	187.03	129.46	158.25	14.09**	-21.03**	-3.47
3x8	165.94	98.23	132.09	1.22	-40.08**	-19.43**
3x9	160.41	122.43	141.42	-2.15	-25.32**	-13.74**
4x5	141.41	109.19	125.3	-13.74**	-33.39**	-23.57**
4x6	160.42	163.9	162.16	-2.14	-0.02	-1.08
4x7	215.5	144.17	179.83	31.46**	-12.06**	9.7
4x8	109.43	104.02	106.72	-33.25**	-36.55**	-34.90**
4x9	147.44	100.54	123.99	-10.06*	-38.67**	-24.36**
5x6	179.51	133.4	156.45	9.5	-18.63**	-4.56
5x7	115.64	108.98	112.31	-29.46**	-33.52**	-31.49**
5x8	159.1	117.67	138.39	-2.95	-28.22**	-15.58**
5x9	157.45	129.62	143.54	-3.96	-20.93**	-12.44**
6x7	176.41	140.18	158.29	7.61	-14.49**	-3.44
6x8	189.4	97.96	143.68	15.53**	-40.25**	-12.36**
6x9	198.99	144.38	171.68	21.38**	-11.93	4.73
7x8	154.85	123.96	139.4	-5.54	-24.38**	-14.96**
7x9	130.4	127.39	128.89	-20.46**	-22.29**	-21.38**
8x9	96.94	114.28	105.61	-40.86**	-30.29**	-35.58**
Check SC10	163.94	139.18	151.56			
LSD 5%	14.84	99.83	8.91			
LSD 1%	19.68	13.04	11.83			

* , **, L1,L2 and C refers to significant $p< 0.05$, $p< 0.01$, Moshtohor, Sids and combined across locations.

Table 3. Estimates of general combining ability effects of nine inbred lines for all the studied traits across two locations.

parent	Days to 50% tasseling	Days to 50% silking	Plant height	Ear height	No of rows/ ear	No of kernels/row	100-grain weight	Grain yield/ plant	shelling %
p1	0.12	-0.22	-3.25**	6.48**	-0.34	-3.19**	-0.6	22.83**	0.93
p2	-0.33	0.49*	2.22**	3.39**	0.11	1.07**	0.74	14.33**	-1.05
p3	-0.02	-0.13	7.70**	-2.09*	0.56**	-1.50**	0.44	-27.74**	2.80**
p4	0.22	-0.01	2.46**	-2.80**	0.37*	0.77	-0.25	-14.26**	-0.15
p5	0.07	0.04	-0.4	0.53	0.30	-0.52	0.1	-37.19**	-2.37**
p6	0.53*	0.04	-5.63**	-1.14	0.49**	2.83**	0.13	11.11**	-0.62
p7	-0.21	-0.41*	3.65**	-1.14	-0.38*	0.95*	0.1	28.06**	-0.22
p8	0.15	-0.39	-4.92**	-2.09*	-0.47**	0.30	-0.39	6.48**	1.50
p9	-0.52*	0.59**	-1.83**	-1.14	-0.62**	-0.71	-0.28	-3.62	-0.81
LSD5%(gi)	0.46	0.41	1.22	2.03	0.35	0.78	0.8	2.95	1.67
LSD1%(gi)	0.60	0.54	1.62	2.69	0.47	1.04	1.06	3.91	2.21
LSD5%(gi-gj)	0.68	0.61	1.83	3.04	0.53	1.18	1.2	4.43	2.51
LSD1%(gi-gj)	0.91	0.81	2.43	4.03	0.7	1.56	1.59	5.87	3.32

* and ** refers to significant at 0.05 and 00.01 level of probability, respectively.

Table 4. Determination of SCA effects of all crosses for all studied characters across two locations.

crosses	**Days to 50% tasseling**	**Days to 50% silking**	**Plant height**	**Ear height**	**No of rows/ ear**	**No of kernels/row**	**100-grain weight**	**Grain yield/ plant**	**Shelling %**
1x2	**0.65**	**1.95****	**11.31****	**4.76**	**1.45**	**0.45**	**0.29**	**-8.21***	**0.41**
1x3	**-0.66**	**-1.43****	**20.83****	**-3.1**	**-7.25****	**-1.27****	**-1.47**	**62.61****	**-4.9***
1x4	**0.1**	**0.12**	**-0.6**	**-4.05**	**-2**	**-0.5**	**-1.25**	**20.37****	**2.79**
1x5	**1.24***	**1.24***	**8.93****	**15.95****	**4.00****	**-0.94***	**0.68**	**92.43****	**2.82**
1x6	**0.46**	**-0.6**	**-7.50****	**-5.71***	**-1.23**	**-0.34**	**0.13**	**-88.50****	**-0.93**
1x7	**-0.8**	**-1.14***	**-15.12****	**-0.71**	**1.52**	**0.17**	**-1.83**	**-10.94****	**-0.67**
1x8	**-0.66**	**-0.33**	**-14.88****	**-8.10****	**-0.31**	**0.36**	**1.77**	**-24.61****	**-2.37**
1x9	**-0.33**	**0.19**	**-2.98**	**0.95**	**3.82****	**2.07****	**1.67**	**-43.14****	**2.9**
2x3	**-0.38**	**0.36**	**-7.98****	**6.67****	**4.02****	**0.18**	**-0.04**	**-22.14****	**1.71**
2x4	**-1.45***	**-1.26***	**8.93****	**4.05**	**-2.18**	**0.27**	**-0.07**	**42.37****	**-1.22**
2x5	**-0.14**	**-1.14***	**-6.55****	**-7.62****	**-4.42****	**0.28**	**-2.53***	**-52.69****	**1.41**
2x6	**0.91**	**0.36**	**10.36****	**-4.29**	**1.87**	**-0.57**	**2.28***	**-21.75****	**-1.4**
2x7	**0.15**	**-0.02**	**2.74**	**5.71***	**-2.86****	**-0.11**	**0.91**	**42.06****	**0.94**
2x8	**-0.71**	**-0.88**	**1.31**	**-1.67**	**5.09****	**0.34**	**-0.58**	**-3.86**	**-3.23**
2x9	**0.96**	**0.64**	**-20.12****	**-7.62****	**-2.97****	**-0.84**	**-0.27**	**24.23****	**1.37**
3x4	**0.58**	**-0.31**	**-4.88****	**-5.48***	**-5.05****	**0.42**	**1.08**	**17.94****	**-3.85**

3x5	**0.22**	**0.81**	**4.64****	**-3.81**	**4.62****	**-0.83**	**2.52***	**12.38****	**3.54**
3x6	**-0.9**	**-0.86**	**-16.79****	**2.86**	**0.13**	**0.46**	**0.88**	**10.57****	**1.26**
3x7	**0.67**	**-0.24**	**-16.07****	**2.86**	**1.13**	**0.03**	**-0.89**	**-46.62****	**2.02**
3x8	**0.98**	**1.07***	**7.50****	**-6.19***	**0.8**	**0.32**	**0.31**	**-13.79****	**-2.42**
3x9	**-0.52**	**0.6**	**12.74****	**6.19***	**1.59**	**0.68**	**-2.39***	**-20.94****	**2.69**
4x5	**-1.18***	**-1.31***	**-6.79****	**-8.10****	**0.4**	**0.11**	**-1.03**	**-34.61****	**4.63***
4x6	**-0.14**	**0.69**	**21.79****	**6.90****	**1.73**	**0.76**	**0.86**	**21.08****	**1.47**
4x7	**-0.4**	**-0.86**	**-10.83****	**-6.43***	**5.61****	**0.43**	**-0.71**	**-45.86****	**-4.41***
4x8	**0.58**	**0.62**	**-7.26****	**7.86****	**-3.17****	**-1.30****	**-0.26**	**-6.61**	**1.88**
4x9	**1.91****	**2.31****	**-0.36**	**5.24***	**4.67****	**-0.19**	**1.37**	**-14.68****	**-1.29**
5x6	**-0.49**	**-0.19**	**1.31**	**3.57**	**1.58**	**-0.27**	**-1.57**	**53.52****	**0.12**
5x7	**1.08**	**1.60****	**-2.98***	**0.24**	**-7.28****	**0.90***	**1.55**	**-1.43**	**0.59**
5x8	**0.22**	**0.24**	**3.93***	**2.86**	**0.07**	**0.69**	**0.87**	**-17.34****	**-0.12**
5x9	**-0.95**	**-1.24***	**-2.5**	**-3.1**	**1.02**	**0.07**	**-0.5**	**-52.25****	**-12.99****
6x7	**0.79**	**1.43****	**2.26**	**-3.1**	**0.64**	**0.04**	**0.42**	**7.27***	**-1.13**
6x8	**-0.73**	**-0.1**	**-4.17****	**6.19***	**-2.39***	**0.06**	**-1.37**	**2.85**	**-0.97**
6x9	**0.1**	**-0.74**	**-7.26****	**-6.43***	**-2.33***	**-0.14**	**-1.64**	**14.95****	**1.59**
7x8	**0.01**	**0.19**	**16.55****	**-2.14**	**3.47****	**-0.13**	**-0.98**	**13.53****	**2.08**
7x9	**-1.49****	**-0.95**	**23.45****	**3.57**	**-2.25***	**-1.32****	**1.52**	**42.00****	**0.58**
8x9	**0.32**	**-0.81**	**-2.98**	**1.19**	**-3.56****	**-0.34**	**0.23**	**49.83****	**5.16***
LSD5%(sij)	**1.11**	**0.99**	**2.97**	**4.93**	**1.91**	**0.85**	**1.95**	**7.18**	**4.06**
LSD1%(sij)	**1.47**	**1.31**	**3.93**	**6.53**	**2.53**	**1.13**	**2.58**	**9.51**	**5.38**
LSD5%(sij-sik)	**1.68**	**1.5**	**4.49**	**7.45**	**2.88**	**1.29**	**2.95**	**10.85**	**6.14**
LSD1%(sij-sik)	**2.22**	**1.99**	**5.95**	**9.88**	**3.82**	**1.71**	**3.9**	**14.38**	**8.13**
LSD5%(sij-skl)	**1.53**	**1.37**	**4.1**	**6.81**	**2.63**	**1.18**	**2.69**	**9.91**	**5.61**
LSD1%(sij-skl)	**2.03**	**1.81**	**5.43**	**9.02**	**3.49**	**1.56**	**3.56**	**13.13**	**7.43**

* and ** refers to significant at 0.05 and 0.01 level of probability, respectively.

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تقدير القدرة على التالف للهجن التبادلية بين تسعه سلالات من الذرة الشامية عبر موقعين للزراعة

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أجرى تقييم الهجن الناتجة من التهجين النصف دائرى بين تسعة سلالات من الذره الشامية وذلك عبر موقعين للزراعة (مشتهر – سدس) لتسعة صفات كمية هى: موعد طرد 50 % من النورات المذكرة و 50% من موعد طرد النوره المؤنثة , طول النبات , ارتفاع الكوز, عدد الحبوب / سطر, عدد السطور/ كوز, وزن ال 100 حبه, محصول الحبوب/ نبات و نسبة التصافى . كانت متوسطات التباين لكل من المواقع والهجن معنوية فى كل الصفات تحت الدراسة . كما كان متوسط التباين للتفاعل بين الهجن والمواقع معنوي لكل الصفات تحت الدراسة ما عدا صفة موعد طرد النوره المذكرة و محصول الحبوب/ نبات . و كانت التباينات للقدرة العامة والخاصة معنوية لكل الصفات تحت الدراسة عدا عدد الايام حتي تزهير 50 % من النورات المذكرة و موعد طرد50 % من النوره المؤنثة بموقع مشتهر و القدرة الخاصه على التالف فى موقع سدس . وكانت النسبة بين القدرة العامة والقدرة الخاصة أكبر من الوحدة لكل من صفة موعد تزهير النوره المذكرة فى موقع سدس و مشتهر و موعد طرد النوره المؤنثة و طول النبات فى موقع مشتهر و ارتفاع النبات و نسبة التصافى فى موقع سدس و التحليل التجميعى و عدد الحبوب /السطر فى موقع مشتهر و التحليل التجميعي و عدد السطور/ كوز فى كلا معادى الزراعة و التحليل التجميعيى و هذا يدل على ان التأثير المضيف هو الذى يتحكم فى توريث تلك الصفات. اما باقى الحالات فنجد ان النسبة اقل من الوحده و هذا يدل على ان الجزء الغير مضيف يلعب الدور الاكبر فى توريث تلك الصفات. أظهرت السلالة الأبوية رقم 1 , 2, 6 و 9 قدرة جيدة عامة على التالف لمحصول الحبوب للنبات واحد مكوناته على الاقل. أظهرت الهجن P_3 X P_1 ,P_4 X P_1 ,P_5 X P_1,P_4 X P_2,P_7 X P_2 ,P_9 X P_2 ,P_4 X P_3 ,P_5 X P_3 ,P_6 X P_3 , P_6 X P_4 ,P_9 X P_6 X P_5 , P_7 X P_6 , P_9 X P_6 , P_8 X P_7 , P_7 و P_9 X P_8 قدرة خاصة على التآلف لصفة متوسط محصول النبات . اظهر الهجن P_1 X P_3 زيادة معنوية عن صنف المقارنة هجين فردى 10 لصفة وزن حبوب / نبات.