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Combining Ability Analysis Using Diallel Crosses among Eight Inbred Lines of maize under Two Planting Dates

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Abstract

A half diallel cross between 8 inbred lines of maize was evaluated at two different planting dates for nine quantitative characters. Planting dates and crosses mean squares were significant for all studied traits. Mean squares due to crosses x planting dates were significant obtained for most studied traits. General (GCA) and specific (SCA) combing ability mean squares were significant for all traits. High ratios which largely exceeded the unity for days to 50% tassling and silking, plant height, ear height, no of rows/ ear , no of grains / row and 100 kernel weight were obtained, indicating that a large part of the total genetic variability associated with these traits indicates that of additive and additive by additive gene action. For remain cases, GCA/SCA ratios were less than unity, therefore, it could be summarized that the most percentage of the total genetic variability for these traits was due to non-additive gene action. For plant height, ear height and grain yield/ plant, the ratio of SCA x D/SCA was higher than GCA x D/GCA. This result indicates that non- additive effects were more influenced by sowing date than additive genetic effects for this trait. P1 seemed to be the best general combiner for early maturity, short plants, low ear position, grain yield/plant and some of its components in the combined analysis of both sowing dates. The parental combination P1xP3, P1xP5, P1xP7, P2xP4, P2xP5, P2xP7 , P3xP4, P3xP5, P3xP6 , P3xP4, P6xP7 and , P7xP8 for grain yield/plant exhibited significant positive $\hat{S}_{ij}$ effects being 13.54, 14.68, 12.79, 21.81, 21.61, 9.15, 21.64, 27.34, 7.36, 6.37 and 33.49, respectively

Key words: Maize, Combining ability, planting date, GxE.

Introduction

Maize (*Zea mays* L.) is the most important cereal crops in the world and Egypt due to its vast grown area. It ranked 3rdcereal crop in the world, after wheat and rice. It is essential for human and animal fed. Also, it used for industrial purposes such as manufacturing starch and cooking oils. In 2018 the corn grown area in Egypt was 0.76 Million hectares (1.76 million feddans) with an annual grain production of 6 Million metric tons and an average productivity of 8 ton ha^{-1} (23.8 ardabs/feddan). (One feddan; fed =4200 m^2 and one ardab; ard = 140 Kg). **(USDA 2018).**

Maximizing food and agricultural production, depends mainly on promoting high yielding maize hybrids to cover the mounting consumption of maize. This depends mostly on producing new hybrid of maize across breeding programs. To carry out a successful breeding program, the breeder should have enough knowledge about the type and relative amount of genetic variance components and their interactions by environment for different attributes.

Diallel cross is an important to produce superior hybrids and both types of combining ability helps breeder to identify the most appropriate parents and provide sufficient genetic information on the inheritance of traits. In this regard, highly general combining ability (GCA) and specific combining ability (SCA) effects leading to high heterosis were asserted by **El-Hosary (2015), Girma *et al* (2015), Al-Naggar *et al* (2016) and Al-Naggar *et al* (2017 a and b)**

The quantitative characters are extremely affected by the environment, and the amount of such effect increases with the increase in the number of predominant genes. Thus, expression of a specific character which controlled by several loci were display greater genotype x environment (GxE) interaction. **Singh (1973 and 1979) and Wani*et al*(2017)** reported that the GxEinteraction variance is very important to detect stable genotypes.

Diallel mating schema used in large scale in determine combining ability analyses in maize breeding programs to locate the combining ability types. Furthermore, the magnitude of genetic components for a certain trait would depend mainly upon the environmental flection under which the breeding populations will be tested. Thus, differences due to GCA and SCA are associated with the type of gene action implicated.

Variance for GCA contains additive part while that of SCA includes non-additive part of total variance emerging mostly from dominance and epistatic deviations **(El-Hosary (2015) and Izhar and Chakraborty 2013).**

The main objectives of this investigation are to : 1) determine hybrid performance for the studied parental combination.2) estimate the amount of superiority over the check hybrid Hytech 2031. and3) establish the magnitude of both general combining ability (GCA) and specific combining ability (SCA) effects and their interaction with two planting date.

Materials and Methods

Eight white inbred lines were used as parents in this study. Moshtohor P_1 (T.S M1), P_2 (T.S M2), P_3 (T.S M3), P_4 (T.S M4), P_5 (T.S M5), P_6 (T.S M6), P_7 (T.S M7) , and P_8 (T.S M1) were obtained by Dr. Maged Hamouda at Techno seeds company. In the first season (summer 2018) the eightnewinbred lines were sown in three different planting dates to avoid differences in flowering time and to secure enough hybrid seed. All possible combinations without reciprocals were made between the eight inbred lines by hand method giving a total of 28 crosses. In the second season (summer 2019), two adjacent experiments were conducted at the two planting dates:9th June and 18th July. In each experiment the 28 F_1 hybrids as well as two check SC Hytech 2031were grown in a randomized complete block design with three replications. Each plot consisted of two ridges of 5 m length and 70 cm width. Hills were spaced by 25 cm with two kernels per hill and later thinned to one plant per hill. The dry method of sowing was used. The first irrigation was given after about 21 days from sowing. The cultural practices were followed as recommended for ordinary maize field in the area. Random sample of 10 guarded plants in each plot was taken to evaluate silking and tasseling dates (days) in 50% of the plant silked or tasseled, plant height (cm), ear height (cm), No. of kernels/row, No. of rows/ear, 100-kernel weight, grain yield/plant which was adjusted for 15.5% moisture and shelling%.

The obtained data were statistically analyzed for analysis of variance by using computer statistical program MSTAT-C. General and specific combining ability estimates were estimated according to **Griffing's (1956)** diallel cross analysis designated as method 4 model I for each experiment. The combined analysis of the two experiments was carried out whenever homogeneity of variance was detected **(Gomez and Gomez, 1984)**. Relative superiority according to **Singh et al. (2004)** and **EL-Hosary (2020)** expressed as the percentage deviation of the F_1 mean performance from S.C. Hytech 2031 was also estimated

Results and Discussion

The analysis of variance for ordinary analysis over the two experiments for all studied traits is given in Table (1). Planting date mean squares for all traits under study were significant, with mean values in earlybeing higher than those in late planting date for all studied traits.

It coud be concluded that planting dates showed positive effect on the previous traits on maize. Genotypes mean squares were significant for all traits in both sowing dates as well as the combined analysis except for ear diameter in the early sowing date and no of rows/ ear at late sowing date (Table 1). This indicates the wide diversity between the parental materials used in the present study. Significant genotypes x sowing date mean squares were obtained for planting height, ear height, ear leaf area, ear length, no of grains/ row, 100 kernel weight, ear weight/ plant and grain yield/ plant revealing that the performance of genotypes differed from one sowing date to another.

Remain traits with insignificant Genotype x planting date was detected reflecting that these hybrids responded similarly to environmental changes. The fluctuation of hybrids from sowing date to another was detected for most traits

Mean performances of F_1 hybrids, S.C. Hytech 2031 are presented in Table (2).

It is favorable if the single crosses were earlier in flowering than parents to develop early maturity hybrids to avoid damage by borers or other environmental adverse conditions. The parental combinations that incorporated earliness in silking and tasseling dates as well as exhibited superiority over SC Hytech 2031 are plants of those F_1hybrids 1x5 and 2x4.Earliness in maize is favorable for escaping destructive injuries caused by *Sesamia cretica*, *Chilo simplex* and *Pyrausta nubilialis*. Similar results were reported by El-Hosary and El-Badawy (2005) and El-Hosary *et al* (2006).

The crosses 2x3, 1x5, 1x6, 1x7, 1x8, 2x5 and 3x4 gave the lowest mean values of plant and ear heights compared with the check hybrids. However, the crosses 3x7 and 4x6 gave the highest value for plant height. The choice between taller plants with highest ear and shorter plants with reduced ear height depends on the breeder's objective. 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 3x8, 2x4, 4x5 and 2x6 recorded the highest number of kernels/row, with significant difference from check hybrid 2031 in the combined analysis.The cross 3x8, 2x4, 4x5 and 2x6 recorded the highest number of kernels/row, with significant difference from check hybrid 2031 in the combined analysis. The crosses 2x4, 2x7, 5x7 and 6x7 in early planting date; the crosses 1x3, 1x5, 1x7, 2x5 and 3x5 in the late planting date and the combined across them had significant superiority over the check hybrid. These hybrids exhibited significant increase of two or more of traits contributing to grain yield Table (7).

Table 1. Observed mean squares from ordinary analysis and combining ability for the studied traits in each and across planting dates.

SOV	df		days to 50% tasseling			days to 50% silking			plant height		
	S.	c.	Early PL	Late PL	C.	Early PL	Late PL	C.	Early PL	Late PL	C.
planting date (D)		1			490.29**			640.38**	33.04	7.15	20.1
blocks/D.	2	4	9.73**	1.3	5.51*	8.33*	0.23	4.28*	1267.67**	1382.28**	2238.03**
Crosses	27	27	5.24**	8.87**	11.39**	5.37*	11.47**	13.92**			411.92**
Crosses x D		27			2.72			2.92	25.94	17.34	21.64
Error/D.	54	108	1.81	1.68	1.75	2.14	2.08	2.11	640.58**	535.80**	1036.01**
GCA	7	7	2.42**	5.01**	6.58**	3.01**	6.02**	8.25**	346.25**	434.49**	644.51**
SCA	20	20	1.51**	2.24**	2.82**	1.36*	3.06**	3.38**			140.37
GCAxD		7			0.85			0.78			136.23
SCAxD		20			0.93			1.04	8.65	5.78	7.21
Error	54	108	0.6	0.56	0.58	0.71	0.69	0.7	1.85	1.23	1.61
GCA/SCA			1.6	2.24	2.33	2.21	1.97	2.44	33.04	7.15	20.1
GCAx D /GCA						0.13		0.09			0.14
SCAxD/SCA						0.33		0.031			0.21
SOV	**Df**		Ear height			No o f rows/ ear			No of kernel/row		
	S.	c.	Early PL	Late PL	C.	Early PL	Late PL	C.	Early PL	Late PL	C.
planting date (D)		1			2325.15**			0.86			107.84**
blocks/D.	2	4	42.86**	27.08**	34.97**	0.46	82.75	41.61	0.33	2.65	1.49
Crosses	27	27	844.74**	555.86**	1223.91**	6.01**	7.16	8.94	37.46**	47.60**	45.23**
Crosses x D		27			176.69**			4.23			39.83**
Error/D.	54	108	9.52	6.1	7.81	1.06	0.82	0.94	5.94	7.43	6.69
GCA	7	7	345.34**	265.21**	578.55	1.43**	2.43**	2.48**	12.60**	32.67**	19.70**
SCA	20	20	259.27**	157.31**	348.27**	2.20**	2.37**	3.15**	12.45**	9.99**	13.46**
GCAxD		7			31.99**			1.37**			25.56**
SCAxD		20			68.31**			1.42**			8.98**
Error	54	108	3.17	2.03	2.6	0.35	0.27	0.31	1.98	2.48	2.23
GCA/SCA			1.33	1.69	1.66	0.65	1.02	0.79	1.01	3.27	1.46
GCAx D /GCA					0.06			0.55			0.74
SCAxD/SCA					0.2			0.45			0.67
SOV			100-kernel weight			grain yield/ plant			Shelling%		
	S.	c.	Early PL	Late PL	C.	Early PL	Late PL	C.	Early PL	Late PL	C.
planting date (D)		1			6.96**			21519.55**			13.71**
blocks/D.	2	4	0.37	3.01	1.69	3.3	13.58	8.44	1.82	5.57**	3.69*
Crosses	27	27	46.75**	119.53**	107.44**	2798.95**	3503.85**	2615.72**	8.41**	6.77**	9.52**
Crosses x D		27			58.84**			3687.08**			5.67**
Error/D.	54	108	2.54	1.98	2.26	33.37	22.4	27.88	1.53	1.99	1.76
GCA	7	7	12.94**	60.27**	44.64**	1038.70**	513.05**	853.38**	1.86*	3.35**	3.44**
SCA	20	20	16.51**	32.69**	32.72**	895.98**	1397.16**	878.39**	3.13**	1.88*	3.08**
GCAxD		7			28.57**			698.38**			1.77*
SCAxD		20			16.48**			1414.75**			1.93*
Error	54	108	0.85	0.66	0.75	11.12	7.47	9.29	0.51	0.66	0.59
GCA/SCA			0.78	1.84	1.36	1.16	0.37	0.97	0.6	1.79	1.12
GCAx D /GCA						0.64			1.36		0.51
SCAxD/SCA						0.50			1.61		0.63

* and ** refers to significant p< 0.05 and p< 0.01, respectively.
C refer to combined across seasons.

Table 2. Mean performance of the crosses for all studied traits across environments, grain yield plant^{-1} at both and across planting dates and superiority relative to check hybrid SCHytech 2031 at both and across environments**.**

cross	Days to 50% tasseling (days)	Days to 50% silking (days)	plant height (cm)	ear height (cm)	No of rows/ ear	No of kernels/ row	100-kernel weight (g)	shelling%
1x2	59.83	57.17	245	117.5	13.83	33.67	42.17	86.91
1x3	60.83	58	295	143.33	14.67	37.33	44.83	85.39
1x4	59.5	59	286.67	140	12.83	36.33	42.83	90.18
1x5	58.67	55.5	276.67	126.67	12.33	34.83	44	87.99
1x6	60.33	57.5	279.17	120.83	14.83	30.67	41.33	85.99
1x7	61	58.17	273.33	122.5	13.33	38	48.17	86.65
1x8	59.67	56.83	276.67	125.83	13.33	33.5	44.67	86.68
2x3	59.83	57.67	301.67	138.33	13.33	39.67	36.67	90.08
2x4	58.67	56.17	292.5	129.17	14.33	40	44.17	84.2
2x5	59	56.33	273.33	128.33	13	38.67	42.17	84.61
2x6	61.5	58	288.33	151.67	13.17	41	44.5	83.55
2x7	60.5	57.33	301.67	148.33	14.33	38.17	40.33	86.29
2x8	60.33	57.17	276	121.67	13.83	35.33	39.17	83.84
3x4	59.17	56.83	238.33	105.83	15.17	36	37	85.42
3x5	60.5	57.5	300	135	15.67	36.67	44.17	90.58
3x6	60.67	58.5	276.67	140	13.17	39.67	42.5	90.05
3x7	61.33	58.17	316.67	161.67	12.17	35.67	38.5	91.21
3x8	63.33	60.67	308.33	153.33	14	41.67	36.33	88.5
4x5	64.33	60.67	306.67	145	13.17	40.07	32.7	88.73
4x6	62.67	59.83	320	166.67	11.67	36	44.83	87.32
4x7	63.83	60.83	300	155	13.67	38.33	36	81.84
4x8	62.17	59.33	301.67	140	13	32.67	42.5	89.85
5x6	62.67	59.33	301.67	132.5	12.83	34.33	47.83	83.75
5x7	62.33	59.5	303.33	150	12.5	38.33	36.83	84.62
5x8	62	59.17	296.67	128.33	15.17	33.67	34.17	85.62
6x7	61.83	58.33	308.33	151.67	12.17	39.33	40.83	84.64
6x8	61.83	59	310	145	16.17	39	32.83	86.53
7x8	60.67	58	295.83	136.67	16.33	35.33	40.33	89.35
Check	63	59.83	316.67	130	13.33	38.67	38.83	86.5
LSD 5	2.34	2.48	8.27	4.01	1.57	4.19	2.44	4.63
LSD 1	3.1	3.29	10.97	5.32	2.08	5.56	3.23	6.21

Table 2. Cont.

cross	Grain yield/ plant (g)			Relative superiority over SC Hytech 2031 H%		
	P L1	PL 2	Comb.	P L1	PL 2	Comb.
1x2	210.33	159.33	184.83	17.2**	11.16**	14.52**
1x3	214.67	208.67	211.67	19.61**	45.58**	31.14**
1x4	217.2	136	176.6	21.03**	-5.12	9.42**
1x5	217.67	200.33	209	21.29**	39.77**	29.49**
1x6	186.67	185	185.83	4.01	29.07**	15.14**
1x7	195.8	242.67	219.23	9.1**	69.3**	35.83**
1x8	215	164.33	189.67	19.8**	14.65**	17.51**
2x3	168	153.67	160.83	-6.39*	7.21**	-0.35
2x4	236.2	184.33	210.27	31.61**	28.6**	30.28**
2x5	220.67	211.67	216.17	22.96**	47.67**	33.93**
2x6	162	228	195	-9.73**	59.07**	20.82**
2x7	245	186.67	215.83	36.52**	30.23**	33.73**
2x8	195.67	195	195.33	9.03**	36.05**	21.02**
3x4	194.73	205	199.87	8.51**	43.02**	23.83**
3x5	208.33	215	211.67	16.08**	50**	31.14**
3x6	208.33	166.67	187.5	16.08**	16.28**	16.17**
3x7	201.67	131.67	166.67	12.37**	-8.14**	3.26
3x8	214.67	142.67	178.67	19.61**	-0.47	10.7**
4x5	93	241.07	167.04	-48.18**	68.19**	3.49
4x6	180.67	156.67	168.67	0.67	9.3**	4.5
4x7	198.33	135.67	167	10.51**	-5.35	3.47
4x8	186	150	168	3.64	4.65	4.09
5x6	182.33	144	163.17	1.6	0.47	1.09
5x7	227.33	133	180.17	26.67**	-7.21**	11.63**
5x8	153	140.67	146.83	-14.75**	-1.86	-9.03**
6x7	225.67	164	194.83	25.74**	14.42**	20.71**
6x8	190.87	157	173.93	6.35*	9.53**	7.77**
7x8	234.4	211.67	223.03	30.61**	47.67**	38.19**
Check	198.8	178	188.4			
LSD 5	9.38	7.69	8.53			
LSD 1	12.44	10.19	11.32			

* and ** refers to significant $p< 0.05$ and $p< 0.01$, respectively.
PL 1 and PL 2 refer to early and lateplanting date, respectively.

Heterosis:

Relative superiority relative to SC Hytech 2031 expressed as the percentage deviation of F_1 mean performance from each of S.C. Hytech 2031 values for grain yield/plant are presented in Table (2). Concerning grain yield/plant ,fourteen, eleven and nine crosses expressed significant and positive heterotic effects in early, late sowing date as well as the combined analysis relative to S.C. Hytech 2031. However, most desirable heterotic effects were detected for the crosses 1x3, 1x5, 1x7, 2x4, 2x5, 2x7, 3x4, 3x5 and 7x8 in a combined across sowing date. Also, the cross 7x8 give the highest heterotic value in the combined analysis being 18.38%.

Hence, it could be concluded that these crosses offer possibility for improving grain yield in maize. Several investigators reported high heterosis for yield of maize; i.e. **Nawar *et al.* (1998), El-Bagoury *et al.* (2004)**, **Nawar *et al.* (2002)**, **and El-Hosary *et al.* (2006)**.

Combining ability

The analysis of variance for combining ability at the combined analysis for all the studied traits is presented in Table (1). The variance of general combining ability includes the additive and additive x additive genetic portion. While, specific combining ability represents 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.

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. For all traits general and specific combing ability mean squares were highly significant in both sowing dates as well as the combined data. Hence, GCA/SCA ratio was used as measure to reveal the nature of genetic variance involved

For days to 50% tassling and silking, plant height, ear height, no of rows/ ear , no of grain / row and 100 kernel weight, high ratios which largely exceeded the unity were obtained, indicating that large part of the total genetic variability associated with these traits was additive and additive by additive gene action.

grain yield/ plant, showed GCA/SCA ratios less than unity. Therefore, it could be concluded that the large portion of the total genetic variability associated with these traits is due to non-additive gene action. The largest heterotic magnitude expressed by the previous traits as the deviation of particular F_1 mean performance from check S.C. Hytech 3031. May strengthened the conclusion about the importance of non-additive gene effects in their inheritance. Similar results were reported by **El-Hosary and El-Badawy (2005), Mosa and Motawei (2005), Soliman *et al.* (2005) and El-Hosary *et al.* (2006)**

The mean squares of interaction between sowing dates and both types of combining ability were significant for plant height, ear height, no of rows/ ear, no of grains/ row, 100-kernel weight and grain yield/ plant. Such results showed that the magnitude of all types of gene action varied from sowing date to another. It is fairly evident that the ratio for GCA x D/GCA was higher than ratio of SCA x D/SCA for no of rows/ ear, no of grains/ row and 100-kernel weight. This result indicated that additive effects were more influenced by the environmental conditions than non- additive effects.The genetic variance was previously reported to be mostly due to non-additivefor Plant, ear heights by **Amer (2003)**; no. of grains/row by **Amer (2003),and Shafey *et al.* (2003**) and grain yield/plant by **Mosa (2003), El-Hosary and El-Badawy (2005); and El-Hosary *et al.* (2006).** On the other hand, the additive genetic variance was previously reported to be the most prevalent for earliness by **Dubey *et al.* (2001); Amer (2003); El-Hosary and El-Badawy (2005), and El-Hosary *et al.* (2006**); 100-kernel weight by **Dubey *et al.* (2001)**, **andEl-Hosary and El-Badawy (2005)**.

For plant height, ear height and grain yield/ plant, the ratio of SCA x D/SCA was higher than GCA x D/GCA. This result indicated that non-additive effects were more influenced by sowing date than additive genetic effects for this trait. This conclusion is in well agreement with those reported by **Gilbert (1958).** These results are in the same line of **Amer (2003)**, **Abdel-El-Hosary and El-Badawy (2005), and El-Hosary *et al.* (2006)**

General combining ability effects:

Estimations of GCA effects ($\hat{g}_i$) for individual parental inbred lines for each trait in the combined analysis are presented in Table (3) General combining ability effects estimated herein differ significantly from zero. High positive values would be of interest under all traits in question except silking, and tassling dates as well as plant and ear heights where high negative effects would be useful from the breeder's point of view.

The parental inbred line no. 1 exhibited significant negative ($\hat{g}_i$) effects for; tassling, silking dates and ear height across planting dates, indicating that this inbred line could be considered as good combiner for developing early and resistance to lodging genotypes. Also, it gave significant ($\hat{g}_i$) effects for 100-kernel weight, and grain yield/ plant. The parental inbred line no. 2 showed significant negative ($\hat{g}_i$) effects for tasseling, silking and plant and ear heights, indicating that this line could be considered as good combiner for developing early, short genotypes. Earliness of inflorescence is required for developing early maturing season to escape corn pest and shorter plant and ear heights are required for lodging resistance. Also, it gave significant positive ($\hat{g}_i$) effects for 100-kernel weight, grain yield/ plant across planting date;

The parental inbred line no. 3 seemed to be good combiner for no of kernels/ row. On the contrarily, it expressed significant undesirable or insignificant ($\hat{g}_i$) effects for the rest traits.The parental inbred line no. 4 seemed to be good combiner for no of kernels/ row and ear length at late planting date. However, it gave undesirable ($\hat{g}_i$) effects for other traits.

The parental inbred line no. 6 seemed to be the best combiner for 100-kernel weight.The parental inbred line no. 7 seemed to be best combiner for; grain yield/ plant.The parental inbred line no. 8 behaved as the best combiner for no of rows/ ear. It is worth noting that the inbred line which possessed high ($\hat{g}_i$) effects for grain yield per plant showed the same effect for one or more of the traits contributing to grain yield.

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

parent	Days to 50% tasseling	Days to 50% silking	Plant height	Ear height	No of rows/ ear	No of kernels/row	100-kernel weight	Grain yield/ plant	shelling%
p1	-0.91**	-1.24**	-17.51**	-11.42**	-0.14	-2.36**	3.73**	10.00**	-0.34
p2	-1.3**	-1.26**	-9.84**	-5.03**	-0.03	1.34*	0.6	10.24**	-0.79**
p3	-0.05	-0.26	-0.15	2.05**	0.36	1.37*	-0.93**	0.01	0.77**
p4	0.84**	0.51	1.38	2.74**	-0.36	0.15	-0.93**	-9.9**	0.31
p5	0.06	0.38	3.47**	-3.23**	-0.22	-0.32	-0.62	-3.8**	-0.46
p6	0.48	0.71*	7.77**	7.19**	-0.33	0.25	1.51**	-7.98**	0.13
p7	0.45	0.71*	10.27**	10.1**	-0.25	0.78	-0.77*	8.32**	0.57
p8	0.42	0.46	4.6**	-2.4**	0.97**	-1.22*	-2.6**	-6.89**	-0.19
LSD5%(gi)	0.58	0.64	2.04	1.23	0.43	1.13	0.66	2.32	0.58
LSD1%(gi)	0.77	0.84	2.71	1.63	0.56	1.5	0.87	3.07	0.77
LSD5%(gi-gj)	0.88	0.96	3.08	1.85	0.64	1.71	1	3.5	0.88
LSD1%(gi-gj)	1.16	1.28	4.09	2.46	0.85	2.27	1.32	4.64	1.17

* and ** refers to significant $p < 0.05$ and $p < 0.01$, respectively.

From the previous result, it could be concluded that the parental inbred lines P1 seemed to be the best general combiner for early maturity, short plants, low ear position, grain yield/plant and some of its components in the combined analysis of both sowing dates.

Specific combining ability:

Estimation of SCA effects in the28 crosses for the studied traits over the two planting dates are presented in table (4). The most desirable inter and intra allelic interactions were presented by P_3xP_4, and P_2xP_4 for days to 50% tasseling and silking; P_3xP_4, P_3xP_6, P_1xP_2, and $P_1xP_7$for plant and ear heights; 3x5for no of rows/ ear, P_3xP_8, P_6xP_8, P_1xP_7 and $P_4xP_5$for No of kernels/ row; P_1xP_7, P_1xP_8, P_2xP_4, P_2xP_6, P_3xP_5, P_4xP_6,P_4xP_8,and P_7xP_8 for 100-kernel weight. The parental combination P_1xP_3, P_1xP_5, P_1xP_7, P_2xP_4, P_2xP_5, P_2xP_7, P_3xP_4, P_3xP_5, P_3xP_6 , P_3xP_4, P_6xP_7 and , P_7xP_8 for grain yield/plant exhibited significant positive $\hat{S}_{ij}$ effects being 13.54, 14.68, 12.79, 21.81, 21.61, 9.15, 21.64, 27.34, 7.36, 6.37 and 33.49, respectively. These crosses may be prime importance in breeding programmes either towards hybrid maize production or synthetic varieties composed of hybrids which involved the good combiners for the traits in view.

Table 4. Estimates of specific combining ability effects of all parental combinations for all studied traits across two the planting dates.

Crosses	Days to 50% tasseling	Days to 50% silking	Plant height	Ear height	No of rows/ ear	No of kernels/row	100-kernel weight	Grain yield/ plant	Shelling %
P1xP2	1.14	1.3	-18.73**	-3.93**	0.29	-2.24	-2.96**	-23.53**	-1.74**
P1xP3	0.73	1.3	21.58**	14.82**	0.73	1.4	1.23	13.54**	0.23
P1xP4	0.84	-0.81	11.71**	10.79**	-0.38	1.61	-0.77	-11.62**	1.02
P1xP5	-1.88**	-1.51*	-0.37	3.43*	-1.02*	0.58	0.09	14.68**	1.62**
P1xP6	-0.3	-0.17	-2.17	-12.82**	1.59**	-4.16	-4.71**	-4.3	-1.27
P1xP7	0.39	0.49	-10.51**	-14.07**	0.01	2.65**	4.4**	12.79**	0.17
P1xP8	-0.91	-0.59	-1.51	1.77	-1.21*	0.15	2.73**	-1.56	-0.04
P2xP3	0.78	0.33	20.58**	3.43*	-0.71	0.04	-3.8**	-37.53**	-0.22
P2xP4	-1.61*	-1.62*	9.88**	-6.43**	1.01*	1.58	3.7**	21.81**	1.63*
P2xP5	-0.66	-1.15	-11.37**	-1.29	-0.46	0.72	1.39	21.61**	0.5
P2xP6	0.59	1.02	-0.67	11.63**	-0.19	2.48	1.59*	4.62	-0.45
P2xP7	-0.05	0.02	10.16**	5.38**	0.9	-0.88	-0.3	9.15**	1.78**
P2xP8	-0.19	0.1	-9.84**	-8.79**	-0.83	-1.71	0.37	3.87	-1.5
P3xP4	-2.19**	-2.12**	-53.98**	-36.85**	1.45**	-2.44	-1.94**	21.64**	-1.49*
P3xP5	-0.75	-0.65	5.6	-1.71	1.81**	-1.31	4.92**	27.34**	0.61
P3xP6	-0.16	-0.81	-22.04**	-7.12**	-0.58	1.12	1.12	7.36**	0.62
P3xP7	-0.47	-0.15	15.46**	11.63**	-1.66**	-3.41	-0.6	-29.78**	-0.71
P3xP8	2.06**	2.1**	12.8**	15.79**	-1.05*	4.59**	-0.93	-2.57	0.95
P4xP5	1.53*	2.41	10.74**	7.6**	0.04	3.31*	-6.55**	-7.39**	-1.17
P4xP6	0.28	0.41	19.77**	18.85**	-1.35**	-1.33	3.45**	-1.57	0.25
P4xP7	1.31*	1.58*	-2.73	4.27**	0.56	0.47	-3.11**	-19.54**	-1.32*
P4xP8	-0.16	0.16	4.6*	1.77	-1.33**	-3.19*	5.23**	-3.33	1.07
P5xP6	0.56	0.55	-0.65	-9.35**	-0.33	-2.53*	6.14**	-13.17**	0.88
P5xP7	0.75	0.21	-1.48	5.24**	-0.74	0.94	-2.58**	-12.48**	-0.89
P5xP8	0.45	0.13	-2.48	-3.93**	0.7	-1.72	-3.41**	-30.59**	-1.57*
P6xP7	-0.83	-0.62	-0.79	-3.51**	-0.96*	1.37	-0.71	6.37*	-0.08
P6xP8	-0.13	-0.37	6.55**	2.32	1.81**	3.04*	-6.88**	0.69	0.05
P7xP8	-1.11	-1.54*	-10.12**	-8.93**	1.9**	-1.16	2.9**	33.49**	1.05
LSD5%(sij)	1.28	1.41	4.51	2.71	0.94	2.51	1.46	5.12	1.29
LSD1%(sij)	1.7	1.87	5.99	3.6	1.25	3.33	1.94	6.8	1.71
LSD5%(sij-sik)	1.96	2.15	6.9	4.14	1.44	3.83	2.23	7.83	1.97
LSD1%(sij-sik)	2.6	2.85	9.15	5.49	1.91	5.08	2.96	10.38	2.61
LSD5%(sij-ski)	1.75	1.92	6.17	3.71	1.29	3.43	1.99	7	1.76
LSD1%(sij-ski)	2.32	2.55	8.18	4.91	1.71	4.55	2.65	9.29	2.33

* and ** refers to significant $p < 0.05$ and $p < 0.01$, respectively.

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تحليل القدرة على التالف باستخدام التهجين التبادلى بين ثمانية سلالات من الذرة الشامية تحت ميعادى زراعه

فريال محمد ترك و محمود الزعبلاوى البدوى و احمد على الحصرى و صديق عبد العزيز صديق محيسن
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أجرى تقييم الهجن الناتجة من التهجين النصف دائرى لثمانية سلالات من الذره الشامية البيضاء وذلك فى ميعادين مختلفين لتسعة صفات . كانت متوسطات التباين لكل من مواعيد الزراعة والهجن معنوية فى كل الصفات تحت الدراسة . كما كان متوسط التباين للتفاعل بين الهجن ومواعيد الزراعة معنوي لكل الصفات تحت الدراسة. و كانت التباينات للقدرة العامة والخاصة معنوية لكل الصفات تحت الدراسة .

وكانت النسبة بين القدرة العامة والقدرة الخاصة أكبر من الوحدة لكل من صفة موعد تزهير النوره المذكرة و المؤنثة ، ارتفاع النبات و ارتفاع الكوز , عدد الحبوب / صف, عدد الصفوف / كوز و وزن 100 حبة فى التحليل المشترك. و هذا يدل على ان التأثير المضيف هو الذى يتحكم فى توريث تلك الصفات. و بالنسبة لباقى الصفات كانت النسبة اقل من الوحده و هذا يدل على ان الجزء الغير مضيف يلعب الدور الاكبر فى توريث تلك الصفات. أظهرت السلالة الأبوية رقم 1 قدرة جيدة عامة على التالف لمحصول الحبوب للنبات و التزهير .

أظهرت الهجن P_1XP_3, P_1XP_5, P, XP_{71}, P_2XP_4, P_2XP_5, P_2XP_7 , P_3XP_4, P_3XP_5, $P_3X P_6$, P_6XP_7 و P_7XP_8, قدرة خاصة على التآلف لصفة متوسط محصول النبات بلغت 13.54, 14.68, 12.79, 21.81, 21.61, 9.15, 21.64, 27.34, 7.36, 7.36, 6.37 و 33.49 على التوالى .