Annals of Agric. Sci., Moshtohor
Vol. 56(2) (2018), 293 – 304

ISSN 1110-0419
http://aasj.bu.edu.eg/index.php

Combining ability analysis using diallel crosses among seven inbred lines of corn under two sowing dates.

Omnya H. Turkey S. A. Sedhom; M.EL.M. EL-Badawy and A.A.A. EL-Hosary
Agron. Dept., Fac. of Agric. Moshtohor, Benha Univ
Correspondence author:Omniaturky0100@Gmail.Com

Abstract

A half diallel cross between 7 inbred lines of maize was evaluated at two different sowing dates for nine quantitative characters. Sowing date and crosses mean squares were significant for all traits under study. Significant crosses x sowing date mean squares were obtained for all studied traits except, No. of rows/ear. General and specific combing ability mean squares were significant for all traits. For days to tasseling and days to silking at early sowing date; ear height, No of rows/ ear at late sowing date; No of kernels/row and 100-kernel weight at early sowing date and combined analysis, high ratios GCA/SCA which largely exceeded the unity were obtained, indicating that a large part of the total genetic variability associated with these traits was a result of additive and additive by additive gene action. For No of rows/ ear at the combined analysis, the ratio equal to one this mean additive and non-additive gene action are similar in controlling this case. For remain cases, showed GCA/SCA ratios less than unity. Therefore, it could be concluded that the large portion of the total genetic variability for these traits was due to non-additive gene action. The parental inbred line No. 6 and 4 seemed to be good combiner for grain yield/plant. Also, the parental inbred line No. 3 exhibited significant desirable ($\hat{g}_i$) effects for silking date and grain yield/ plant. The crosses P_1xP_3, P_1xP_5, P_2xP_5, P_2xP_6, P_2xP_7, P_3xP_4, P_3xP_7, P_4xP_5, P_4xP_6, and P_5xP_6 had the highest values for SCA effects. The crosses 2x6 and 3x4 out yielded the check hybrid 168 by 7.1 and 7.9%, respectively in the combined analysis.

Key words: Maize, Combining ability, Sowing dates, GxE.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops in Egypt and the world due to its vast grown area. It ranked the third cereal 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 2016 the corn grown area in Egypt was 0.75 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 the produce 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 a useful tool to produce promising hybrids and combining ability helps 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 **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. The elimination of GxE variance from the assessments of genetic variance forms an integral part of any endeavor to determine genetic variances without partiality **(Singh 1973 and 1979 and Wani *et al* 2017).**

Diallel mating pattern utilizing combining ability analyses are vastly used 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 **(Izhar and Chakraborty 2013).**

The main objectives of this investigation are to: 1) determine hybrid performance for the studied parental combination. 2) To estimate the amount of superiority over than the check hybrid SC 168. and 3) To establish the magnitude of both general combining ability (GCA) and specific combining ability (SCA) effects and their interaction with two different sowing dates.

Materials and Methods

Seven yellow inbred lines were used as parents in this study. Moshtohor P_1 (851), P_2 (852), P_3 (853), P_4 (854), P_5 (855), P_6 (856) and P_7 (857) were obtained by Prof. Dr. A.A.M. El-Hosary at the Department of Agronomy, Faculty of Agric. at Moshtohor, Benha Univ.. In the first season (summer 2016) the seven parental inbred lines were sown in 1st May, 7th May and 12th May to avoid differences in flowering time and to secure enough hybrid seed. All possible combinations without reciprocals were made between the seven inbred lines by hand method giving a total of 21 crosses. In the second season (summer 2017), two adjacent experiments were conducted at the two sowing dates: 15th May and 15th June. In each experiment the 21 F_1 hybrids as well as check hybrid SC G.168 were 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 secomended for ordinary maize field in the area. Random sample of 10 guarded plants in each plot were taken to evaluate silking and tasseling dates (days) in 50% of the plant silked or tasseled, leaf area of ear leaf (cm^2), plant height (cm), ear height (cm), No. of kernels/row, No. of rows/ear, 100-kernel weight and grain yield/plant which was adjusted for 15.5% moisture.

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 expressed as the percentage deviation of the F_1 mean performance from S.C. G.168.

Results and Discussion

The analysis of variance for ordinary analysis over the two experiments for all studied traits is given in Table (1). Sowing date mean squares for all traits under study were significant, with mean values in early sowing being higher than those in late sowing for all studied traits. The increase in these traits at early sowing date may be due to the prevailing of favorable temperature and day length leading to greater vegetative growth, yield and its components of corn plants therefore, the first sowing date seemed to be non-stress environment.

Crosses mean squares were significant for all traits (Table 1). This indicates wide diversity between the parental materials used in the present study. Significant crosses x sowing date mean squares were obtained for all traits except No. of rows/ear. Such results indicate that, these hybrids behaved somewhat differently from sowing date to another. For the exceptional traits, insignificant interaction was obtained, reflecting that the hybrids were suspected to environmental changes by nearly similar magnitudes. Mean performances of F_1 hybrids, S.C. G.168 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 168 are plants of those F_1 hybrids 2x3, 2x6, 2x7, 3x4, 3x5 and 3x6. The crosses 1x2, 1x6, 2x4, 2x6, 3x4, 3x5, 3x6, 4x5, 4x7, 5x7 and 6x7 gave the lowest mean values and differ significantly relative to SC 168 of plant and ear heights.

The crosses 1x3, 2x5, 2x6, 2x7, 3x4 and 3x7 gave the highest mean value of No of kernels/ row and differ significantly relative to SC 168. For 100-kernel weight none of the studied crosses differ significantly relative to SC 168. The crosses 2x5, 2x6, 2x7, 3x4, 3x7, 4x6, 5x7in early sowing date, 1x3, 2x6, 3x4, 3x7, 4x5 and 5x6 at late sowing date and 2x5, 2x6, 3x4, 3x7, and 5x6 in the combined data gave the highest mean value of grain yield / plant. Also, the mention hybrids showed significant superiority over the check hybrids.

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

SOV	df		days to 50% tasseling			days to 50% silking			Leaf area of ear		
	S.	c.	E	L	C.	E	L	C.	E	L	C.
Sowing dates (D)		**1**			314.29**			200.64**			313801.14**
blocks/D.	**2**	**4**	3.35**	0.33	1.84*	4.49**	2.11*	3.30*	70.86**	74.33**	72.60**
Crosses	**20**	**20**	23.42**	19.38**	36.73**	19.00**	8.18**	21.07**	12990.77**	18636.65**	22628.26**
Crosses x D		**20**			6.06**			6.11**			8999.16**
Error/D.	**40**	**80**	0.87	0.92	0.89	1.81	0.51	1.16	29.72	25.65	27.69
GCA	**6**	**6**	8.45**	2.74**	8.90**	6.81**	1.70**	6.56**	2296.39**	5011.95**	5558.29**
SCA	**14**	**14**	7.53**	8.05**	13.68**	6.13**	3.17**	7.22**	5201.91**	6726.62**	8393.24**
GCAxD		**6**			2.29**			1.95**			1750.05**
SCAxD		**14**			1.90**			2.07**			3535.29**
Error	**40**	**80**	0.29	0.31	0.30	0.60	0.17	0.39	9.91	8.55	9.23
GCA/SCA			1.12	0.34	0.65	1.11	0.54	0.91	0.44	0.75	0.66
GCAx D /GCA					0.26			0.30			0.31
SCAxD/SCA					0.14			0.29			0.42
SOV	**Df**		plant height			Ear height			No o f rows/ ear		
	S.	c.	E	L	C.	E	L	C.	E	L	C.
Sowing dates (D)		**1**			16801.79**			9991.14**			21.38**
blocks/D.	**2**	**4**	49.54*	16.78	33.16*	4.30	1.97	3.13	0.15	0.45	0.30
Crosses	**20**	**20**	669.65**	458.43**	831.90**	210.12**	154.80**	210.11**	1.54**	1.52**	2.86**
Crosses x D		**20**			296.19**			154.81**			0.20
Error/D.	**40**	**80**	9.92	9.28	9.60	2.70	3.47	3.08	0.21	0.17	0.19
GCA	**6**	**6**	49.31**	26.35**	50.04**	58.54**	82.90*	54.64**	0.42**	0.58**	0.95**
SCA	**14**	**14**	297.75**	207.01**	374.69**	74.97**	38.19**	76.63**	0.55**	0.48**	0.95**
GCAxD		**6**			25.61**			86.80**			0.04
SCAxD		**14**			130.07**			36.52**			0.08
Error	**40**	**80**	3.31	3.09	3.20	0.90	1.16	1.03	0.07	0.06	0.06
GCA/SCA			0.17	0.13	0.13	0.78	2.17	0.71	0.76	1.20	1.00
GCAx D /GCA					0.51			1.59			
SCAxD/SCA					0.35			0.48			
SOV			No o f kernel/row			100-kernel weight			grain yield/ plant		

	S.	c.	E	L	C.	E	L	C.	E	L	C.
Sowing dates (D)		**1**			720.97**			574.29**			39396.70**
blocks/D.	**2**	**4**	0.17	0.41	0.29	0.29	0.40	0.35	59.63	53.59	56.61
Crosses	**20**	**20**	42.05**	52.98**	76.45**	19.48**	12.29**	23.12**	1509.59**	2254.25**	2852.37**
Crosses x D		**20**			18.58**			8.65**			911.47**
Error/D.	**40**	**80**	0.28	0.19	0.24	0.34	0.25	0.29	19.20	28.94	24.07
GCA	**6**	**6**	20.92**	13.36**	32.13**	10.45**	3.00**	9.42**	286.02**	472.84**	596.74**
SCA	**14**	**14**	11.06**	19.50**	22.63**	4.80**	4.57**	6.97**	596.27**	870.81**	1102.53**
GCAxD		**6**			2.15**			4.02**			162.12**
SCAxD		**14**			7.93**			2.39**			364.55**
Error	**40**	**80**	0.09	0.06	0.08	0.11	0.08	0.10	6.40	9.65	8.02
GCA/SCA			1.89	0.69	1.42	2.18	0.66	1.35	0.48	0.54	0.54
GCAx D /GCA					0.07			0.43			0.27
SCAxD/SCA					0.35			0.34			0.33

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

S, C, E and L refer to single season, combined across seasons, Early and late sowing dates, respectively.

Table 2. Mean performance of the crosses for all studied traits across environments, grain yield plant^{-1} at both and across sowing dates and superiority relative to check hybrid SC168 at both and across environments.

cross	Days to 50% tasseling (days)	Days to 50% silking (days)	plant height (cm)	ear height (cm)	leaf area of ear leaf (cm^2)	No of rows/ ear	No of kernels/ row	100-kernel weight (g)
1x2	59.67	64.83	254.67	109.50	860.83	12.90	35.17	37.50
1x3	61.00	65.33	232.83	116.67	815.83	12.80	42.17	37.03
1x4	59.67	65.33	267.50	108.17	867.67	13.38	34.15	37.55
1x5	56.50	62.17	262.83	108.33	959.00	14.55	33.58	36.50
1x6	54.83	62.17	249.00	109.67	803.17	13.83	34.93	33.95
1x7	60.83	62.17	266.50	110.83	749.83	13.45	37.17	35.73
2x3	54.83	61.50	266.50	116.50	911.33	14.62	38.40	33.58
2x4	57.00	63.83	233.83	110.33	831.50	14.27	31.83	35.70
2x5	61.50	66.67	262.17	100.83	904.67	14.07	41.97	36.92
2x6	57.67	65.67	252.83	105.17	808.50	14.57	43.63	37.40
2x7	58.00	61.67	238.17	116.33	764.67	13.75	41.97	36.43
3x4	56.50	61.17	256.17	107.67	875.00	13.97	43.35	37.73
3x5	56.50	61.17	257.67	105.67	782.00	12.22	38.43	31.07
3x6	59.50	61.67	242.33	100.67	790.83	13.12	38.73	36.05
3x7	60.17	62.00	262.67	109.83	928.67	13.85	42.50	36.43
4x5	53.50	60.83	242.33	111.50	825.17	14.38	39.27	35.88
4x6	60.83	63.17	274.83	96.83	800.83	14.77	36.27	38.75
4x7	59.67	65.17	245.17	107.50	944.00	13.57	33.60	39.25
5x6	56.17	64.17	262.83	118.17	862.33	13.63	37.63	38.08
5x7	53.83	60.67	247.33	105.33	878.00	14.78	34.85	39.17
6x7	59.00	64.83	252.67	98.17	769.17	13.78	37.90	38.48
SC 168	59.50	63.00	264.83	114.17	852.83	13.47	39.83	38.85
LSD 5%	1.08	1.24	3.56	2.02	6.04	0.50	0.56	0.62
LSD 1%	1.44	1.64	4.72	2.68	8.01	0.66	0.74	0.83

Table 2. Cont.

cross	Grain yield/ plant (g)			Relative superiority over SC 168		
	E	L	Comb.	E	L	H%
1x2	175.00	158.33	166.67	-17.92**	-20.14**	-18.99**
1x3	206.67	198.00	202.33	-3.06	-0.14	-1.65
1x4	180.00	149.67	164.83	-15.57**	-24.51**	-19.88**
1x5	205.33	140.00	172.67	-3.69*	-29.39**	-16.07**
1x6	189.33	126.00	157.67	-11.19**	-36.45**	-23.36**
1x7	197.00	142.00	169.50	-7.60**	-28.38**	-17.61**
2x3	208.00	140.67	174.33	-2.44	-29.05**	-15.26**
2x4	172.33	148.00	160.17	-19.17**	-25.35**	-22.15**
2x5	228.67	181.67	205.17	7.25**	-8.37**	-0.28
2x6	222.67	218.00	220.33	4.44*	9.95**	7.10**
2x7	233.33	172.33	202.83	9.44**	-13.08**	-1.41
3x4	230.00	214.00	222.00	7.88**	7.93**	7.91**
3x5	151.67	129.67	140.67	-28.86**	-34.60**	-31.63**
3x6	200.33	172.00	186.17	-6.04**	-13.25**	-9.51**
3x7	224.00	194.33	209.17	5.07**	-1.99	1.67
4x5	201.67	201.00	201.33	-5.41**	1.38	-2.14
4x6	233.00	167.67	200.33	9.29**	-15.44**	-2.63
4x7	196.67	160.67	178.67	-7.75**	-18.97**	-13.16**
5x6	197.67	197.00	197.33	-7.29**	-0.64	-4.08**
5x7	230.67	151.00	190.83	8.19**	-23.84**	-7.24**
6x7	196.33	175.67	186.00	-7.91**	-11.40**	-9.59**
SC 168	213.20	183.33	198.27			
LSD 5%	7.23	8.88	5.63			
LSD 1%	9.67	11.88	7.47			

* and ** refers to significant $p< 0.05$ and $p< 0.01$, respectively.
E and L refer to early and late sowing dates, respectively

Heterosis:

Relative superiority relative to SC 168 expressed as the percentage deviation of F_1 mean performance from each of S.C. G.168 values for grain yield/plant are presented in Table (2). Concerning grain yield/plant the crosses 2x5, 2x6, 2x7, 3x4, 3x7, 4x6 and 5x7, out yielded the check hybrid in early sowing date; the crosses 2x6 and 3x4 out yielded the check hybrid 168 in late sowing date as well as the combined analysis. Also, six hybrids had insignificant heterotic effects relative to S.C. G.168. Hence, it could be concluded that these crosses offer possibility for improving grain yield in maize. Many investigators reported high heterosis for yield of maize; i.e. **Nawar *et al.*, (2002), Shafey *et al.*, (2003), El-Bagoury *et al.*, (2004), Singh *et al.*, (2004), El-Hosary *et al.*, (2006), El-Hosary (2015)** and **EL-Hosary and EL-Fiki (2015)**

Combining ability

The analysis of variance for combining ability at the combined analysis for all the studied traits is presented in Table (1). The mean squares 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 significant for all the studied 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 general and specific combing ability mean squares which were highly significant. Hence, GCA/SCA ratio was used as measure to reveal the nature of genetic variance involved

For days to tasseling and days to silking at early sowing date; ear height, No of rows/ ear at late sowing date; No of kernel/row and 100-kernel weight at early sowing date and combined analysis, high ratios which largely exceeded the unity were obtained, indicating that a large part of the total genetic variability associated with theses traits was a result of additive and additive by additive gene action. For No of rows/ ear at the combined analysis, the ratio equal to one this mean additive and non-additive gene action are similar in controlling this case. For remain cases, showed GCA/SCA ratios less than unity. Therefore, it could be concluded that the large portion of the total genetic variability for these traits was due to non-additive gene action. The largest heterotic magnitude expressed in the previous traits as the deviation of particular F_1 mean performance from check S.C. G168, may strengthened the conclusion about the importance of non-additive gene effects in the inheritance of these traits. The genetic variance was previously reported to be mostly due to non-additive for Plant, ear height , no. of grains/row by **(Amer 2003 and Shafey *et al.*, 2003)** and grain yield/ plant by **(Amer 2003; Mosa 2003; Shafey *et al.*, 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 most prevalent for earliness and No. of rows/ear by **(Amer, 2003; Mosa, 2003; EL-Hosary and EL-Badawy 2005)**; and 100-kernel weight by **(Dubey *et al.*, 2001; Shafey *et al.*, 2003; EL-Hosary and EL-Badawy 2005).**

The mean squares of interaction between sowing dates and both types of combining ability were significant for all studied traits except No of rows/ ear. 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 kernels/ row and grain yield/ plant. This result indicated that additive effects were more influenced by the environmental conditions than non- additive genetic effects of these traits. Such results indicated that non-additive effects are influenced by seasonal changes **(Mosa and Motawei 2005 and El-Hosary *et al.*, 2006).** For other traits, 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 of this trait. This conclusion is in well agreement with those reported by **(Gilbert 1958).**

For No of rows/ ear, insignificant mean squares of interaction between sowing date and both combining abilities were obtained for ear height, No. of rows/ ear revealing that all types of gene action were not appreciably fluctuated in magnitude from sowing date to another. This finding confirms those obtained above from the ordinary analysis of variance. Such results indicated that additive effects are influenced by environmental changes **(Amer 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. 2 exhibited significant negative ($\hat{g}_i$) effects for; plant height, indicating that this inbred line could be considered as good combiner for developing short genotypes. Shortest plant and ear heights are required for lodging resistance. Also, it gave positive and significant ($\hat{g}_i$) effects for leaf area of ear, no of rows/ ear, No of kernels/ row and grain yield/ plant. The parental inbred line no. 3 showed significant negative ($\hat{g}_i$) effects for silking date. On the same time, it gave positive $\hat{g}_i$ effects for leaf area, No of kernels/ row and grain yield/ plant.

. The parental inbred line No. 4 seemed to be good combiner for; ear height, leaf area of ear, No. of rows/ ear, and 100-kernel weight. The parental inbred line No 5 gave desirable ($\hat{g}_i$) effects for days to 50% tasseling and silking, leaf area of ear. The parental inbred line No. 6 ranked the first for grain yield/plant. However it gave desirable ($\hat{g}_i$) effects for ear height, No of kernels/ row, 100-kernel weight. The parental inbred line No. 6 seemed to be good combiner for plant height, No of kernels/ row, 100-kernel weight and grain yield/plant. The parental inbred line No. 7 seemed to be good combiner for; plant height, 100-kernel weight and grain yield/plant. It seemed to be poor combiner for other traits.

It is worth noting that the inbred line which possessed high ($\hat{g}_i$) effects for grain yield per plant might show the same for one or more of the traits contributing grain yield. In most traits, the values of ($\hat{g}_i$) effects was mostly differed from sowing date to another. This finding coincided with that reached above where significant GCA by sowing date mean squares were detected Table (1).

Specific combining ability:

Estimation of SCA effects in 21 crosses for the studied traits over the two sowing date are presented in table (4). The most desirable inter and intra allelic interactions were presented by P1xP6, P2xP3, P2xP7, P4xP5 and P5xP7 for days to 50% tasseling and silking; P3xP4, P3xP5 and P6xP7 for plant and ear heights; P1xP4, P1xP5, P1xP7, P2xP3, P2xP6, P3xP5, P3xP7, P4xP6, and P5xP6 for leaf area of ear, P1xP5, P2xP3, P3xP7, P4xP6 and P5xP7 No of kernels/ row; P1xP2, P1xP3, P1xP5, P2xP5, P2xP6, P3xP4, P4xP6, P5xP6, and P5xP7 for 100-kernel weight. The parental combination P1xP3, P1xP5, P2xP5, P2xP6, P2xP7, P3xP4, P3xP7, P4xP5, P4xP6, and P5xP6 for grain yield/plant exhibited significant positive $\hat{S}_{ij}$ effects being 29.27, 4.93, 18.27, 25.47, 10.13, 30.20, 15.43, 14.87, 5.90 and 6.77, 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 3. Estimates of general combining ability effects of eightseven inbred lines for all the studied traits across two sowing dates.

parent	Days to 50% tasseling	Days to 50% silking	Leaf area of ear	Plant height	Ear height	No of rows/ ear	No of kernels/row	100-kernel weight	Grain yield/ plant
p1	0.95**	0.62*	-2.05	2.05**	2.71**	-0.40**	-2.14**	-0.30*	-16.64**
p2	0.18	1.05**	2.99*	-2.99**	1.81**	0.25*	1.02**	-0.45**	2.53*
p3	0.15	-1.21**	7.42**	-0.99	1.48**	-0.47**	3.15**	-1.57**	3.56**
p4	-0.12	0.12	15.52**	-0.65	-1.52**	0.28**	-1.88**	1.02**	2.10
p5	-1.95**	-0.65*	28.92**	2.41**	0.04	0.14	-0.42**	-0.43**	-1.77
p6	0.05	0.55*	-46.35**	2.28**	-4.19**	0.15	0.25*	0.59**	6.20**
p7	0.75**	-0.48	-6.45**	-2.12**	-0.32	0.05	0.03	1.15**	4.03**
LSD5%(gi)	0.45	0.51	2.50	1.47	0.84	0.21	0.23	0.26	2.33
LSD1%(gi)	0.60	0.68	3.32	1.95	1.11	0.27	0.31	0.34	3.09
LSD5%(gi-gj)	0.69	0.78	3.82	2.25	1.28	0.31	0.35	0.39	3.56
LSD1%(gi-gj)	0.91	1.04	5.07	2.98	1.69	0.42	0.47	0.52	4.73

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

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

	Days to 50% tasseling	Days to 50% silking	Leaf area of ear	Plant height	Ear height	No o f rows/ ear	No o f kernel/row	100-kernel weight	Grain yield/ plant
P1 x P2	0.58	0.01	1.76	-3.29**	15.47**	-0.77**	-1.69**	1.62**	-5.37*
P1 x P3	1.94**	2.78**	-22.08**	4.21**	-33.97**	-0.15	3.18**	2.28**	29.27**
P1 x P4	0.88	1.44**	12.26**	-1.29	9.77**	-0.32	0.19	0.20	-6.77**
P1 x P5	-0.46	-0.96	4.52**	-2.69**	87.70**	0.99**	-1.83**	0.60**	4.93*
P1 x P6	-4.12**	-2.16**	-9.18**	2.88**	7.13**	0.26	-1.15**	-2.97**	-18.03**
P1 x P7	1.18**	-1.12*	12.72**	0.18	-86.10**	-0.02	1.30**	-1.74**	-4.03
P2 x P3	-3.46**	-1.49**	16.62**	4.94**	56.50**	1.02**	-3.74**	-1.02**	-17.90**
P2 x P4	-1.02*	-0.49	-16.38**	1.78*	-31.43**	-0.08	-5.29**	-1.50**	-30.60**
P2 x P5	5.31**	3.11**	8.89**	-9.29**	28.33**	-0.14	3.39**	1.17**	18.27**
P2 x P6	-0.52	0.91	-0.31	-0.72	7.43**	0.34	4.39**	0.63*	25.47**
P2 x P7	-0.89*	-2.06**	-10.58**	6.58**	-76.30**	-0.37	2.94**	-0.89**	10.13**
P3 x P4	-1.49**	-0.89	3.96**	-0.56	7.63**	0.34	4.11**	1.66**	30.20**
P3 x P5	0.34	-0.12	2.39	-4.12**	-98.77**	-1.27**	-2.26**	-3.56**	-47.27**
P3 x P6	1.34**	-0.82	-12.81**	-4.89**	-14.67**	-0.39	-2.64**	0.41	-9.73**
P3 x P7	1.31**	0.54	11.92**	0.41	83.27**	0.45*	1.35**	0.23	15.43**
P4 x P5	-2.39**	-1.79**	-13.28**	4.71**	-63.70**	0.14	3.59**	-1.33**	14.87**
P4 x P6	2.94**	-0.66	19.36**	-5.72**	-12.77**	0.51*	-0.08	0.51*	5.90*
P4 x P7	1.08*	2.38**	-5.91**	1.08	90.50**	-0.59**	-2.52**	0.46	-13.60**
P5 x P6	0.11	1.11*	4.29**	14.04**	35.33**	-0.48*	-0.17	1.30**	6.77
P5 x P7	-2.92**	-1.36**	-6.81**	-2.66**	11.10**	0.77**	-2.73**	1.82**	2.43
P6 x P7	0.24	1.61**	-1.34	-5.59**	-22.47**	-0.24	-0.35	0.12	-10.37
LSD5%(sij)	0.89	1.01	2.91	1.65	4.93	0.40	0.46	0.51	4.60
LSD1%(sij)	1.17	1.34	3.85	2.18	6.54	0.54	0.60	0.67	6.10
LSD5%(sij-sik)	1.37	1.56	4.50	2.55	7.64	0.63	0.71	0.79	7.13
LSD1%(sij-sik)	1.82	2.07	5.97	3.38	10.14	0.83	0.94	1.05	9.45
LSD5%(sij-ski)	1.19	1.35	3.90	2.21	6.62	0.54	0.61	0.68	6.17
LSD1%(sij-ski)	1.58	1.80	5.17	2.93	8.78	0.72	0.81	0.91	8.19

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

Reference

Al-Naggar, A.M.M., M.M.M. Atta, M.A. Ahmed and A.S.M. Younis (2016). Mean performance, heterobeltiosis and combining ability of corn (*Zea mays* L.) agronomic and yield traits under elevated plant density. J Appl. Life Sci. Int. 7(3):1-20.

Al-Naggar, A.M.M., R. Shabana, M. S. Hassanein , T. A. Elewa, A.S.M. Younis and A.M.A. Metwally (2017a). The effect of increasing plant density on performance and heterobeltiosis in maize testcrosses among 23 inbreds and three testers. J. Archives of Cur. Res. Int. 8(4): 1-14.

Al-Naggar, A.M.M., R. Shabana, M. S. Hassanein , T. A. Elewa, A.S.M. Younis and A.M.A. Metwally (2017 b). Estimation of genetic parameters controlling inheritance of maize quantitative traits under different plant densities using Line × Tester analysis. Asian J of Adv. Agric. Res. 2(2): 1-12.

Amer, E.A. (2003). Diallel analysis for yield and its components of maize under two different locations. Minufiya J. Agric. Res.28 (5): 1363-1373.

Amer, E.A. (2005): Estimates of combining ability using diallel crosses among eight new maize inbred lines. j. Aric. Res. Tanta Univ., 31(2) 67-73.

Dubey, R.B.; V.N. Joshi and N.K. Pandiya (2001). Heterosais and combining ability for quality, yield and maturity traits in conventional and non-conventional hybrids of maize (*Zea mays L.*). Indian J. of Gen. and Plant Breed. 61(4): 353-355.

El-Bagoury, O.H.; K.A. El-Shouny; H.Y. El-Sherbieny and S.A. Al-Ahmad (2004). Estimation of heterosis and its interaction with plant densities in some yellow maize crosses. Arab Universities J. Agric.Sci. 12(1): 201-219.

EL-Hosary, A. A. A and I. A. I. EL-Fiki (2015). Diallel cross analysis for earliness, yield, its components and resistance to late wilt in maize. Inter. J Agric. Sci. Res. 5(6):, 199-210

EL-Hosary, A.A. and M.EL.M. EL-Badawy (2005). Heterosis and combining ability in yellow corn (*Zea mays L.*) under two nitrogen levels. The 11th Conf. Agron., Agron. Dept., Fac. Agric., Assiut Univ., 89-99.

EL-Hosary, A.A.; M.EL.M. EL-Badawy and Y.M. Abdel-tawab (2006). Genetic distance of inbred lines and prediction of maize single-cross performance using RAPD and SSR markers. Egypt. J. Genet. Cytol. 35: 209-224.

El-Hosary, A.A.A. (2015). Genetic analysis of water stress tolerance attributes in F_1 maize diallel crosses. Egypt. J. Plant Breed. 19 (6): 1765-1781

Gilbert, N.E.G. (1958). Diallel cross in plant breeding heredity, 12: 477-492.

Girma, C.H., A. Sentayehu, T. Berhanu and M. Temesgen (2015). Test cross performance and combining ability of maize (*Zea mays* L.) inbred lines at Bako, Western Ethiopia. Global J. of Sci. Fron. Res. 15(4)1:1-12.

Gomez, K.N. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. John.Wiley and Sons. Inc., new york, 2nd ed.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. Aus. J. of Biol. Sci. 9: 463-493.

Izhar, T. and M. Chakraborty (2013). Combining ability and heterosis for grain yield and its components in maize inbreds over environments (Zea mays L.). African J. of Agric. Res. 8(25): 3276-3280.

Mosa, H.E. (2003). Combining ability of eight yellow maize (*Zea mays L.*) inbred lines for different characters in diallel crosses. J. Agric. Res. Tanta Univ., 31(4-A) 604-614.

Mosa, H.E. and A.A. Motawei (2005). Combining ability of resistance to late wilt diseases and grain yield and their relationships under artificial and natural infections in maize. J. Agric. Sci. Mansoura Univ., 30(2): 731-742.

Nawar, A.A.; S.A. El-Shamarka and E.A. El-Absawy (2002). Diallel analysis of some agronomic traits of maize. J. Agric. Sci. Mansoura Univ., 27 (11): 7203-7213.

Shafey, S.A.; yassien, H.E.; El-Beially, I.E.M.A. and Gad-Alla, O.A.M. (2003). Estimation of combining ability and heterosis effects for groth, earliness and yield in maize (*Zea mays L.*). J. Agric. Sci. Mansoura Univ., 28 (1): 55-67.

Singh A.K.; Shahi, J.P. and Singh, J.K. (2004). Heterosis in maize. J. Applied Biology 14(1): 1-5.

Singh, D. (1973). Diallel analysis over different environments-I. Indian J Genetics and Plant Breed. 33: 127-136.

Singh, D. (1979). Diallel analysis for combining ability over environments. Indian J Genetics and Plant Breed., 39: 383-386.

USDA-FAS, (2018). United States Department of Agriculture, Foreign Agricultural Service. Circular Series January 2018 WAP 1-18

Wani, M.M.A., S.A. Wani, Z.A. Dar, A.A. Lone, I. Abedi and A. Gazal (2017). Combining ability analysis in early maturing maize inbred lines under temperate conditions, Int. J. Pure App. Biosci. 5(2): 456-466.

Williams, J.K.F.; A.R. Kubelik,; K.G. Livak,; J.A. Rafalki, and S.V. Tingey (1990). DNA polymorphisms amplified by arbitrary primers are useful as genetic markers. Nucleic Acid Res., 18:6531-6535.

Zhang, C.L.; Z.L. Sun; D.M. Jin; S.M. Sun; B.T. Guo and B. Wang (1998). Identification of maize inbred lines and validation of genetic relation among maize inbred lines using RAPD markers. Maize Genetics Cooperation newsletter 72: 9-10.

تحليل القدرة على التالف باستخدام التهجين التبادلى بين سبعة سلالات من الذرة الشامية تحت ميعادى زراعة

امنية حسن تركى – سيدهم أسعد سيدهم – محمود الزعبلاوى البدوى– احمد على الحصرى
قسم المحاصيل – كلية زراعة مشتهر – جامعة بنها

أجرى تقييم الهجن الناتجة من التهجين النصف دائرى لسبعة سلالات من الذرة الصفراء وذلك فى ميعادين مختلفين لتسعة صفات كمية . 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 ما عدا صفة عدد الصفوف للكوز . 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 فى ميعاد الزراعة المبكر، ارتفاع النبات و عدد الصفوف / كوز فى ميعادى الزراعة المتأخر و وزن 100 حبة فى ميعادى الزراعة المبكر و التحليل المشترك. و هذا يدل على ان التأثير المضيف هو الذى يتحكم فى توريث تلك الصفات. و بالنسبة لصفة عدد الصفوف بالكوز فأن النسبة تساوى الوحدة و هذا يدل على تساوى التأثير المضيف و الغير مضيف فى توريث تلك الصفة. 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 4 و 6 قدرة جيدة عامة على التالف لمحصول الحبوب للنبات . كما أظهرت السلالة رقم 3 قدرة جيدة على التألف للتزهير و محصول الحبوب للنبات . أظهرت الهجن P_1 X P_3, P_1 X P_5, P_2 X P_5, P_2 X P_6, P_2 X P_7, P_3 X P_4, P_3 X P_7, P_4 X P_5, P_4 X P_6 و P_5 X P_6, قدرة خاصة على التآلف لصفة متوسط محصول النبات . اظهرت الهجن 2x6 و 3x4 زيادة معنوية عن صنف المقارنة هجين فردى 168 بنسبة 7.1 و 7.9 % على الترتيب.