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COMBINING ABILITY AND HETEROSIS FOR SOME FLOWERING AND VEGETATIVE TRAITS OF FIVE MAIZE INBREDS UNDER TWO NITROGEN LEVELS FERTILIZATION

Sultan, M. S.[1] ; M. A. Abdel-Moneam[1] ; S. M. G. Salama[2] and A. M. EL. Oraby[3]
1Dept. of Agronomy, Fac. Agric. , Mans. Univ.
2Central Lab. for Design and Statistical Analysis Res. ARC Egypt.
3Fine Seeds International Company.

ABSTRACT

A half diallel cross among 5 inbred lines of maize was evaluated under two different nitrogen rates for flowering and vegetative characters i.e. anthesis date, silking date, Anthesis-Silking Interval (ASI), plant height, ear height, ear leaf area and stem diameter, to evaluate the role of GCA and SCA of inbred lines in hybrids performance under high and low of nitrogen levels, and to establish the magnitude of heterosis as well as both GCA and SCA effects and their interaction with the nitrogen fertilization rates. Mean squares were significant for all studied traits except, ear leaf area under normal nitrogen level. General and specific combining ability (GCA and SCA) mean squares were significant for all studied traits, except stem diameter under normal nitrogen level at GCA and ear leaf area under normal nitrogen level at GCA and SCA. GCA/SCA ratios revealed that the non-additive gene action for anthesis date, silking date, plant height under normal nitrogen, ASI, ear height, stem diameter under both nitrogen levels and ear leaf area under stress nitrogen level. While, the additive gene action was recorded for anthesis date, silking date and plant height under stress nitrogen level and ear leaf area under normal nitrogen level. The additive gene action was the most expression under normal nitrogen level. The best combiners were P_2 (Inb.95) and P_4 (Inb.204) inbred lines for most of studied traits under normal and stress nitrogen levels. This result indicated that these inbred lines could be considered as good combiners for improving these traits. The best crosses for anthesis and ASI date was P_2 (Inb.95) X P_5 (Inb.213), for silking date was P_2 (Inb.95) X P_3 (Inb.144), for plant height was P_3 (Inb.144) X P_5 (Inb.213), ear height was P_1 (Inb.84) X P_4 (Inb.204) and stem diameter was P_4 (Inb.204) X P_5 (Inb.213) under both nitrogen levels. These crosses could be selected and used in breeding programs for improving these traits. Results showed significant heterosis for all studied traits. The best crosses over both their mid-parents and better-parents for anthesis date and silking date was P_2 (Inb.95) X P_3 (Inb.144) under both nitrogen levels for ASI date was P_2 (Inb.95) X P_5 (Inb.213), for ear height was P_1 (Inb.84) X P_4 (Inb.204), for plant height was P_3 (Inb.144) X P_5 (Inb.213), for ear leaf area was P_1 (Inb.84) X P_3 (Inb.144) under stress nitrogen level and for stem diameter were P_2 (Inb.95) X P_5 (Inb.213), P_3 (Inb.144) X P_5 (Inb.213) and P_4 (Inb.204) X P_5 (Inb.213).

INTRODUCTION

Maize belongs to poaceae family and tribe Maydaeae. Maize is an annual short day, cross pollinated crop. Based on area and production, maize is the 3rd most important cereal crop after wheat and rice, all over the world for production and consumption. In addition to its use as a human food, it is also utilized as a poultry and livestock feed. Moreover it is also used for many industrial purposes (White and Johnson, 2003) . Maize (*Zea mays* L.) forms major dietary part of millions of people in the form bread making where the government policy is to mix wheat flour (80%) with maize flour (20%) in bread making all over the country in order to reduce wheat imports. Maize is the most important crop in eastern and southern Africa in area harvested and the contribution of calories and protein to diets (FAO, 2011). Nitrogen is the most important nutritive element for the worldwide production of cereals (wheat, barley, rice, sorghum and maize). It is mostly supplied to the soil in the form of inorganic fertilizers and to a lesser extent as organic manure. A considerable portion of fertilizer N is lost through gaseous plant emissions, soil denitrification, surface runoff, ammonia volatilization, and leaching (Akintoye *et al*., 1999 and Raun and Johnson, 1999) These losses account for the low estimate of 33% for worldwide N-use efficiency (NUE) (NUE=N recovered / N supplied) with a slightly higher 42% estimate for developed than developing 29% countries (Raun and Johnson, 1999) The affordability of N in the developed countries has led to its misuse and over application (Raun and Johnson, 1999) and created growing environmental concerns from increased nitrate leaching that may lead to ground water contamination. In contrast, the rates of N fertilizers in most developing countries are considerably low because of the limited access to fertilizers and the low purchasing power of small farmers due a high fertilizer / cereal grain price ratio. The two main genetic parameters of diallel analysis are GCA and SCA which are essential in developing breeding strategies. In this concern, several investigators reported that additive gene action was responsible for the inheritance of growth characters (Sedhom, 1994; Ahmed *et al*, 2000; Al-Nagger *et al*, 2002; Alamnie *et al*, 2006 and El-Badawy, 2006). However, Dadheech and Joshi, (2007), Barakat and Osman, (2008) and Irshad-El-Haq *et al*, (2010) reported that non-additive gene action was more important in the inheritance of agronomic traits in maize. Therefore, the objectives of this study were evaluate the role of GCA and SCA of inbred lines in hybrids performance under high and low of nitrogen levels, and to establish the magnitude of heterosis as well as both GCA and SCA effects under two nitrogen fertilization rates.

MATERIALS AND METHODS

Plant materials: Five inbred lines of corn (*Zea mays*, L.) were used as parents in this study i.e., P_1(Inb. 84), P_2(Inb95), P_3(Inb. 144), P_4(Inb. 204) and P_5(Inb. 213). These inbred lines were obtained from Agriculture Research Center (ARC).

Field experiments: The field trials were started in the 2011 growing season in the Experimental Farm of the Faculty of Agric., Mansoura Univ., and lasted in 2012.

In 2011 growing season, the five parental inbred lines were planted on April 21st and May 7th, and each inbred line was grown in two rows, to overcome the differences in flowering date and to secure enough hybrid seeds. During this season, all possible cross combinations, without reciprocals, were made giving a total of 10 F_1 's hybrid seeds. In 2012 growing season, 16 entries (10 F_1's along their 5 parental inbred lines plus one check cultivar (S.C.10)) were grown in two experiments representing two different nitrogen levels, which were 60Kg N / fad (stress) and 120Kg N / fad (normal) by using distance of 70cm between ridges and 25 cm between hills. Each experiment was designated in a Randomized Complete Blocks Design (RCBD) with three replicates. Each plot consisted of one ridge three meters long. Hills were thinned after seedling emergence to secure one plant per hill. Each experiment was hoed twice, before first and second irrigations. Phosphorus in the form of calcium super phosphate (15.5 % P2O5) at a rate of 200 kg/fad, was added to the soil during seedbed preparation, and potassium sulphate (48 % K2O) at a level of 50 kg / fad was applied after thinning. Moreover, nitrogen in the form of Urea (46% N) at a rate studied (60 and 120 kg/fad) was added in two equal split doses, before the first and the second irrigation. Other agriculture practices were applied as recommended.

Studied traits: The following measurements were recorded: anthesis date (day), silking date (day), anthesis-silking interval (ASI) (day), plant height (cm), ear height (cm) , stem diameter (cm) and ear leaf area (cm^2).

Statistical analysis: The obtained data were statistically analyzed for anlaysis of variance by using computer statistical program MSTAT-C.The Ten single crosses comprise a half diallel among 5 inbred parents. Data of all 10 single crosses at each nitrogen level treatment were analyzed as randomized blocks. The sum squares of genotypes were partitioned to general and specific combining ability, following method 2 model 1 (fixed) of **Griffing** (1956).

RESULTS AND DISCUSSION

Results in table 1 indicated that mean square of genotypes were highly significant for all studied traits under both nitrogen levels i.e., tasselling date, anthesis date, silking date, ASI, plant height, ear height and stem diameter except, ear leaf area under normal nitrogen level. Mean squares for general combining ability (GCA) were significant or highly significant for all studied traits under both nitrogen levels except, ASI under stress nitrogen level, ear leaf area and stem diameter under normal nitrogen level were non-significant. Mean quares for specific combining ability (SCA) were highly significant for all studied traits under both nitrogen levels except, ear leaf area under normal nitrogen level. The GCA/SCA ratio was less than unity for ASI, ear height and stem diameter this means that these traits are predominantly controlled by non-additive gene action under both nitrogen levels, also, anthesis date, silking date and plant height under normal nitrogen level as well as ear leaf area under stress nitrogen level show same trend while, anthesis date, silking date and plant height under stress nitrogen level and ear leaf area under normal nitrogen level were controlled by additive gene action, which the GCA/SCA ratio was more than one, as shown in Table 1. Similar results were obtained by El-Hosary *et a*l. (1994), Nawar *et al*. (2002), Katta *et al*. (2007) and El-Ghonemy and Ibrahim (2010).

Table 1: Mean squares of genotypes, GCA and SCA for studied maize flowering and vegetative traits under normal and stress nitrogen levels conditions.

Traits		Anthesis date (day)		Silking date (day)		ASI (day)	
S.V.	d.f.	Normal	Stress	Normal	Stress	Normal	Stress
Genotypes	14	26.75**	24.26**	24.21**	20.61**	0.85**	0.59**
GCA	4	5.44**	8.89**	6.31**	9.11**	0.28*	0.06
SCA	10	10.31**	7.77**	8.77**	5.98**	0.29**	0.25**
Error	28	0.44	0.69	0.44	0.68	0.08	0.06
GCA/SCA		0.53	1.14	0.72	1.52	0.97	0.24

Table 1: Continue

Traits		Plant height (cm)		Ear height (cm)		Ear leaf area (cm^2)		Stem diameter (cm)	
S.V.	d.f.	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress
Genotypes	14	5562.1**	5446.7**	1725.1**	1748.7**	794133.5	77908.0**	0.38**	0.36**
GCA	4	1680.2**	1969.8**	317.2**	422.1**	576528.0	12516.6**	0.03	0.02**
SCA	10	1923.6**	1753.9**	678.2**	647.2**	139984.5	31350.4**	0.17**	0.16**
Error	28	16.40	34.60	9.815	14.42	276049.2	351.5	0.01	0.0001
GCA/SCA		0.87	1.12	0.47	0.65	4.12	0.40	0.18	0.13

***and**significant at 5% and 1% probability levels, respectively.**

Table 2: Means of studied traits for maize inbreds and their crosses under normal and stress nitrogen levels.

Traits	Anthesis date (day)		Silking date (day)		ASI (day)	
Genotypes	Stress	Normal	Stress	Normal	Stress	Normal
P_1(Inb.84)	63.00	68.67	64.00	70.33	1.00	1.67
P_2(Inb.95)	62.00	68.00	62.67	69.33	0.67	1.33
P_3(Inb.144)	63.33	68.67	64.33	70.67	1.00	2.00
P_4(Inb.204)	65.33	69.00	66.33	71.00	1.00	2.00
P_5(Inb.213)	62.33	66.67	63.00	68.33	0.67	1.67
Parents mean	**63.20**	**68.20**	**12.60**	**13.67**	**0.87**	**1.73**
P_1 X P_2	59.67	63.67	60.67	65.33	1.00	1.67
P_1 X P_3	59.00	64.67	60.00	66.33	1.00	1.67
P_1 X P_4	63.67	68.33	65.33	70.67	1.67	2.33
P_1 X P_5	60.00	65.00	61.33	67.33	1.33	2.33
P_2 X P_3	55.33	60.33	57.00	62.67	1.67	2.33
P_2 X P_4	61.33	66.00	62.67	68.67	1.33	2.67
P_2 X P_5	55.33	60.00	57.33	63.00	2.00	3.00
P_3 X P_4	59.00	62.67	60.67	65.33	1.67	2.67
P_3 X P_5	59.67	68.00	61.67	70.67	2.00	2.67
P_4 X P_5	60.67	67.00	62.33	70.00	1.67	3.00
Check S.C.10	64.33	71.33	65.67	73.67	1.33	2.33
Crosses mean	**59.82**	**65.18**	**61.33**	**67.61**	**1.52**	**2.42**
L.S.D. at 0.05	**2.40**	**1.93**	**2.39**	**1.93**	**0.71**	**0.82**
L.S.D. at 0.01	**3.24**	**2.60**	**3.22**	**2.60**	**0.95**	**1.11**

Table 2: **Continue…**

Traits	Plant height(cm)		Ear height(cm)		Ear leaf area(cm^2)		Stem diameter(cm)	
Genotypes	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**
P_1(Inb.84)	204.0	217.6	126.9	136.8	381.7	501.6	2.73	2.95
P_2(Inb.95)	162.8	181.1	104.6	120.7	524.6	649.6	2.58	3.03
P_3(Inb.144)	180.9	197.9	110.6	124.1	490.3	624.8	2.60	2.82
P_4(Inb.204)	216.8	232.8	113.7	125.9	582.9	688.2	2.75	2.95
P_5(Inb.213)	140.0	159.9	97.1	113.2	494.8	646.8	2.15	2.35
Parents mean	**180.9**	**197.9**	**110.6**	**124.1**	**494.9**	**622.2**	**2.56**	**2.82**
P_1 X P_2	260.0	279.7	159.2	177.2	675.7	797.9	3.07	2.90
P_1 X P_3	266.3	284.8	160.4	175.2	797.2	921.4	3.08	3.33
P_1 X P_4	293.1	307.9	178.2	188.6	765.5	879.1	3.15	3.43
P_1 X P_5	237.9	256.7	152.2	166.9	733.4	876.5	3.25	3.45
P_2 X P_3	235.7	261.7	148.6	167.0	810.8	969.2	3.20	3.44
P_2 X P_4	260.0	285.1	155.6	174.4	839.1	973.9	3.23	3.47
P_2 X P_5	212.7	237.4	137.3	151.4	746.0	847.5	3.23	3.47
P_3 X P_4	270.0	289.1	164.7	172.3	929.9	1072.7	3.23	3.52
P_3 X P_5	242.6	260.7	139.9	151.6	816.6	992.9	3.24	3.48
P_4 X P_5	247.6	270.4	135.5	157.3	828.6	956.0	3.35	3.59
Check S.C.10	257.1	284.5	128.1	154.8	8921.0	1079.9	3.22	3.79
Crosses mean	**253.0**	**274.4**	**150.9**	**167.0**	**803.2**	**942.8**	**3.20**	**3.44**
L.S.D. at 0.05	**17.04**	**11.73**	**11.00**	**9.07**	**54.30**	**-**	**0.18**	**0.31**
L.S.D. at 0.01	**22.98**	**15.82**	**14.84**	**12.24**	**73.25**	**-**	**0.24**	**0.42**

Mean performance of traits:

Means of number of days to 50% anthesis as affected by normal and stress nitrogen levels are presented in Table (2). The earliest parent in pollen shedding was P_2(Inb.95) under stress nitrogen level and p_5 (Inb.213) under normal nitrogen levels. The earliest crosses in pollen shedding were p_2xp_5 under normal nitrogen level and P_2xP_3 under stress nitrogen level. The earliest parents in silking date was P_5 (Inb.213) under normal nitrogen level and P_2 (Inb.95) under stress nitrogen level. The earliest crosses in silking date were p_2xp_3 under normal nitrogen level and P_2xP_3 under stress nitrogen level. The earliest parent in (ASI) was P_2(Inb.95) and P_5(Inb.213) under stress nitrogen level and P_2(Inb.95) under normal nitrogen level. The earliest crosses in ASI were P_1xP_2 and P_1xP_3 under normal nitrogen level and P_1xP_2 and P_1xP_3 under stress nitrogen level. The tallest parent was P_4 (Inb.204) under both nitrogen levels. Mean while, parent P_5(Inb.213) was the shortest parent under both nitrogen levels. The tallest cross was P_1xP_4 under both nitrogen levels. Meanwhile, cross P_2xP_5 under both nitrogen levels was the shortest crosses. The highest parent in ear height was P_1(Inb.84) under both nitrogen levels. The highest cross in ear height was P_1xP_4 under both nitrogen levels. Meanwhile, crosses P_2xP_5 under normal nitrogen level and S.C.10 under stress nitrogen level were the lowest crosses. It may indicated that ear height is greatly influenced by different agronomic treatments. These results are in agreement with findings by Abdel-Monaem, (2000) and Oliverira (2011). Ear leaf area ranged from 381.7 to 582.9 cm^2 under stress nitrogen level. The highest values were recorded by P_4(Inb.204) under both nitrogen levels. . Ear leaf area ranged from 675.7 to 929.9 cm^2 under stress nitrogen level. The highest value was recorded by P_3xP_4 under stress nitrogen level. Stem diameter ranged from 2.35 to 3.03 cm under normal nitrogen level. While, under stress nitrogen level ranged from 2.15 to 2.75 cm. The highest value 3.03 cm was recorded by P_2(Inb.95) under normal nitrogen level and P_4(Inb.204) 2.75 cm under stress nitrogen level. Stem diameter ranged from 2.9 to 3.79 cm under normal nitrogen level, and from 3.07 to 3.35 cm under stress nitrogen level. The highest value was recorded by S.C.10 under normal nitrogen level and P_4xP_5 under stress nitrogen level.

General combining ability: Based on GCA estimates, it could be concluded that the best combiners for anthesis date and silking date was inbred line P_2(Inb.95), for plant height, ear height was P_5(Inb.213) and ear leaf area was P_4(Inb.204). These results indicated that these inbred lines could be as good combiners for improving these traits (Table,2).

Table 3: Estimates of G.C.A. effects of five parents maize genotypes:

Traits	Anthesis date (day)		Silking date (day)		ASI (day)	
Parent	Stress	Normal	Stress	Normal	Stress	Normal
P_1 (Inb.84)	0.64	0.62	0.51	0.35	-0.12	-0.27
P_2 (Inb.95)	-1.17*	-1.24**	-1.25*	-1.36**	-0.08	-0.12
P_3 (Inb.144)	-0.60	-0.24	-0.53	-0.22	0.07	0.02
P_4 (Inb. 204)	1.64**	1.05*	1.70**	1.26**	0.07	0.21
P_5 (Inb. 213)	-0.50	-0.19	-0.44	-0.03	0.07	0.16
S. E. (gi)1	**0.28**	**0.23**	**0.28**	**0.22**	**0.08**	**0.10**
S. E. (gi - gj)2	**0.44**	**0.36**	**0.44**	**0.36**	**0.13**	**0.15**

Table 3: Continue.

Traits	Plant height (cm)		Ear height (cm)		Ear leaf area (cm^2)		Stem diameter (cm)	
Parent	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal
P_1 (Inb.84)	13.30**	10.73**	9.99**	8.63**	-61.65**	-185.44	0.01	-0.04
P_2 (Inb.95)	-11.17**	-9.00**	-3.41	-1.36	-6.55	-126.94	-0.01	0.01
P_3 (Inb.144)	0.61	0.41	0.14	-0.96	24.03*	-81.49	0.00	0.02
P_4 (Inb. 204)	18.88**	18.44**	3.95*	3.34*	51.71**	508.97*	0.07*	0.09
P_5 (Inb. 213)	-21.61**	-20.59**	-10.68**	-9.64**	-7.53	-115.10	-0.08*	-0.08
S. E. (g_i)	**1.99**	**1.37**	**1.28**	**1.06**	**6.34**	**177.62**	**0.02**	**0.04**
S. E. (g_i - g_j)	**3.14**	**2.16**	**2.03**	**1.67**	**10.02**	**280.84**	**0.03**	**0.06**

***, ** significant at 0.05 and 0.01 level of probability , respectively**
S.E.(gi), standard error for an GCA effects.
S.E.(gi-gj), standard error for the difference between two estimates of GCA effects.

Specific combining ability effects (S_{ij}): Significant SCA effects were found in all studied traits for most crosses under both nitrogen levels (Table,3). Based on SCA effects, it could be concluded that under both nitrogen levels highly significant negative SCA effects for anthesis date and silking date were recorded with P_2 (Inb.95) X P_3 (Inb.144) and P_3 (Inb.144) X P_4 (Inb.204) while, the positive significant for ear height was P_1(Inb.84)XP_4(Inb.204), for plant height was P_3 (Inb.144) X P_5 (Inb.213), for stem diameter was P_4(Inb.204)XP_5(Inb.213) under both nitrogen levels for ear leaf area was P_3(Inb.144)XP_4(Inb.204) under stress nitrogen level. These crosses could be selected and used in hybridization programs for improving these traits.

Table (4): Estimates of S.C.A. effects of 10 single crosses maize for flowering and vegetative traits under normal and stress nitrogen levels.

Traits	Anthesis date (day)		Silking date (day)		A.S.I. (day)	
Crosses	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**
P_1 X P_2	-0.44	-1.49*	-0.56	-1.64*	-0.11	-0.14
P_1 XP_3	-1.68*	-1.49*	-1.94*	-1.78*	-0.25	-0.29
P_1 XP_4	0.75	0.89	1.16	1.08	0.41	0.19
P_1 X P_5	-0.78	-1.21	-0.70	-0.97	0.08	0.24
P_2 X P_3	-3.54**	-3.97**	-3.18**	-3.73**	0.37	0.24
P_2 X P_4	0.22	0.41	0.25	0.79	0.03	0.38
P_2 X P_5	-3.64**	-4.35**	-2.94**	-3.59**	0.70**	0.76*
P_3 XP_4	-2.68**	-3.92**	-2.46**	-3.68**	0.22	0.24
P_3 X P_5	0.13	2.65**	0.68	2.94**	0.56*	0.29
P_4 X P_5	-1.11	0.37	-0.89	0.79	0.22	0.43
S. E. (S_{ij})	0.72	0.58	0.72	0.58	0.21	0.25
S. E. (S_{ij}-S_{ik})	1.09	0.87	1.08	0.87	0.32	0.37
S. E. (S_{ij}-S_{kl})	0.99	0.80	0.99	0.79	0.29	0.34

Table 4: Continue.

Traits	Plant height (cm)		Ear height (cm)		Ear leaf area (cm^2)		Stem diameter (cm)	
Crosses	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**
P_1 X P_2	29.18**	29.75**	13.63**	16.47**	49.45*	147.50	0.07	-0.28*
P_1 XP_3	23.73**	25.48**	11.28**	14.04**	140.37**	225.60	0.08	0.14
P_1 XP_4	32.19**	30.55**	25.30**	23.10**	80.94**	-407.20	0.07	0.17
P_1 X P_5	17.55**	18.38**	13.93**	14.37**	108.13**	214.30	0.33**	0.36**
P_2 X P_3	17.60**	22.10**	12.95**	15.80**	98.93**	215.00	0.22**	0.20
P_2 X P_4	23.59**	27.50**	16.10**	18.97**	99.42**	-370.80	0.17**	0.15
P_2 X P_5	16.82**	18.83**	12.44**	8.90**	65.65**	126.80	0.33**	0.33**
P_3 XP_4	21.81**	22.06**	21.68**	16.43**	159.64**	-317.50	0.16**	0.19
P_3 X P_5	34.91**	32.66**	11.45**	8.74**	105.60**	226.80	0.33**	0.34**
P_4 X P_5	21.67**	24.36**	3.24	10.10**	89.95**	-396.60	0.37**	0.37**
SE (S_{ij})	5.13	3.53	3.31	2.73	16.36	458.61	0.05	0.09
SE(S_{ij}-S_{ik})	**7.70**	**5.30**	**4.97**	**4.10**	**24.55**	**687.92**	**0.08**	**0.14**
SE(S_{ij}-S_{kl})	**7.03**	**4.84**	**4.54**	**3.74**	**22.41**	**627.98**	**0.07**	**0.13**

***, ** significant at 0.05 and 0.01 level of probability , respectively.**
SE(Sij), standard error for an SCA effects.
SE(Sij-Sik), standard error for the difference between two SCA effects for a common parent.
SE(Sij-Skl), standard error for the difference between two SCA effects for a non-common parent.

Heterosis over mid-parents: Results showed significant heterosis for studied traits for all crosses . For anthesis date and silking date were cross P_2XP_3 under both nitrogen levels. The highest positive significant for ear height was cross P1XP4, for plant height was cross P_3XP_5 and stem diameter was cross P_4XP_5 (Table, 5).

Heterosis over better-parents: Results showed significant heterosis over better-parent in all studied traits for most crosses under both nitrogen levels (Table, 5). For anthesis date and silking date were cross P_2XP_3 under both nitrogen levels, for ASI date was cross P_2XP_5 under both nitrogen levels, for ear height was cross P_1XP_4 under both nitrogen levels, for plant height was cross P_4XP_5 under both nitrogen levels, for ear leaf area was cross P_1XP_3 under stress nitrogen level, for stem diameter was cross P_3XP_5 under normal nitrogen level, while, cross P_2XP_5 under stress nitrogen level.

Table 5: Percentage of heterosis over mid-parent (M.P) and better parent (B.P) for F1 crosses of studied maize flowering and vegetative traits under normal and stress nitrogen levels:

Traits	Anthesis date (day)				Silking date (day)				ASI (day)			
	Normal		Stress		Normal		Stress		Normal		Stress	
Crosses	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
P_1xP_2	-6.8**	-6.4**	-4.5	-3.8	-6.4**	-5.8**	-4.2	-3.2	11.3	25.6	19.8	49.3
P_1xP_3	-5.8**	-5.8**	-6.6**	-6.3**	-5.9**	-5.7**	-6.5**	-6.3**	-9.0	0.0	0.0	0.0
P_1xP_4	-0.7	-0.5	-0.8	1.1	0.0	0.5	0.3	2.1	27.0	39.5	67.0	67.0
P_1xP_5	-3.9*	-2.5	-4.3	-3.7	-2.9	-1.5	-3.4	-2.7	39.5	39.5	59.3	98.5
P_2xP_3	-11.7**	-11.3**	-11.7**	-10.8**	-10.5**	-9.6**	-10.2**	-9.0**	39.9	75.2*	100.0	149.3**
P_2xP_4	-3.6*	-2.9*	-3.7	-1.1	-2.1	-1.0	-2.8	0	60.4*	100.8**	59.3	98.5
P_2xP_5	-10.9**	-10.0**	-11.0**	-10.8**	-8.5**	-7.8**	-8.8**	-8.5**	100**	125.6**	198.5**	198.5**
P_3xP_4	-9.0**.	-8.7**	-8.3**	-6.8**	-7.8**	-7.6**	-7.1**	-5.7**	33.5	33.5	67.0	67.0
P_3xP_5	0.5	2.0	-5.0*	-4.3*	1.7	3.4*	-3.1	-2.1	45.5	59.9*	139.5*	198.5**
P_4xP_5	-1.2	0.5	-5.0*	-2.7	0.5	2.4	-3.6	-1.1	63.5*	79.6**	100	149.3**
L.S.D. at 5%	**2.4**	**1.9**	**2.9**	**2.4**	**2.4**	**1.9**	**2.9**	**2.4**	**1.0**	**0.8**	**0.9**	**0.7**
L.S.D. at 1%	**3.2**	**2.6**	**4.0**	**3.2**	**3.2**	**2.6**	**3.9**	**3.2**	**1.4**	**1.1**	**1.2**	**1.0**

Table 5: Continue.

Traits	Ear height (cm)				Plant height (cm)			
	Normal		Stress		Normal		Stress	
Crosses	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
P_1xP_2	37.7**	46.8**	37.5**	52.2**	40.3**	54.4**	41.8**	59.7**
P_1xP_3	34.3**	41.2**	35.1**	45.0**	37.1**	43.9**	38.4**	47.2**
P_1xP_4	43.6**	49.8**	48.1**	56.7**	36.7**	41.5**	39.3**	43.7**
P_1xP_5	33.5**	47.5**	35.9**	56.8**	36.0**	60.5**	38.3**	70.0**
P_2xP_3	36.4**	38.3**	38.2**	42.1**	38.1**	44.5**	37.2**	44.8**
P_2xP_4	41.5**	44.5**	42.6**	48.8**	37.8**	57.4**	37.0**	59.7**
P_2xP_5	29.5**	33.8**	36.2**	41.4**	39.3**	48.5**	40.5**	52.0**
P_3xP_4	37.9**	38.9**	46.9**	49.0**	34.2**	46.1**	35.8**	49.3**
P_3xP_5	27.8**	34.0**	34.7	44.1**	45.7**	63.0**	51.2**	73.3**
P_4xP_5	31.6**	39.0**	28.5**	39.6**	37.7**	69.1**	38.8**	76.9**
L.S.D.at 5%	11.1	9.1	13.5	11.0	14.4	11.7	20.9	17.1
L.S.D.at 1%	15.0	12.2	18.2	14.8	19.4	15.8	28.1	23.0

Table(5) Continue.

Traits	Stem diameter (cm)				Ear leaf area (cm^2)			
	Normal		Stress		Normal		Stress	
Crosses	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
P_1xP_2	-3.0	-4.3	15.6**	12.5**	38.6	22.8	49.1**	28.8**
P_1xP_3	15.4*	12.9*	15.6**	12.8**	63.6	47.5	82.9**	62.6**
P_1xP_4	16.3**	16.3**	15.0**	14.5**	47.8	36.0	58.7**	31.3**
P_1xP_5	30.2**	16.9**	33.2**	19.0**	52.6	35.5	67.4**	48.2
P_2xP_3	17.6**	13.5**	23.6**	23.1**	52.1	49.2	59.8**	54.6**
P_2xP_4	16.1**	14.5**	21.2**	17.5**	45.6	41.5	51.5**	43.9**
P_2xP_5	29.0**	14.5**	36.6**	25.2**	30.7	30.5	46.4**	42.2**
P_3xP_4	22.0**	19.3**	20.7**	17.5**	63.4	55.9	73.3**	59.5**
P_3xP_5	34.6**	23.4**	36.4**	24.6**	56.2	53.5	65.8**	65.0**
P_4xP_5	35.5**	21.7**	36.7**	21.8**	43.8	39.5	53.8**	42.1**
L.S.D. at 5%	04	0.3	0.2	0.2	1865.6	1523.2	66.6	54.4
L.S.D. at 1%	0.5	0.4	0.3	0.2	2511.7	2050.8	89.6	73.2

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

REFERENCES

Abdel-Monaem, M. A. (2000). Breeding studies on maize tolerance to low nitrogen fertilization. M.Sc. Thesis Agric. Sci. (Agronomy), Faculty of Agric. Mansoura Univ.Egypt.

Ahmed, M.A.; M.H. El-Sheikh and Sh.A. EL-Shamarka (2000). Diallel analysis of yielding ability and earliness in maize. J. Agric. Sci. Mansoura Univ., 25 (7): 3717-3726.

Akintoye, H. A; J. G. Kling, and E. O. Lucase (1999). N-use efficiency of single, double and synthetic maize lines grown at four N levels in three ecological zones of West Africa. Field Crops Res., 60 : 3, 189-199.

Alamnie, A., M.C. Wali, P.M. Salimath and R.C.Jagadeesha (2006). Combining ability and heterosis for grain yield and ear characters in maize. Karnata j. Agric. Sci., 19:13-16.

Al-Naggar, A. M., M.S. Radwan and M.M.M. Atta (2002). Analysis of diallel crosses among ten maize populations differing in drought tolerance. Egypt .J. Plant Breed, 6:179-198.

Barakat, A.A. and M.M.A. Osman (2008). Evaluation of some newly developed yellow maize inbred lines for combining ability in two location. J.Agric.Sci .Mansoura Univ., 33(7): 4667-4679.

Dadheech, A. and V.N. Joshi (2007). Heterosis and combining ability for quality and yield in early maturing single cross hybrids of maize(*Zea mays* L.). Indian J. Agric. Res., 41: 210-214.

El-Badawy, M. E. M. (2006). Genetic analysis of diallel crosses in maize (*Zea mays* L.) over two years. Annals of Agric. sci. Moshtohor, 44(3):911-922.

El-Ghonemy, M.A. and M.H.A. Ibrahim (2010). Diallel analysis of yellow maize for combining ability and heterosis. J. Plant production, Mansoura Univ., 1(6): 779-92.

El-Hosary, A.A.; Mohamed, M.K.; Sedhom S.A. and Abo-El-Hassan, G.K.A. (1994). Performance and combining ability in diallel crosses of maize. Annals of Agric. Sci. Moshtohor. 32(1) : 203-215.

FAO. (2011). Area of maize harvested (ha) in 2009, food supply (kcal/capita/day) and protein supply quantity (g/capita/day) in 2007. Available at http:faostat.fao.org/site/567/Desktop Default. Aspx? Page ID=567#ancor (verified 7 Jan. 2012). Food and Agric. Organization of the United Nations, Rome, Italy.

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

Irshad-El-Haq, M., S.U. Ajmal, M. Munir and M. Gulfaraz (2010). Gene action studies of different quantitative traits in maize. Pak. J. Bot., 42: 1021-1030.

Katta,Y.S; M.S.M. Abd El-Aty.; M.A. El-Hity and M.M. Karmara (2007). Estimate of heterosis and combining ability of some white inbred lines of maize (*Zea mays* L.). J. Agric. Sci .Mansoura Univ., 32(9): 7077-7088.

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.

Oliveira S.M. (2011). Genetic parameters of maize population in contrasting nitrogen levels. Rev. Cienc. Agron. Vol. 42,n.1,PP. 168-174 ISSN 1806-6690.

Raun, W. R. and G. V. Johnson (1999). Improving nitrogen use efficiency for cereal production. Agron. J., 91 : 357-363.

Sedhom, S. A. (1994). Estimation of general and specific combining ability In maize under two different planting dates. Annals of Agric. Sci. Moshtohor, 32(1) : 119-130.

White, P. J. and L. A. Johnson (2003). Corn: Chemistry and technology. 2nd Ed., American Association of Cereal Chemists, St. Paul, MN., USA., ISBN-13:9781891127335,Pages:892.

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القدرة علي التآلف وقوة الهجين لبعض صفات التزهير والصفات الخضرية لخمسة سلالات من الذرة الشامية تحت مستويين من التسميد النيتروجيني

محمود سليمان سلطان*، مأمون أحمد عبد المنعم* ، سليمان محمد جمعه سلامه و أحمد محمد السيد عرابي*****
*** قسم المحاصيل – كلية الزراعة – جامعة المنصورة**
****المعمل المركزى للتصميم والتحليل الإحصائى – مركز البحوث الزراعية**
*****شركة فاين سيدز إنترناشيونال**

الهدف من البحث التحليل الوراثى لبعض الصفات في بعض سلالات الذرة الشامية والهجن الناتجة منها وتقدير القدرة العامة والخاصة علي التآلف لهذه السلالات وكذلك قوة الهجين تحت مستويين من التسميد النيتروجيني (العادى والمنخفض).

في العام ٢٠١١ تم التهجين بين خمس سلالات من الذرة الشامية وفي عام ٢٠١٢ قيمت السلالات والهجن الناتجة منها تحت مستويين من التسميد النيتروجينى لصفات التزهير والصفات الخضرية وهي: عدد الأيام حتي انتشار ٥٠% من حبوب اللقاح، عدد الأيام حتي ظهور ٥٠% من الحريرة، الفترة بين اللقاح و الحريرة ، إرتفاع النبات، إرتفاع الكوز، قطر الكوز ومساحة ورقة الكوز حيث كانت متوسطات مربعات الانحرافات للتراكيب الوراثية لكل الصفات المدروسة معنوية ما عدا مساحة ورقة الكوز تحت مستوي التسميد النيتروجينى العادى.

كانت متوسطات مربعات الإنحراف للقدرة العامة والخاصة علي التآلف معنوية لكل الصفات المدروسة عدا قطر الكوز تحت مستوي التسميد النيتروجينى العادي للقدرة العامة علي التألف ومساحة ورقة الكوز تحت مستوي التسميد النيتروجينى العادي للقدرة العامة والخاصة علي التألف. اظهرت النسبة بين القدرة العامة والخاصة علي التألف أن الفعل الجيني الغير مضيف له دور رئيسى فى توريث صفات عدد الايام حتى انتشار ٥٠% من حبوب اللقاح، وكذلك ارتفاع النباتات تحت مستوي التسميد النيتروجينى العادي بينما الفعل الجيني المضيف كان له دور رئيسي في توريث صفات عدد الايام حتي انتشار ٥٠% من حبوب اللقاح، عدد الايام حتى ظهور ٥٠% من الحريرة، ارتفاع النبات تحت مستوي التسميد النيتروجينى المنخفض ومساحة سطح ورقة الكوز تحت المستوى التسميد النيتروجينى العادى.

أظهرات السلالاتP_4 ، P_2 أفضل قدرة عامة علي التألف للصفات المدروسة تحت مستويين من التسميد النيتروجينى حيث يمكن استخدمها في تحسين هذه الصفات. أظهر الهجين P_2XP_5 أعلي قوة هجين بالنسبة لمتوسط و أفضل الابوين لصفات عدد الايام حتي ٥٠% من إنتثار حبوب اللقاح والفترة ما بين انتثار اللقاح و الحريرة، الهجين P_2XP_3 لصفة عدد الايام حتي ٥٠% من ظهور الحريرة، الهجين P_3XP_5 لصفة ارتفاع النبات، الهجين P_1XP_4 لصفة ارتفاع الكوز والهجين P_4XP_5 لصفة قطر الساق تحت مستوين من التسميد النيتروجينى لذلك يمكن انتخاب هذه الهجن وادخالها في برامج تربية لتحسين هذه الصفات.

كانت قوة الهجين معنوية لكل الصفات المدروسة فالهجين P_2XP_3 لصفات عدد الايام حتي انتثار ٥٠% من حبوب اللقاح وعددالايام حتى ظهور ٥٠% من الحريرة، الهجين P_2XP_5 لصفة الفترة ما بين إنتثار اللقاح و الحريرة، الهجين P_1XP_4 لصفة إرتفاع الكوز، الهجين P_3XP_5 لصفة إرتفاع النبات، الهجن P_2XP_5, P_3XP_5, P_4XP_5 لصفة قطر الساق تحت مستويين من التسميد النيتروجيني والهجين P_1XP_3 لصفة مساحة سطح ورقة الكوز تحت مستوى التسميد النيتروجيني المنخفض أفضل الهجن.

قام بتحكيم البحث

أ.د / عبد الرحيم عبد الرحيم ليله	**كلية الزراعة – جامعة المنصورة**
أ.د / محمود الزعبلاوى محمود	**كلية الزراعة بمشتهر – جامعة بنها**