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

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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 P₂ (Inb.95) and P₄ (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 P₂ (Inb.95) X P₅ (Inb.213), for silking date was P₂ (Inb.95) X P₃ (Inb.144), for plant height was P₃ (Inb.144) X P₅ (Inb.213), ear height was P₁ (Inb.84) X P₄ (Inb.204) and stem diameter was P₄ (Inb.204) X P₅ (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 P₂ (Inb.95) X P₃ (Inb.144) under both nitrogen levels for ASI date was P₂ (Inb.95) X P₅ (Inb.213), for ear height was P₁ (Inb.84) X P₄ (Inb.204), for plant height was P₃ (Inb.144) X P₅ (Inb.213), for ear leaf area was P₁ (Inb.84) X P₃ (Inb.144) under stress nitrogen level and for stem diameter were P₂ (Inb.95) X P₅ (Inb.213), P₃ (Inb.144) X P₅ (Inb.213) and P₄ (Inb.204) X P₅ (Inb.213).

INTRODUCTION

Maize belongs to poaceae family and tribe Maydaceae. 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) ($NUE = N \text{ recovered} / N \text{ supplied}$) 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; Alammie *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., P₁(Inb. 84), P₂(Inb95), P₃(Inb. 144), P₄(Inb. 204) and P₅(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 F₁'s hybrid seeds. In 2012 growing season, 16 entries (10 F₁'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 (cm²).

Statistical analysis: The obtained data were statistically analyzed for analysis 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 squares 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 al.* (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.

Anthesis 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)	
	Stress	Normal	Stress	Normal	Stress	Normal
Genotypes						
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)	
	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal
Genotypes								
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 P₂(Inb.95) under stress nitrogen level and P₅(Inb.213) under normal nitrogen levels. The earliest crosses in pollen shedding were P₂xP₅ under normal nitrogen level and P₂xP₃ under stress nitrogen level. The earliest parents in silking date was P₅(Inb.213) under normal nitrogen level and P₂(Inb.95) under stress nitrogen level. The earliest crosses in silking date were P₂xP₃ under normal nitrogen level and P₂xP₃ under stress nitrogen level. The earliest parent in (ASI) was P₂(Inb.95) and P₅(Inb.213) under stress nitrogen level and P₂(Inb.95) under normal nitrogen level. The earliest crosses in ASI were P₁xP₂ and P₁xP₃ under normal nitrogen level and P₁xP₂ and P₁xP₃ under stress nitrogen level. The tallest parent was P₄(Inb.204) under both nitrogen levels. Mean while, parent P₅(Inb.213) was the shortest parent under both nitrogen levels. The tallest cross was P₁xP₄ under both nitrogen levels. Meanwhile, cross P₂xP₅ under both nitrogen levels was the shortest crosses. The highest parent in ear height was P₁(Inb.84) under both nitrogen levels. The highest cross in ear height

was P₁xP₄ under both nitrogen levels. Meanwhile, crosses P₂xP₅ 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 cm² under stress nitrogen level. The highest values were recorded by P₄(Inb.204) under both nitrogen levels. Ear leaf area ranged from 675.7 to 929.9 cm² under stress nitrogen level. The highest value was recorded by P₃xP₄ 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 P₂(Inb.95) under normal nitrogen level and P₄(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 P₄xP₅ 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 P₂(Inb.95), for plant height, ear height was P₅(Inb.213) and ear leaf area was P₄(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)	
	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. (g _i) ¹	0.28	0.23	0.28	0.22	0.08	0.10
S. E. (g _i - g _j) 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)	
	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.(g_i), standard error for an GCA effects.

S.E.(g_i-g_j), 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)XP₄(Inb.204), for plant height was P_3 (Inb.144) X P_5 (Inb.213), for stem diameter was P_4 (Inb.204)XP₅(Inb.213) under both nitrogen levels for ear leaf area was P_3 (Inb.144)XP₄(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)	
	Stress	Normal	Stress	Normal	Stress	Normal
$P_1 \times P_2$	-0.44	-1.49*	-0.56	-1.64*	-0.11	-0.14
$P_1 \times P_3$	-1.68*	-1.49*	-1.94*	-1.78*	-0.25	-0.29
$P_1 \times P_4$	0.75	0.89	1.16	1.08	0.41	0.19
$P_1 \times P_5$	-0.78	-1.21	-0.70	-0.97	0.08	0.24
$P_2 \times P_3$	-3.54**	-3.97**	-3.18**	-3.73**	0.37	0.24
$P_2 \times P_4$	0.22	0.41	0.25	0.79	0.03	0.38
$P_2 \times P_5$	-3.64**	-4.35**	-2.94**	-3.59**	0.70**	0.76*
$P_3 \times P_4$	-2.68**	-3.92**	-2.46**	-3.68**	0.22	0.24
$P_3 \times P_5$	0.13	2.65**	0.68	2.94**	0.56*	0.29
$P_4 \times P_5$	-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)	
	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal
$P_1 \times P_2$	29.18**	29.75**	13.63**	16.47**	49.45*	147.50	0.07	-0.28*
$P_1 \times P_3$	23.73**	25.48**	11.28**	14.04**	140.37**	225.60	0.08	0.14
$P_1 \times P_4$	32.19**	30.55**	25.30**	23.10**	80.94**	-407.20	0.07	0.17
$P_1 \times P_5$	17.55**	18.38**	13.93**	14.37**	108.13**	214.30	0.33**	0.36**
$P_2 \times P_3$	17.60**	22.10**	12.95**	15.80**	98.93**	215.00	0.22**	0.20
$P_2 \times P_4$	23.59**	27.50**	16.10**	18.97**	99.42**	-370.80	0.17**	0.15
$P_2 \times P_5$	16.82**	18.83**	12.44**	8.90**	65.65**	126.80	0.33**	0.33**
$P_3 \times P_4$	21.81**	22.06**	21.68**	16.43**	159.64**	-317.50	0.16**	0.19
$P_3 \times P_5$	34.91**	32.66**	11.45**	8.74**	105.60**	226.80	0.33**	0.34**
$P_4 \times P_5$	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(S_{ij}), standard error for an SCA effects.

SE($S_{ij}-S_{ik}$), standard error for the difference between two SCA effects for a common parent.

SE($S_{ij}-S_{kl}$), 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_2 XP₃ under both nitrogen levels. The highest positive significant for ear

height was cross P₁X₄, for plant height was cross P₃X₅ and stem diameter was cross P₄X₅ (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 P₂X₃ under both nitrogen levels, for ASI date was cross P₂X₅ under both nitrogen levels, for ear height was cross P₁X₄ under both nitrogen levels, for plant height was cross P₄X₅ under both nitrogen levels, for ear leaf area was cross P₁X₃ under stress nitrogen level, for stem diameter was cross P₃X₅ under normal nitrogen level, while, cross P₂X₅ 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 ₁ X 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 ₁ X 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 ₁ X 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 ₁ X 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 ₂ X 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 ₂ X 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 ₂ X 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 ₃ X 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 ₃ X 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 ₄ X 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 ₁ X ₂	37.7**	46.8**	37.5**	52.2**	40.3**	54.4**	41.8**	59.7**
P ₁ X ₃	34.3**	41.2**	35.1**	45.0**	37.1**	43.9**	38.4**	47.2**
P ₁ X ₄	43.6**	49.8**	48.1**	56.7**	36.7**	41.5**	39.3**	43.7**
P ₁ X ₅	33.5**	47.5**	35.9**	56.8**	36.0**	60.5**	38.3**	70.0**
P ₂ X ₃	36.4**	38.3**	38.2**	42.1**	38.1**	44.5**	37.2**	44.8**
P ₂ X ₄	41.5**	44.5**	42.6**	48.8**	37.8**	57.4**	37.0**	59.7**
P ₂ X ₅	29.5**	33.8**	36.2**	41.4**	39.3**	48.5**	40.5**	52.0**
P ₃ X ₄	37.9**	38.9**	46.9**	49.0**	34.2**	46.1**	35.8**	49.3**
P ₃ X ₅	27.8**	34.0**	34.7	44.1**	45.7**	63.0**	51.2**	73.3**
P ₄ X 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	
	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
Crosses								
P ₁ xP ₂	-3.0	-4.3	15.6**	12.5**	38.6	22.8	49.1**	28.8**
P ₁ xP ₃	15.4*	12.9*	15.6**	12.8**	63.6	47.5	82.9**	62.6**
P ₁ xP ₄	16.3**	16.3**	15.0**	14.5**	47.8	36.0	58.7**	31.3**
P ₁ xP ₅	30.2**	16.9**	33.2**	19.0**	52.6	35.5	67.4**	48.2
P ₂ xP ₃	17.6**	13.5**	23.6**	23.1**	52.1	49.2	59.8**	54.6**
P ₂ xP ₄	16.1**	14.5**	21.2**	17.5**	45.6	41.5	51.5**	43.9**
P ₂ xP ₅	29.0**	14.5**	36.6**	25.2**	30.7	30.5	46.4**	42.2**
P ₃ xP ₄	22.0**	19.3**	20.7**	17.5**	63.4	55.9	73.3**	59.5**
P ₃ xP ₅	34.6**	23.4**	36.4**	24.6**	56.2	53.5	65.8**	65.0**
P ₄ xP 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.

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**القدرة علي التآلف وقوة الهجين لبعض صفات التزهير والصفات الخضرية لخمسة
سلالات من الذرة الشامية تحت مستويين من التسميد النيتروجيني**
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*****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 النيتروجيني 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، ارتفاع النبات، ارتفاع 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
النيتروجيني العادى.

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

أظهرت السلالات P_2 , P_4 أفضل قدرة عامة علي التآلف للصفات المدروسة تحت مستويين من
التسميد النيتروجيني حيث يمكن استخدامها في تحسين هذه الصفات. أظهر الهجين P_2XP_5 أعلى قوة هجين
بالنسبة لمتوسط وأفضل الابوين لصفات عدد الايام حتي ٥٠% من إنتثار حبوب اللقاح والفترة ما بين انتشار
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 مستويين من
التسميد النيتروجيني 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 انتشار
٥٠% من حبوب اللقاح وعددايما حتي ظهور ٥٠% من الحريرة، الهجين P_2XP_5 لصفة الفترة ما بين
إنتثار اللقاح و الحريرة، الهجين P_1XP_4 لصفة ارتفاع الكوز، الهجين P_3XP_5 لصفة ارتفاع 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

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