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GENETIC ANALYSIS OF DIALLEL CROSSES BETWEEN FIVE MODERATELY MATURING INBRED LINES OF MAIZE

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ABSTRACT

This study was conducted during the spring season of 2008 at the Farm of the College of Agriculture – Duhok University, Iraq by using five maize inbred lines locally developed. Half diallel cross design was applied for these inbred lines to produce ten F_1 single crosses. A yield trial for the 10 hybrids and their parents was carried out in the Research Farm of the College of Agriculture Salahaddin University, Iraq using a randomized complete block design with three replications in order to study the gene action for yield and yield components beside estimating heterosis, combining ability and variance components (additive, dominance and environmental variance) in addition to estimate some other genetic parameters. The results showed the presence of significant differences among genotypes for all characters. For mean grain yield the best parent was (ZP – 197), while the best hybrid was (ZP – 707 × DK). The parent (ZP – 595) appeared to be the best general combiner for most studied characters, while the hybrid (ZP – 607) × (ZP – 707) appeared to be the best for specific combining ability. Ratio of general to specific combining ability variances was more than one for all characters, indicating that the characters were under the effect of over dominance. Broad sense heritability value was found to be high in all the studied characters, while the narrow sense heritability was moderate for silking and tasselling date, grain yield / plant, number of kernels / row , 100- kernel weight and low for plant height , ear height , leaf area , number of rows / ear, ear length and number of kernels / ear. The expected genetic advance from selection was high for grain yield / plant and 100- kernel weight. The hybrids (DK × ZP-197) and (ZP – 707 × ZP – 197) gave the highest heterosis value in silking and tasselling date, while the heterosis value was high for the flag leaf area, ear height and grain yield / plant and was low for kernels / row , rows / ear, ear length and 100- kernel weight with different hybrids.

Key words: *combining ability, diallel cross, genetic parameters, heterosis, maize.*

1. INTRODUCTION

Maize is the third most important cereal food crops of the world after wheat and rice. It is a multipurpose crop which provides edible oil for human use, feed for poultry and fodder for livestock. In fact, maize has been subjected to extensive genetic studies than any other crop (Hallauer and Miranda, 1988). The development of high yielding hybrids is one of the important objectives of plant breeders. The inbred lines should be evaluated according to general and specific combining ability and selecting the best of them to be entered in hybrid for achieving the high yield. Hybridization is considered one of the most important programs which is used for obtaining superior hybrids for local environment. Such programs need testing the combining ability of inbred lines that are used as parents according to the general combining ability and then selecting the best hybrid combination for specific combing ability for yield (Ahmed and Ali, 2003). Half diallel cross method is considered one of the effective ways for estimating the general and specific combining ability to select the best parents of inbred lines. The first who used diallel cross was Sparague and Tatum (1942) working on maize. The concept of diallel cross was laid by Griffing (1956) and described by Singh and Chaudhary (2007). Many researchers and plant breeders used the inbred lines of maize in diallel cross analysis(Ojo *et al.*, 2001; Al-Sweediy, 2002; Reza'ei *et al.*,2004; Al-Jamili ,2006 ; Chungji *et al.*, 2006; Rather *et al.*, 2007 and Rather *et al.*, 2009). Many studies were conducted concerning heritability for characters in different crops, Deletic *et al*., (2005) and Najeeb *et al.*, (2009) obtained high heritability for the most characters, while Cook and Hallauer and Miranda (1988) and Dawod *et al.* (2009) showed that the average dominance was less than one for all characters except the grain yield/plant, which reached 1.7. Paterniani *et al.* (2004) found that the best expected genetic advance in grain yield reached 7.9 %. Lee *et al.* (2006); Chungji *et al.* (2006) and Dawod *et al.* (2009) obtained high heterosis for plant height, ear height and grain yield/plant.

The objective of this study was to estimate some genetic parameters and heterotic effect and to determine suitable inbred parents and promising crosses for grain yield by using half diallel cross design between five inbred lines of corn.

2. MATERIALS AND METHODS

The diallel crosses were carried out at the experimental field of the College of Agriculture, Duhok University, Iraq during the spring season 2008. Five inbred lines of corn were used [(1) ZP-607, (2) ZP-707, (3) DK, (4) ZP-197, and (5) ZP-595]. The inbred lines were sown on April; each inbred was planted in two rows of 4 m length, 75 cm between rows and 25 cm between plants (Al-Falahi, 2000). A weight of 600 kg / ha of compound fertilizer (N. P. K.) (27-27-0) was applied during land preparation. Also, 200 kg / ha Urea fertilizer (46 % N) were added in two doses , the first dosage were added after 30 days from planting and the second was added at anthesis stage. A half diallel crossing program was applied to produce ten single crosses. During the spring season (on April 21, 2009) ten hybrids and five parents were planted at the experimental field of the College of Agriculture, Salahaddin University, Iraq. A randomized complete block design (RCBD) with three replicates was applied. Each replicate consisted of 15 rows (5 for parents and ten for hybrids). All recommended cultural practices were done at the same spring season. The data were recorded on days to 50 % tasselling and 50% silking, plant height (cm), ear height (cm), flag leaf area ($cm^{2)}$, ear length (cm), kernels/row, rows/ear, 100- kernel weight (g), kernels/ear and grain yield/plant (g).The data were analysed by using RCBD design according to Al-Rawi and Khalaf – Allah (1980). L.S.D was used to compare the means of genotypes. The genetic analysis was based on Griffing's method 2 – fixed model to determine the variance and effects of general and specific combining ability, additive, dominance and environmental variance, average degree of dominance. Heritabilities in broad and narrow sense were determined. Expected genetic advance in absolute and percentage was calculated. Heterosis was estimated as a deviation of F_1 from the mid - parent and high parent values.

3. RESULTS AND DISCUSSION

The data in Table (1) show significant mean squares due to genotypes for all studied characters at level 0.01 except for plant height where the significance was at level 0.05. Table (2) presents the means of genotypes (five inbreds and ten hybrids). The results in Table (2) indicate that inbreds (4) and (5) were shorter than others in plant height (120 cm) and the inbred (3) was the tallest one (151.66 cm). The hybrid (3×5) was the tallest hybrid (161.6 cm) whereas hybrid (3×5) was the shortest in plant height (130.0 cm). It can be noticed that inbred (2) was the earliest in days to 50 % tasselling while inbred (4) could be considered the latest (73 days). The lowest value in this character (65 days) was found in the hybrid (3×4), while the hybrid (1×3) was the most delayed genotype in days to 50 % tasselling and the inbreds 2 and 4 were the earliest and latest in days to 50 % silking, respectively. The largest flag leaf area was found in inbred (3) (693.33 cm^2), whereas the lowest leaf area was that of inbred (5) (550 cm^2). The hybrid (1×5) gave the largest flag leaf area (716.66 cm^2), while the lowest one was observed in hybrid (1×4) (610 cm^2) . The inbred line (3) scored a high ear height (71.66 cm), while the inbred line (5) gave the lowest ear height (58.33 cm). The hybrid (1×5) showed the largest ear height (82.33 cm), while hybrid (1×2) scored the lowest ear height (64.33 cm). High number of kernels/row was found in inbred (2) (37.00), while the inbred line (5) showed the lowest kernels/row (25.66). The hybrid (2×5) showed the highest number of this trait (40.33), whereas the lowest kernels /ear were observed in hybrid (1×4) (31.66). The largest number of rows/ear was found in line (1) (18), whereas the lowest value of this trait was obtained in line (4) (14). For hybrids, the hybrid (1×3)

Table (1) : Mean squares for the combining ability effects.

S.O.V.	Plant height (cm)	Days to 50 % tasselling	Days to 50 % silking	Flag leaf area (cm^2)	Ear height (cm)	Grain yield /plant (g)	Kernels / row	Rows/ ear	Ear length (cm)	100 Kernel weight (g)	Kernels / ear
Rep.	1457.22	3.28	3.28	6202.22	596.28	256.15	8.86	2.28	0.55	16.02	10002.07
Genotypes	468.36**	24.16**	7.46**	5968.88**	135.23*	2255.74**	45.19**	7.27**	2.74**	16.94**	25426.7**
G.C.A.	496.61**	29.39**	8.19**	7215.71**	128.65*	4750.19**	61.19**	5.84**	2.92**	34.29**	21526.23**
S.C.A.	457.06**	22.07**	7.16**	5470.15**	137.86*	1257.96**	38.79**	7.85**	2.67**	10.00**	26986.9**
Error	35.28	0.76	0.60	1044.39	31.49	198.38	5.47	0.88	0.47	2.31	3148.46

*and ** indicate significant at 0.05 and 0.01 probability levels, respectively.

Table (2): Mean performance of parents and hybrids for the studied characters.

Genotypes	Plant height (cm)	Days to 50 % tasselling	Days to 50 % silking	Flag leaf area (cm^2)	Ear height (cm)	Grain yield /plant (gm)	Kernels / row	Rows/ ear	Ear length (cm)	100 Kernel weight (g)	Kernels / ear
1	145.00	67.66	70.33	683.33	65.00	115.33	33.33	18.00	15.33	19.66	600.00
2	125.00	68.00	67.33	616.66	60.00	136.66	37.00	15.00	15.00	23.66	592.00
3	151.66	67.33	69.66	693.33	71.66	104.66	33.00	16.00	15.00	20.33	527.00
4	120.00	73.00	76.00	596.66	68.33	74.00	31.33	14.00	14.00	18.00	480.00
5	120.00	70.00	72.00	550.00	58.33	66.66	25.66	14.66	13.66	19.00	372.66
1×2	145.00	67.66	69.66	623.33	64.33	160.33	36.00	16.66	17.00	26.33	614.66
1×3	151.00	68.66	71.00	683.33	76.66	149.66	33.66	19.33	16.33	23.00	644.00
1×4	145.00	67.33	69.33	610.00	66.66	100.66	31.66	14.00	15.00	22.00	430.66
1×5	150.00	67.33	70.33	716.66	82.66	120.00	32.33	17.33	15.00	22.33	540.00
2×3	145.00	68.00	70.66	626.66	66.66	163.33	40.00	17.33	15.66	22.00	686.00
2×4	146.60	65.33	68.00	616.66	71.66	118.66	37.66	18.00	14.66	18.33	666.00
2×5	139.00	65.66	68.00	683.33	66.66	129.33	40.33	16.00	16.66	20.33	618.66
3×4	130.00	65.00	67.33	633.33	71.66	108.66	34.33	16.66	14.66	19.66	570.66
3×5	161.60	68.33	71.00	670.00	79.00	110.66	34.33	16.66	14.33	20.33	572.66
4×5	151.60	68.33	71.00	660.00	73.33	119.66	39.33	17.66	16.00	17.66	696.00
L.S. D 5%	14.29	2.10	1.86	77.74	13.44	33.88	5.62	2.26	1.6	3.66	134.97
L.S. D 1%	20.72	3.04	2.71	112.74	19.57	49.14	8.16	3.29	2.41	2.31	195.76

gave the largest number of rows / ear (19.33); the hybrid (1×4) gave the lowest number for this trait (14). The inbred line (1) exhibited the largest ear length (15.33 cm), while the shortest ear was observed in line (5) (13.66 cm). For hybrids, the hybrid (1×2) showed the largest ear length (17.00 cm), while the shortest ear was recorded in hybrid (3×5) (14.33 cm)

The highest mean of 100- kernel weight was observed in inbred (2) (23.66 gm) whereas the lowest mean was obtained in inbred (4) (18.66 gm). The hybrid (1×2) gave the highest kernel weight (26.33 gm), while the lowest grain weight was obtained in hybrid (4×5) (17.66 gm). The inbred line (1) was the best line for number of kernels / ear (600). The lowest for this trait was found in inbred (5), (372.66). For hybrids, the hybrid (4×5) gave the highest number of kernels/ear (696) while the lowest number was found in hybrid (1× 4) (430.66). The highest mean grain yield/plant was observed in line (3) (71.66 gm), while the lowest grain yield/plant was recorded in line (5) (66.66 g). The hybrid (2×3) gave the highest mean grain yield/plant and value was (163.33 g). The lowest grain yield/plant was found in hybrid (1×4) (100.66 g). These results agree with the findings of Ojo *et al.*(2001), AlSweediy (2002), Rezaei *et al.* (2004)and Rather *et al.,* (2007 and 2009).

Table (3) shows that for plant height trait, the highest positive G.C.A. effect was in parent (3), while the highest positive S.C.A. effect was found in hybrid (1×2). For days to 50 % tasselling the highest negative G.C.A. effect was in parent (3). The highest negative S.C.A. effect for the same trait was found in hybrid (3×4). For days to 50 % silking the highest negative G.C.A. effect was in parent (2), whereas the highest negative S.C.A. effect was in hybrid (3×4). The parent (2) gave high G.C.A. effect for three traits (flag leaf area, yield/plant and kernels/ear), while the hybrid (1×2) had negative S.C.A. effects in traits: flag leaf area, yield /plant, ear length and 100- kernel weight. Similar results in maize have been reported by Al-Savie (2005), Derera *et al*. (2007), Mohammdi *et al*. (2008) and Rather *et al.* (2009). Table (4) presents estimates of additive, dominance and environmental variance for the studied characters. The dominance variance was more than additive variance for all characters except the traits: 100- kernel weight and number of kernels/row. This indicates that these traits were under control of the dominance gene effect. These results are in conformity with findings of Hamed (2008) and Rather *et al*.(2009). The data in Table (5) show the average degree of dominance and heritability in broad and narrow sense. The average degree of dominance was greater than one for all characters, indicating that these traits were under control of overdominance gene effect. High heritability in a broad sense was reported for all the studied characters and medium heritability in narrow sense was obtained for days to 50 % tasselling and to 50% silking, grain yield/plant, kernels/ row and 100- kernel weight, whereas low heritability in narrow sense was observed for plant height, flag leaf area, ear height, rows/ear, ear length and kernels/ear. The excepted genetic advance from selection was high for number of kernels/ear, grain yield/plant, flag leaf area and the value was 27.18, 24.30 and 18.55, respectively. The excepted genetic advance was high as a percent for grain yield/plant and the value reached 20.50%. These results are in agreement with studies of Deletic *et al.* (2005); Cook and Hallauer (2008) Hamed (2008); and Najeeb *et al*. (2009). Table (6) presents estimates of heterosis for all the studied characters. The hybrid (2×4) gave high value of heterosis for plant height , while the hybrid (3×4) and hybrid (2×4) gave negative heterosis for days to 50 % tasselling and silking. But in flag leaf area the hybrids (2×5) and (1×5) gave high heterosis (100%) for each of them. The hybrid (2×3) and hybrid (4×5) gave high value of heterosis for grain yield/plant (42.66 and 49.33%, respectively). The other characters gave low value of heterosis in number of kernels/row, number of rows/ear, ear length and 100- kernels weight, while the number of kernels/ear gave high heterosis in hydrids (4×5) , (3×5) , (2×5) , (2×4) , (2×3) and (1×3) , when compared with the heterosis that was calculated in relation to high parent. The same table showed that high heterosis was observed in hybrid (4×3) for traits plant height, flag leaf area, ear height, grain yield/plant and the number of kernels/row and also the value of heterosis was high for number of kernels/ear in hybrids (2×3) , (2×4) , (3×4) and hybrid (3×5). These results are in accordance with those of Chungji These results are in accordance with

Table (3): Estimates of general and specific combining ability effects of parents and hybrids for studied characters.

Characters / Genotypes	Plant height (cm)	Days to 50 % tasselling	Days to 50 % silking	Flag leaf area (cm^2)	Ear height (cm)	Grain yield /plant (g)	Kernels / row	Rows/ ear	Ear length (cm)	100 Kernel weight (g)	Kernels / ear
1	4.33	-0.21	0.33	19.23	0.46	7.14	-1.09	0.62	0.38	1.13	-2.11
2	-3.57	-1.60	-1.09	-11.71	-3.96	19.09	2.85	-0.13	0.38	1.32	46.36
3	5.76	-0.45	0.09	19.23	2.89	4.33	0.04	0.43	-0.04	0.08	11.88
4	-5.33	1.44	0.42	-21.71	0.41	-16.52	-0.33	-0.65	-0.42	-1.62	-17.35
5	-1.19	0.82	0.23	-5.04	0.18	-14.04	-1.43	-0.27	-0.28	-0.91	-38.78
SE(g_i-g_k)	3.17	0.46	0.41	17.27	2.99	7.52	1.25	0.50	0.36	0.81	29.99
1×2	20.31	10.79	10.26	59.68	6.88	35.06	4.85	1.82	3.15	6.41	80.85
1×3	-0.87	1.36	0.79	0.63	3.79	19.63	0.04	1.77	0.77	0.93	60.09
1×4	4.22	-1.87	-1.20	-31.74	-3.73	-8.50	-1.57	-2.46	-0.17	1.65	-124.00
1×5	5.07	-1.25	-0.01	58.25	12.50	8.34	0.23	0.49	-0.31	1.26	7.42
2×3	1.03	2.07	1.88	-25.07	-1.77	21.34	2.42	0.53	0.11	-0.25	53.61
2×4	13.79	-2.49	-1.11	5.87	5.69	-2.46	0.47	2.30	-0.50	-2.20	62.85
2×5	1.98	-1.53	-0.92	55.87	0.93	5.73	4.28	-0.07	1.34	-0.92	36.95
3×4	-12.2	-3.96	-2.96	-8.41	-1.15	2.30	-0.04	0.39	-0.07	0.36	2.00
3×5	15.31	-0.01	0.88	11.58	6.41	1.82	1.09	0.01	-0.55	0.31	25.42
4×5	16.41	-1.92	0.55	42.53	3.22	31.68	6.47	2.11	1.49	-0.63	178.22
SE(s_{ij}-s_{ik})	7.77	1.14	1.01	42.31	7.34	18.44	3.06	1.23	0.90	1.99	73.46

Table (4) : Estimates of additive (σ^2 A), dominance (σ^2 D) , environmental (σ^2 E) and phenotypic (σ^2 P) variances for studied characters.

Variances	Plant height	Days to 50 % tasselling	Days to 50 % silking	Flag leaf area	Ear Height	Grain yield /Plant	Kernels / row	Rows/ ear	Ear length	100 Kernel weight	Kernels / ear
σ^2 A	43.93 27.32 ±	2.72 1.61 ±	0.722 0.45 ±	587.74 397.58 ±	9.25 7.11 ±	433.50 261.23 ±	5.30 3.36 ±	0.47 0.32 ±	0.23 0.16 ±	3.04 1.88 ±	1750.26 1186.14±
σ^2 D	140.59 62.27 ±	7.10 3.00 ±	2.18 0.97 ±	1475.25 749.80 ±	35.45 18.95 ±	353.19 172.03±	11.10 5.29 ±	2.32 1.07 ±	0.73 0.36 ±	2.56 1.37 ±	7946.14 3682.43±
σ^2 E	35.28 9.11 ±	0.76 0.19 ±	0.60 0.15 ±	1044.39 269.66 ±	31.49 8.13 ±	198.38 51.22 ±	5.47 1.41 ±	0.88 0.22 ±	0.47 0.12 ±	2.31 0.59 ±	3148.46 812.9 ±
σ^2 P	219.81	10.59	3.51	3107.39	76.20	985.08	21.88	3.68	7.92	7.92	12844.87

Table (5): The average degree of dominance (ā), heritability in broad sense ($h._{b.s}.$), and narrow sense ($h._{n.s}$) and expected genetic advance(GA) from selection for studied characters.

Characters / Genetic parameters	Plant height	Days to 50 % tasselling	Days to 50 % silking	Flag leaf area	Ear height	Grain yield /Plant	Kernels / row	Rows/ ear	Ear length	100 Kernel weight	Kernels / ear
ā	2.52	2.28	2.46	2.24	2.76	1.27	2.04	3.13	2.50	1.29	3.01
$h._{b.s.}$	83.94	92.79	82.80	66.39	58.67	79.86	74.99	75.83	66.82	70.76	75.48
$h._{n.s.}$	19.98	25.74	20.55	18.91	12.14	44.00	24.24	12.80	16.16	38.42	13.61
GA	5.21	1.47	0.67	18.55	1.86	24.30	1.99	0.43	0.34	1.90	27.18
GA %	3.67	2.16	0.97	2.88	2.68	20.50	5.75	2.62	2.24	9.13	4.73

Table (6) : Heterosis (%) relative to the mid - parent and high parent for studied characters.

Characters / Crosses	Plant height	Days to 50 % tasselling	Days to 50 % silking	Flag leaf area	Ear height	Grain yield /plant	Kernels / row	Rows/ ear	Ear length	100 - Kernel weight	Kernels / ear
	Heterosis relative to mid-parent										
1×2	10.00*	1.33*	0.83	-26.66	1.83	34.33**	0.83	0.16	1.83**	4.66	18.66
1×3	2.66	1.16	1.00	-5.00	8.33*	39.66**	0.50	2.33**	1.16*	3.00	80.33*
1×4	12.50**	-4.5**	-2.33**	-30.00	0.000	6.00	-0.66	-2.00**	0.33	3.16	-109.33**
1×5	17.50**	-2.5*	0.16	100.00**	21.00**	29.00**	2.83	1.00	0.50	8.00	54.33
2×3	6.66	1.83*	2.16**	-28.33	0.83	42.66**	5.00**	1.83*	0.66	-0.60	126.33**
2×4	24.16**	-5.16**	-2.16**	10.00	7.50	13.33	3.50	3.50**	0.16	-2.50*	130.00**
2×5	16.5**	-2.83*	-0.66	100.00**	7.50	27.66**	9.00**	1.16	2.33**	-1.00	136.00**
3×4	-5.83	-6.66**	-4.00**	-11.66	1.66	19.33*	2.16	1.66*	0.16	0.50	67.00
3×5	25.83**	-1.33*	1.16*	48.33*	14.00**	25.00*	5.00**	1.33	0.00	0.66	122.66**
4×5	31.66**	-5.66**	-0.5	86.66**	10.00*	49.33**	10.83**	3.33**	2.16	-0.83	269.66**
	Heterosis relative to high parent										
1×2	0.00	2.66**	2.33**	-60.00*	-0.66	23.66*	-1.00	-1.33	1.66**	2.66*	14.66
1×3	-0.66	1.33	1.33*	-10.00	5.00	34.33**	0.33	1.33	1.00	2.66*	44.00
1×4	0.00	-0.33	-1.00	-7.300	-1.66	-14.66	-1.66	-4.00**	-0.33	2.33	-169.33**
1×5	5.00	-0.33	0.33	93.33**	-59.33**	4.66	-1.00	-0.66	-0.33	2.66*	-59.33
2×3	-6.66	3.00**	3.33**	-66.66*	94.00**	26.66*	3.00	1.33	0.66	-1.66	94.00*
2×4	21.66**	0.33	0.66	0.00	74.00**	-18.00*	0.66	3.00**	-0.33	-5.33	74.00
2×5	14.00**	0.66	0.66	66.66*	26.66**	-7.33	3.33	1.00	1.66**	-3.33	26.66
3×4	-21.66**	-2.33*	-2.33**	-60.00*	43.33**	4.00	1.33	0.66	-0.33	1.66	43.33
3×5	10.00*	1.00	1.33*	-23.33	45.33**	6.00	1.33	0.66	-0.66	0.00	45.33
4×5	31.66**	-3.66**	1.00	63.33*	5.00	45.66**	8.00**	3.00**	2.00**	-1.33	216.00**

*and ** indicate significant at 0.05 and 0.01 probability levels , respectively .

those of Chungji *et al*. (2006) Lee *et al*. (2008), and Dawod *et al*. (2009).

From this study it is concluded that the parent (ZP-197) showed a high general combining ability in the number of traits and some hybrids showed high heterosis as well as high specific combining ability for many traits such as (DK×ZP-197) and (ZP-707× ZP-197) which can be of great benefit in the future breeding programs.

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التحليل الوراثي للتهجين التبادلي النصفي بين خمس سلالات تربية داخلية من الذرة الشامية متوسطة التبكير بالنضج

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ملخص

نفذت التجربة خلال الموسم الربيعي لعام 2008 في حقل كلية الزراعة - جامعة دهوك بالعراق بزراعة خمس سلالات تربية داخلية مستنبطة محلياً. طبق برنامج التهجين التبادلي النصفي بين هذه السلالات لإنتاج عشرة هجن فردية زرعت مع آبائها الخمسة في حقل كلية الزراعة جامعة صلاح الدين بالعراق فى موسم عام 2009 باستخدام تصميم القطاعات العشوائية الكاملة بثلاثة مكررات لدراسة الفعل الجيني للحاصل ومكوناته وتقدير قوة الهجين والقدرة على الائتلاف العامة والخاصة والتباين المصنف والسيادي والبيئي إضافة إلى بعض المعالم الوراثية.

أظهرت النتائج وجود فروقات معنوية بين التراكيب الوراثية في جميع الصفات. كانت السلالة ZP – 197 أفضل الآباء في حاصل الحبوب ، و(ZP-707 X DK) قدرة أفضل هجين . و أظهر الأب ZP – 595 قابلية ائتلاف عامة جيدة لكل الصفات المدروسة بينما أظهر الهجين (ZP- 607×ZP-607) قدرة ائتلاف خاصة عالية. كانت النسبة بين قدرة الائتلاف العامة والخاصة أكثر من الواحد وهذا يعني ان تلك الصفات خاضعة الى تأثير السيادة الفائقة. وكانت نسبة التوريث بالمعنى الواسع عالية لكل الصفات المدروسة بينما كانت بالمعنى الضيق معتدلة لصفة التزهير الذكري والأنثوي وحاصل النبات وعدد الحبوب في الصف ووزن 100 حبة ومنخفضة لصفات ارتفاع النبات والعرنوص ومساحة ورقة العلم وعدد صفوف العرنوص وطول العرنوص وعدد الحبوب في العرنوص. كان التحسين الوراثي المتوقع عالياً لحاصل النبات ووزن 100 حبة. وأعطى الهجينان (DK × ZP – 197) و (ZP × ZP – 197 – 707) أعلى قيمة لقوة الهجين في التزهير الذكري والأنثوي، وأظهرت بعض الهجن قوة هجين عالية في مساحة ورقة العلم وحاصل النبات وارتفاع العرنوص ولكن منخفضة لعدد الحبوب في الصف وعدد الصفوف في العرنوص وطول العرنوص ووزن 100 حبة ولمختلف الهجن.

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