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DIALLEL CROSSES ANALYSIS FOR YIELD AND YIELD COMPONENTS IN WHEAT

Mostafa, A. K.

Wheat Research Dept., Field Crops Research Institute, Agricultural Research Center, Giza, Egypt.

ABSTRACT

A half diallel set of six bread wheat (*Triticum aestivum* , L.)genotypes, genetically diverse, were done in all possible combinations excluding reciprocals in 1998/1999. In 1999/2000 growing season, the F_1 crosses and the six parents were grown in a field experiment in the Sakha Experimental Farm, Agricultural Research Center .The experimental design of randomized complete blocks with four replications was used . Plant height, number of spikes per plant, number of kernels per spike, 100-kernel weight and grain yield per plant were studied. The F_1's of 15 wheat crosses and their respective parents were statistically analyzed to detect information on the genetic effects governing the studied characters. The obtained results showed that positive heterosis were detected for the six, two, nine and eleven crosses in case of number of spikes per plant, number of kernels per spike, 100 kernel weight and grain yield/plant ,respectively .The mean squares of genotypes, parents and crosses were highly significant for all studied traits .

The variances associated with general combining ability reached the level of significant in case of number of spikes per plant, 100-kernel weight and grain yield per plant. The same level of significance was found in case of specific combining ability for all studied traits. General combining ability variance were about two times higher than the specific combining ability variance for 100-kernel weight, suggested a predominant role of additive type of gene action.

The variance due to additive genetic effects (D) was significant only for 100-kernel weight. The relatively proportions of variance due to non-additive effect, was significant and greater in magnitude than the additive component (D). Overall dominance effect of heterozygous loci (h^2) was significant only for number of kernels/spike, which indicates that the effect of dominance is due to heterozygousity. Additive genetic components (D) appeared to be the major portion of the genetic variation for 100-kernel weight, which confirmed by the higher magnitude of GCA than those of SCA values. Over-dominance was observed for all studied traits. The proportion of genes with positive and negative alleles in parents showed that positive and negative alleles were not equally distributed among the parents for plant height, number of spikes/plant, number of kernels/spike and 100-kernel weight. Dominant genes in the parents were found for plant height and number of spikes per plant, number of kernels/spike, 100-kernel weight and grain yield per plant. Low values for heritability were detected for all studied traits, indicating that most of the genetic variances are due to non-additive genetic effects.

INTRODUCTION

Wheat is one of the major cereal crops in Egypt, which receives the most attention of specialists in plant breeding. To increase grain yield per unit area which is, in most cases, the main or the only solution for overcoming the increase demand of food from a limited cultivated area, plant breeders would develop high yielding wheat cultivars.

The assessment of nature of genetic variation is very crucial in any breeding program, since the choice of an appropriate breeding method depends on the relative importance of various genetic parameters. In wheat, plant height and spike characters are important plant attributes that determine the desirability of progeny of any cross. The appropriate selection of these traits may greatly contribute towards enhancement in the yielding ability. Thus, information on the nature of gene action with respect to those traits would prove useful in development of better cultivars. Dominance gene action would tend to favor the production of hybrids, whereas additive gene action signifies that standard selection procedures would be effective in breeding about advantageous changes in the characters (Edwards *et al.*, 1976).

Successful breeding programs need continuous information on the genetic variation and systems governing grain yield and its components. Contradictory results were obtained by many authors with respect to genetic systems governing such yield and its components. Khalifa *et al.* (1984), Singh *et al.* (1985), Singh *et al.* (1986), Singh *et al.* (1987), Uddin and Joader (1987), Hendawy (1990) and Ikram and Tanah (1991) indicated that both additive and non-additive gene effects played an equal role in the inheritance of grain yield, number of spikes/plant, number of kernels/spike and 1000-kernel weight. While Sharma and Smith (1986) and Salem and Hassan (1991) reported that non-additive gene effects were more important for grain yield/plant and number of spikes/plant. Singh *et al.* (1985), Dawam and Hendawi (1990), El-Hennawy (1991) and Darwish (1992) found that dominance gene effects were significant for grain yield/plant, number of kernels/spike and 1000-kernel weight. Meanwhile, El-Hennawy (1992) revealed that additive and dominance gene effects were important for grain yield and number of kernels/spike. On the other hand, Jain and Singh (1976) and Mekhamer (1995) reported that additive gene effects were significant for number of kernels/spike and 1000-kernel weight. Results obtained by Mahmoud (1999) found that additive and non-additive gene effects were controlling the genetic systems of grain yield and its components. The additive gene effect mainly influenced the inheritance of studied characters. Also, El-Sayed *et al.* (2000) found that both additive and dominance variances were significant for number of spikes/plant, number of kernels/spike, 1000-kernel weight and grain yield/plant. Moreover, Hamada and Tawfelis (2001) showed that additive and non additive gene effects were contributed to control the genetic system for plant height, number of spikes/plant, number of kernels/spike, 100 kernel weight and grain yield/plant.

The present study was initiated to estimate heritability and nature of gene action for grain yield and its components in six parental diallel crosses of bread wheat (*Triticum aestivum* L.).

MATERIALS AND METHODS

The field work of this study was conducted at Sakha Agricultural Research Station, Agricultural Research Center (ARC), Egypt. Five different bread wheat cultivars and one promising line representing a wide range of genetic variability were selected for this study during the two growing successive seasons 1998/1999 and 1999/2000. Names and pedigree of the six parental materials are presented in Table (1).

Table 1. Names and pedigrees of the six parents used in this investigation.

No.	Name	Pedigree	
P1	Giza 168	MRL/BUC//Seri	CM 93046-8M-0Y-0M-2Y-0B
P2	Gemmeiza 9	AQld”S”/Huac”S”//CMH74A.630/5 x CGM 4583-5GM-1GM-0GM	
P3	Line # 1	CHIL/SLM75	
P4	Sakha 93	Sakha 92/TR 810328	S8871-1S-2S-1S-0S
P5	Sakha 61	Inia/RL 4220///7c/Yr”S”	CM 15430-25-55-0S-0S
P6	Sids 6	Maya”S”/Mon”S”/CMH47.A.592/3/Sakha 82	SD 10002-4sd-1sd-0sd

In 1998/1999 season all possible crosses among the six selected parents (without reciprocals) were made to produce hybrid seeds of the fifteen crosses. In the second season, 1999/2000, the 21 entries (15 F_1’s and 6 parents) were planted in the field using the randomized complete block design with four replications according to Steel and Torri (1980). Each entry was planted in a plot of three rows; 4.2 m long and 30 cm apart. Every row contained 22 seeds spacing 20 cm. Data were recorded on a random sample of 10 garded plants for parents and F1 hybrids. Five characters were studied, i.e. plant height (cm), number of spikes/plant, number of kernels/spike, 100-kernel weight and grain yield/plant (gm).

Heterosis was calculated as the difference of the F_1 mean from the mid parent, and expressed in percentage (Matzinger *et al.*, 1959 and Fonseca and Patterson, 1968).

The analysis of variance for combining ability effects was done following the technique of Griffing (1956). The genetic analysis was carried out by the procedures described by Hayman (1954) and Jinks (1956).

RESULTS AND DISCUSSION

Analysis of variance for the plant height, number of spikes/plant, number of kernels/spike, 100- kernel weight and grain yield/plant are presented in Table (2).Test of significance indicated that the mean squares of genotypes were highly significant for all studied traits. The significance of the mean squares indicated the presence of true differences among these genotypes . Mean squares due to parents and crosses were highly significant for all studied traits. These findings indicate that parental varieties and /or lines differed in their mean performance in all traits under test .

Table 2 shows the results of the analysis of combining ability (general combining ability/specific combining ability ratio (GCA/SCA)). The variances associated with general combining ability reached the level of significant in case of no. of spikes per plant, 100-kernel weight and grain yield per plant. The same level of significance was found in case of specific combining ability for all studied traits. The significance of variances which were due to both general combining ability and specific combining ability revealed presence of both additive and non-additive types of gene effects. From the same table, it could be noticed that relatively large general combining ability effects were recorded for 100-kernel weight. The general combining ability variances were about two times higher than the specific combining ability variances for 100-kernel weight, suggested a predominant role of additive type of gene action for this trait and selection it could be successful.

Table 2. Pertinent portion of the analysis of variance for the studied characters and combining ability.

Source of variation	Plant height (cm)	Number of spikes per plant	Number of kernel per spike	100-kernel weight (gm)	Grain yield per (gm)
Replication	35.797**	7.125*	24.697	0.063	2.615**
Genotypes	52.967**	68.399**	108.028**	0.821**	20.699**
Parents (P)	37.888**	39.47**	85.187*	2.321**	6.422**
Crosses (C)	50.307**	79.174**	94.394**	0.291*	25.362**
P vs C	165.601**	62.190**	413.116	0.738**	26.397**
GCA	22.066**	26.651**	31.302	1.314**	9.723**
SCA	63.268**	82.314**	133.602**	0.656**	24.33**
Error	12.735	2.819	34.172	0.140	0.858
GCA/SCA	0.35	0.33	0.23	2.00	0.40

The mean performance of the six parental genotypes of wheat are presented in Table (3) .The parental cultivar Giza 168 (P_1)ranked the first for number of kernels /spikes. The parental cultivar gemmeiza 9 (P_2) ranked the first for grain yield / plant and the second for number of kernels /spikes. The parental line CHII /SLM75 (P_3) ranked the first for plant height and the third for 100 kernels weight . The parental cultivar Sakha 93 (P_4) ranked the moderately for all studied traits . The parental cultivar Sakha 61 (P_5) ranked the first for number of spikes /plant and the second for 100 kernel weight . The parental cultivar Sids 6 (P_6) ranked the first for 100 kernel weight. The mean performance of the tested fifteen crosses are presented in Table (3) . For plant height ,the best two crosses were P_1 x P_4 and P_2 x P_4. The three crosses P_4 xP_6, P_2 x P_4 and P_3 x P_5 possessed the higest number of spikes /plant ,while the two crosses P_4 xP_5 and P_5 xP_6 possessed the highest number of kernels /spike .For 100 kernel weight the best two crosses P_4 xP_5 and P_2xP_4 . The three crosses P_2 xP_5 ,P_5 xP_6 and P_1 xP_6 possessed the highest grain yield /plant however, two crosses P_3 xP_5 and P_2 xP_4 gave the lowest values for this trait .

Table 3.Mean performance (X), and heterosis for the studied traits.

Genotype	Plant Height (cm)		Number of spikes per plant		No. of kernels per spike		100-kernel per plant (gm)		Grain yield (gm)	
	$\bar{X}$	H	$\bar{X}$	H	$\bar{X}$	H	$\bar{X}$	H	$\bar{X}$	H
P_1	104.33		18.97		66.07		4.62		21.51	
P_2	108.00		21.25		62.38		4.47		26.07	
P_3	99.00		13.65		54.09		5.21		23.94	
P_4	103.00		19.80		56.01		5.21		24.22	
P_5	105.50		23.47		53.65		5.26		24.42	
P_6	99.33		15.57		53.49		6.94		24.15	
P_1 x P_2	103.67	-2.35	15.97	-20.60	48.64	-24.27	5.19	14.26**	25.20	5.95**
P_1 x P_3	103.33	1.64	17.55	7.61**	50.33	-16.23	5.53	12.51**	25.42	11.88**
P_1 x P_4	100.67	-2.50	14.43	-25.54	48.58	-20.42	5.32	8.31**	27.68	21.04**
P_1 x P_5	108.33	3.26	8.08	-61.90	48.36	-19.21	5.64	14.28**	20.09	-12.50
P_1 x P_6	105.00	3.11	15.13	-12.36	56.54	-5.43	5.23	-9.54	28.37	24.25**
P_2 x P_3	106.33	2.74	17.90	2.58*	50.02	-14.10	5.63	16.39**	27.85	11.39**
P_2 x P_4	101.33	-3.57	23.23	13.20**	51.54	-12.93	5.78	19.49**	26.26	4.45**
P_2 x P_5	105.67	-1.01	12.53	-43.94	46.82	-19.30	5.74	17.96**	29.46	16.71**
P_2 x P_6	105.33	1.61	18.37	-0.23	50.84	-12.24	5.05	-11.45	22.46	-10.55
P_3 x P_4	110.33	9.69	13.00	-22.27	52.32	-4.96	5.57	6.97**	26.44	9.79**
P_3 x P_5	110.00	7.58	22.35	20.43**	57.22	6.23	5.02	-4.14	24.85	2.79**
P_3 x P_6	109.67	10.59	20.83	42.61**	45.13	-16.10	5.54	-8.78	26.90	11.87**
P_4 x P_5	103.00	-0.80	10.10	-53.31	65.53	19.52**	6.18	18.03**	21.49	-11.64
P_4 x P_6	114.33	13.48	26.67	50.80**	47.13	-13.92	5.68	-6.47	21.36	-11.69
P_5 x P_6	112.67	10.01	12.61	-35.39	60.19	12.36**	5.75	-5.74	28.42	17.04**
L.S.D 5%	5.888	5.099	2.770	2.399	9.646	8.353	0.617	0.534	1.529	1.324
L.S0.D 1%	7.878	6.823	3.707	3.210	12.906	11.177	0.826	0.715	2.045	1.771

Parents vs crosses mean squares (Table 2) as an indication to average heterosis overall crosses were found to be highly significant for all traits studied indicating that the average heterosis was detected .

The heterosis values for the five characters are given in Table (3). High positive values would be of interest in all studied traits except plant height was negative values would be useful from the breeder point of view .For plant height no useful heterotic effects toward shortness were fount .Moreover, most of the hybrid combinations were found to be significantly taller than their corresponding mid parents . On the same time, six, two, nine and eleven F_1's crosses had higher number of spikes per plant, number of kernels per spike, 100 kernel weight and grain yield than the means of corresponding parents, in respective order. It is clear from the tabulated data that, three crosses, out of the fifteen crosses, seem to be promising, crosses (P_1 x P_3, P_2 x P_3 and P_2x P_4) for number of spikes per plant , 100 kernel weight and grain yield /plant. In the same time, crosses P_1 x P_2, P_1 x P_4, P_2 x P_5 and P_3 x P_4 gave positive heterosis for grain yield and 100 kernel weight and finally ,two crosses P_3 x P_5 and P_3 xP_6 for grain yield and number of spikes per plant. Walton (1971) emphasized that a parent superior for one yield components character should be crossed with a parent superior for the other components to obtain heterosis in a complex trait such as grain yield. The particular components contributing to high yielding crosses were not consistent from cross to cross. Our results are in good agreement with those reported by Abd El-Magied (1995) and Hassan and Saad (1996).

Estimates of general combining ability effects for each parents are presented in Table (4).High positive values would be of interest in all studied traits except plant height was negative value would be useful from the breeder point of view. Results indicated that the cultivars Gemmeiza 9 (P_2) showed significant positive general combining ability effects for number of spikes /plant and grain yield /plant. While the cultivar Sakha 93 (P_4) proved to be good combiner for number of spikes /plant . As for grain yield per plant, line P_3 (CHIL/ SLM75) showed positive and significant value for general combing ability effect .However, the cultivar Sids 6 (P6) showed significant positive general combining ability effects for 100 kernel weight .

Specific combining ability effects calculated for each cross are presented in Table (5). Five, two, five and seven crosses showed significant positive specific combining ability effects for number of spikes/plant, number of kernels per spike, 100-kernel weight and grain yield per plant respectively. The crosses P_2xP_3, P_2xP_5, P_3xP_6 and P_5xP_6 are considered to be promising hybrids for grain yield improvement purpose, as they showed high specific combining ability effects and involved one of the parents as good combiner .It is worthy to note that the first thise hybrids were a result of crossing poor x good and good x good general combiners.. In such hybrids, desirable transgressive segregates would be expected in the subsequent generations, if the additive genetic system present in the good combiner and the complementary epistatic effects in the F1 acted in the same direction to maximum the yielding ability.

The main objective of plant breeding program is to produce plants that perform certain functions better than the existing types. For this, the plant breeder must have sufficient information on the inheritance of economic traits, if he is intending for efficient planning of the breeding program.

Table 4. Estimates of general combining ability effects for plant height ,yield and yield components.

Parent	Plant Height (cm)	Number of spikes per plant	No. of kernels per spike	100-kernel weight (gm)	Grain yield per plant (gm)
Giza 168 (P_1)	-1.208	-1.423	1.203	-0.254	-0.716
Gemmeiza 9(P_2)	-0.125	1.251**	-0.292	-0.232	0.981**
Line (P_3)	-0.208	-0.194	-1.470	-0.059	0.476**
Sakha 93 (P_4)	-0.666	0.818*	0.269	0.095	-0.481*
Sakha 61 (P_5)	1.416	-0.984	1.308	0.080	-0.296
Sids 6 (P_6)	0.791	0.532	-1.018	0.369**	0.035
L.S.D gi 5%	1.343	0.632	2.201	0.141	0.349
L.S.D gi 1%	1.797	0.846	2.945	0.189	0.467
L.S.D gi-gj 5%	2.081	0.980	3.410	0.218	0.541
L.S.D gi-gj 5%	2.785	1.311	4.563	0.292	0.723

Table 5. Estimates of specific combining ability effects for the fifteen crosses evaluated for plant height ,yield and yield components.

Genotype	Plant height (cm)	Number of spikes per plant	No. of kernels per spike	100-kernel weight (gm)	Grain yield per plant (gm)
P_1 x P_2	-0.619	-1.074	-5.836	0.223	-0.135
P_1 x P_3	-0.869	1.955*	-2.972	0.387*	0.589
P_1 x P_4	-3.077	-2.174	-6.462	0.025	3.801**
P_1 x P_5	2.505	-6.721	-7.715	0.360	-3.967
P_1 x P_6	-0.202	-1.187	2.785	-0.341	3.973**
P_2 x P_3	1.047	-0.369	-1.778	0.468*	1.317**
P_2 x P_4	-3.494	3.956**	-2.002	0.462*	0.689
P_2 x P_5	-1.244	-4.946	-7.765	0.431*	3.700**
P_2 x P_6	-0.952	-0.629	-1.410	-0.540	-3.631
P_3 x P_4	5.589	-4.836	-0.047	0.081	1.368**
P_3 x P_5	3.172	6.316**	3.819	-0.460	-0.404
P_3 x P_6	3.464	3.283**	-5.946	-0.222	1.310**
P_4 x P_5	-3.369	-6.946	10.389**	0.544**	-2.808
P_4 x P_6	8.589	8.103**	-5.689	-0.237	-3.271
P_5 x P_6	4.839	-4.149	6.337*	-0.156	3.607**
L.S.D. Sij 5%	3.691	1.737	6.046	0.387	0.958
L.S.D. Sij 1%	4.938	2.324	8.089	0.518	1.282
L.S.D Sij –SiK 5%	5.508	2.592	9.023	0.578	1.430
L.S.D Sij –SiK 1%	7.370	3.468	12.073	0.773	1.914

The diallel analysis as outlined by Hayman (1954) and Jinks (1954) is an attempt to partition phenotypic variation into genotypic and environmental components and to further subdivided genotypic variation into its additive and dominance components, which can be used to draw inferences about the genetic system.

The estimates of the genetic components of variation; D, H_1, H_2, h^2 and F obtained from diallel analysis for plant height, number of spikes per plant, number of kernel per spike, 100-kernel weight and grain yield per plant are presented in Table 6. Additive genetic effects (D) was significant only for 100-kernel weight. The estimates of H_1 which gives the relatively proportions of variance due to non-additive effect, was significant and greater in magnitude than the additive component (D). The component of variation due to the dominance effects associated with gene distribution (H2) was highly significant and greater than D for number of spikes/plant, number of kernel per spike, 100-kernel weight and grain yield per plant. All H2 values were smaller than H1 values for all traits indicating unequal allelc frequency. Overall dominance effects of heterozygous loci (h^2) was significant only for number of kernels/spike, which indicate that the effect of dominance is due to heterozygousity. The covariance of additive and dominance effect (F) was not significant for all traits except 100-kernel weight. From the a forementioned results, it could be concluded that the additive genetic components (D) appeared to be the major portion of the genetic variation for 100-kernel weight. This was confirmed by the higher magnitude of GCA than those of SCA values.

The proportion of the genetic components are presented also in Table 6. The mean degree of dominance $(H_1/D)^{\frac{1}{2}}$ was 3.170, 3.163, 2.994, 1.126 and 4.148 for plant height, number of spikes per plant, number of kernel per spike, 100-kernel weight and grain yield per plant which indicated over-dominance for all studied traits. The proportion of genes with positive and negative alleles in parents $(H_2/4H_1)$ were slightly below the maximum value (0.25), which arises when U = V = 0.5 over all loci, indicating that the positive and negative alleles were not equally distributed among the parents for plant height, number of spikes/plant, number of kernels/spike and 100-kernel weight. While in case of grain yield per plant, the proportion of genes with positive and negative alleles in parents was in equal proportion being 0.238. The ratio $[(4DH_1)^{\frac{1}{2}}+F\ /\ (4DH_1)^{\frac{1}{2}}-F)]$ gives the proportion of dominant and recessive genes. Dominant genes in the parents were found for plant height and number of spikes per plant, number of kernels/spike, 100-kernel weight and grain yield per plant (3.405, 2.718, 2.709, 3.920 and 1.218). Low values for heritability were detected for all studied traits, indicating that most of the genetic variances are due to non-additive genetic effects. This result supported the previous results concerning the genetic components, where the H1 estimates played greater role than that of D (Table 6). In this respect, it could be suggested that bulk method program for most traits might be quite promising.

Table 6. Estimates of genetic components and various ratios for plant height, yield and its components from 6x6 diallel crosses.

Genetic parameters and ratios	Plant height (cm)	Number of spikes per plant	Number of kernel/spike	100-kernel weight (gm)	Grain yield per plant (gm)
D	8.019	12.148	17.155	0.728**	1.827
H_1	80.572*	121.590**	153.812**	0.923**	31.438**
H_2	54.368	88.604**	119.409**	0.561**	30.021**
h^2	33.216	12.876	83.009**	0.134	5.529
F	27.753	35.519	47.340	0.973**	1.494
$(H_1/D)^{\frac{1}{2}}$	3.170	3.163	2.994	1.126	4.148
$H_2/4H_1$	0.169	0.182	0.194	0.152	0.238
$(4DH_1)^{\frac{1}{2}}+F\ /\ (4DH_1)^{\frac{1}{2}}-F$	3.405	2.718	2.709	3.920	1.218
Heritability	0.151	0.172	0.048	0.240	0.101
r	-0.886	0.371	0.853	0.929	-.287

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تحليل الهجن التبادلية للمحصول ومكوناته فى القمح

أحمد كمال مصطفى أحمد

برنامج بحوث القمح - معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - الجيزة - جمهورية مصر العربية.

أجرى التهجين الدائرى فى إتجاه واحد بين ستة تراكيب وراثية من قمح الخبز (خمسة من الأصناف التجارية وسلالة مبشرة) خلال الموسم ١٩٩٨/١٩٩٩. و ١٩٩٩/٢٠٠٠ حيث زرعت الآباء الستة والخمسة عشر هجين (الجيل الأول) المتحصل عليها من التهجين الدائرى فى تجربة حقلية بالمزرعة التجريبية لمركز البحوث الزراعية بسخا. زرعت الآباء ونباتات الجيل الأول فىتصميم قطاعات كاملة العشوائية فى اربع مكررات . أخذت القراءات على صفات : طول النبات ، عدد السنابل بالنبات ، عدد حبوب السنبلة ، وزن المائة حبة ووزن محصول النبات من الحبوب. أجرى التحليل الإحصائى على القراءات المسجلة على الآباء ونباتات الجيل الأول للتعرف على العوامل الوراثية التى تحكم هذه الصفات ويمكن تلخيص اهم النتائج كما يلى :

أظهرت النتائج أن هناك قوة هجين لمتوسط الابوين فى ستة هجن بالنسبة لصفة عدد السنابل بالنبات ، هجينن بالنسبة لصفة عدد حبوب السنبلة ، تسعة هجن بالنسبة لصفة وزن المائة حبة ، واحدى عشر هجين بالنسبة لصفة محصول الحبوب بالنبات.و من ناحية أخرى أظهرت الدراسةعلى وجود معنوية عالية لكل من التراكيب الوراثية والاباء والهجن وكذلك اظهرت القدرة العامة على الإئتلاف على وجود معنوية بالنسبة لصفات عدد حبوب الستبلة ، وزن المائة حبة ، وزن محصول الحبوب للنبات. كما وجدت معنوية لجميع الصفات المدروسة عند دراسة القدرة الخاصة على الإئتلاف.

وكان تباين القدرة العامة على الإئتلاف أعلى من القدرة الخاصة للإئتلاف بالنسبة لوزن المائة حبة فقط مما يوضح حقيقة السيادة الجزئية لطبيعة فعل الجين الإضافى. وكان تأثير التباين الراجع للإضافة معنوياً فقط لصفة وزن المائة حبة. وكان التأثير الراجع إلى السيادة معنوياً وأكبر من تأثير الإضافة.و كانت السيادة الفائقة معنوية فى كل الصفات تحت الدراسة حيث أوضحت النتائج أن تأثير السيادة يرجع إلى الإختلاف الوراثيى. وكان للعوامل المضيفة ذات اهمية فى وراثة وزن المائة حبة. ويرجع ذلك لأن قيمة القدرة العامة للإئتلاف كانت أكبر من قيمة القدرة الخاصة للإئتلاف. وأوضحت الدراسة أن توزيع الجينات الموجبة والسالبة كان عير منتظماً بالنسبة لطول النبات وعدد السنابل فى النبات وعدد حبوب السنبلة ووزن المائة حبة.وكذلك أظهرت قيمة التوريث قيماً منخفضة لكل الصفات تحت الدراسة.