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ASSESSMENT OF SOME GENETIC PARAMETERS USING DIALLEL CROSS FASHION AND THEIR IMPLICATIONS IN BREEDING PROGRAMS OF BREAD WHEAT (*Triticum aestivum* L.)

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ABSTRACT: A 6 x 6 half diallel cross fashion in F_1 and F_2 generations was employed to study heterotic effects, gene action, heritability and graphical analysis for days to heading, flag leaf area, plant height, spike length as well as yield and its components. The results indicated highly significant differences among parental wheat genotypes and their F_1 and F_2 progeneis for all studied characters. The most superior crosses exhibited desirable heterobeltiosis for grain yield, its components, earliness and the broadest flag leaf area were (Giza 168 x H.D 1220), (Giza 168 x Pvn"S"/Sprw"S") and (Gzia 168 x Gemmeiza3), with specific superiority for the wheat cross (Giza168 x H.D1220) in grain yield by about 25%, also, positive and highly significant true heterosis was observed for spike length in both wheat crosses (H.D1220 x BR-12)and(H.D1220 x Pvn"S"/Sprw"S"), suggesting their importance as promising crosses in wheat breeding programs.

The magnitudes of F_1 relative to mid-parents as indicated by {h} values revealed that,the highest and significantly desirable {h} values for grain yield, its components, earliness, broader flag leaf area were recorded in cross combinations (Giza 168 x H.D 1220), (Giza 168 x Gemmeiza3), (Giza 168 x Pvn"S" / Sprw "S"),(Gemmeiza3 x BR-12) and (BR-12 x Pvn"S" / Sprw "S"), indicating the presence of heterotic effects.

Negative and highly significant F_2 deviations have been reported towards earliness in the wheat crosses (H.D 1220 x Gemmeiza3),(H.D 1220 x BR-12),(Gemmeiza3 x BR- 12)and(BR-12 x Pvn"S"/Sprw"S") and for shortness in the crosses (Sakha 61 x Gemmeiza3) and (BR-12 x Pvn"S" / Sprw "S"),indicating accumulation effect of decreasing alleles .Whereas, positive and highly significant F_2 deviations were observed for flag leaf area in the crosses (Sakha 61 x Gemmeiza3)and(Giza 168 x Gemmeiza3) as well as grain yield, number of grains / spike and 1000-grain weight in the crosses (Giza 168 x BR-12) and (H.D 1220 x BR-12),indicating accumulation of increasing alleles.

The additive and dominance gene effects were significant and involved in the inheritance of days to heading, plant height, number of spikes/plant, number of grains/spike and grain yield/plant in the F_1 and F_2 generations, as well as flag leaf area and spike length in the F_1 hybrid only. The dominance genetic variance was the main component controlling the inheritance of 1000-grain weight in the F_1 and F_2 generations and flag leaf area and spike length in F_2 generation. The dominance gene action was larger in it's magnitude than additive ones,resulting in $(H1/D)_{0.5}$ more than unity in most cases. Hereby, hybrid breeding method was effective. Whereas, the additive component played the major role in the inheritance of days to heading in F_1 and F_2 generations as well as spike length in F_1 only. Thus, phenotypic selection would be an effective procedure for improving both characters. The "F" values coupled with KD/KR ratio indicated excess of dominant increasing alleles for all characters, except flag leaf area and number of spikes/plant in F_1 hybrid. Narrow sense heritability showed an increase from F_1 to F_2 generation for days to heading, plant height, number of grains/spike and 1000-grain weight. High heritability estimate (>50%) was obtained for days to heading in F_1 and F_2 generations ; spike length in F_1 and plant height in F_2 generation, however low values were detected for grain yield /plant and its components in F_1 and F_2 generations . Graphical analysis indicated that the parental wheat genotype Sakha 61 contained high frequency of recessive alleles for earliness and shortness . Meanwhile, Sakha61, Gemmeiza3 and the exotic genotype H.D1220 displayed high concentration of dominant alleles for broader flag leaf area; Giza 168 for tallness,spike length, number of spikes/plant and number of grains/spike. as well as Gemmeiza 3 for number of spikes/plant, 1000-grain weight and grain yield/plant, reinforcing their importance to produce F_1 hybrid, or to isolate new promising recombinant lines from segregating generations.

INTRODUCTION

Information about heterotic effects and genetic components for yield and its attributes are of prime powerful tools in wheat improvement.

Heterobeltiosis is exteremely useful in identifying the best cross combinations displayed more favourable genes for the economic characters. The superiority of the hybrids over parent average was 32%(Livers and Heyne, 1968) and in the meantime certain hybrids yielded more than the better parent and as much as 27% (Allan, 1973 and Hassan ,1998). Therefore, the development of hybrid wheat became possible after male sterility and fertility- restoring genes were identified in wheat or by using chemical hybridizing agents (Gametocide)that suppress pollen production in the female parents. Pickett (1993) in UK, in his reports on hybrid wheat - results and problems, reported that the three aspects must be taken in consideration i.e, heterosis and the genetices of hybrids, male sterility and hybrid seed production.

From another point of view, when the F_1 hybrid was superior in yield potentiality, this offer the wheat breeder great apportunity for isolating new promising recombinant lines after"n"of selfing generations, exceeding F_1 hybrid or exceeding parental range.

Significant heterobeltiosis (heterosis retative to the high performing parent) and inbreeding deviations in F_2 for yield contributing characters in wheat were reported by several authers (Walia *et al.*,1993; Khan *et al* .,1995; Perenzin *et al* .,1996; Hassan, 1998 and Salama,2000) . Considerable amount of {h} estimates were recorded for days to heading and yield contributing characters by Eissa and Awaad (1993) and Awaad (1996).

Assessment of the genetic components of variance using second degree statistic help the breeder to identify the genetic system controlling yield contributing characters and then the effective breeding method for improving these characters. In this respect, additive and dominance gene effects with great importance to dominance found to be controlled the genetic system of days to heading, plant height and spike length (Eissa, 1993); flag leaf area (Singh *et al.*, 1986) as well as grain yield and its components (Awaad ,1996a) and Salem *et al.*, 2000).

Heritability in narrow sense (T_n) was more than 50% for days to heading,plant height and spike length (Salama, 2000 and Salem *et al.*, 2000), howerer Singh *et al.*(1986) recorded (T_n) estimates of 31.03% for flag leaf area and 9.69% for grain yield / plant. Meanwhile, prevalence of the dominance genetic vairance resulting in low to moderate (T_n) values for grain yield and its attributs (Hassan, 2002).

The high potential of genetic diversity in wheat genotypes makes it imperative to carry out this investigation to estimate heterobeltiosis,{h}, F_2 deviation parameters , gene action, heritability and graphical analysis using 6 x 6 diallel cross analysis for yield and its attributes .

MATERIALS AND METHODS

1-Parental genotypes and experimental layout :

The present investigation was conducted at the Experimental Farm, Fac. of Agric., Zagazig University, Egypt during the three winter growing seasons of 1999/2000, 2000/2001 and 2001/2002 to study some genetic parameters controlling yield and its attributes using a diallel cross set between six diverse bread wheat genotypes excluding receprocal. The origin and pedigree of the six parental wheat genotypes involved in the present study are illustrated in Table (1).

Table(1):The origin and pedigree of the studied parental wheat genotypes.

No.	Parent	Origin	Pedigree
1	Sakha 61	Egypt	Inia/RL4220// 7C/3/Yr "S" CM15430-2S-5S-0S-61S-OEGY
2	Giza 168	Egypt	MIL/BUC//Seri: CM93046-8M-OY- OM-2Y-OB
3	H.D 1220	Mex.	H.D 1220- Kal(3) x Nac/ Psn "S" CM 64792 -3 Gm - OGm.
4	Gemmeiza 3	Egypt	B6/7c*21//y50E / Kal//*3 xSakha8/ 4/RRV/15/3/BJ
5	BR-12	Brazil	BR12*2/3/Jup// PAR 214* 6/ F86631
6	Pvn "S"/ Sprw "S"	Syr/Mex	CM46702- 2AP-OAP-2AP-1AP-OAP

In the first season of 1999/2000, the six bread wheat genotypes were evaluated in a randomized complete block design experiment with three replications, at the meantime half diallel crosses were made to produce 15 F_1 cross grains. In the second season of 2000/2001, the obtained 15 F_1 seeds were sown to produce F_1 plants which have been selfed to produce F_2 grains, and the parents were crossed again in a half diallel to produce more F_1 cross grains. In the third season of 2001/2002, the obtained grains of the 6 parents, 15 F_1's and 15 F_2's crosses were evaluated using a completely randomized block design with three replications. Wheat grains were sown on the last week of November. Each plot consists of 10 rows (2 rows for each parent and F_1 crosses and 4 rows for F_2 generation). Each row was 3m. long , row to row and plant to plant spacing were 20 and 10 cm, respectively. All the recommended agronomic practices for wheat production were applied. Date of main spike emergence and flag leaf area were recorded at the time of full emergence of main spike, however, at harvest, the data of plant height, spike length, number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant were recorded on 10 competitive individual plants for each of (P_1,P_2 and F_1) and 70 plants for each F_2 generation in each replicate.

2- Biometrical assessment:

The obtained data were subjected firstly to the conventional two way analysis of variance .Heterobeltiosis and {h}- parameters were estimated according to Mather and Jinks (1982) as follows:

Heterobeltiosis (heterosis over the better parent "$\bar{BP}$").

"BP" value $=(\bar{F}_1-\bar{BP}/\bar{BP})100$

Dominance deviation {h}

$\{h\} = \bar{F}_1 - \frac{1}{2}(\bar{P}_1+\bar{P}_2)$.

F_2 deviation (Sun *et al.*, 1972) was calculated as follows :

F_2 deviation$=\bar{F}_2-\frac{1}{2}\{\bar{F}_1 + \frac{1}{2}(\bar{P}_1+\bar{P}_2)\}$

The t-test was used to measure the significancy of these parameters.

The components of genetic variance were computed in the F_1 and F_2 generations as well as graphical analysis was made in the F_1 according to Hayman (1954) and Mather and Jinks (1982).

RESULTS AND DISCUSSION

Results given in Table (2) revealed highly significant differences among parental wheat genotypes, F_1 and F_2 generations for the studied characters, providing evidence for the presence of a high degree of genetic variability which considered adequate for further biometrical assessment.

The two local parental wheat genotypes; Giza 168(P_2) and Gemmeiza 3 (P_4) as well as the exotic one Pvn"S"/Sprw"S"(P_6) and their F_1's and F_2's progeneis (P_2XP_3), (P_2 X P_4), (P_2 X P_6)and (P_4X P_5) were the best for earliness, broader flag leaf area, spike length as well as yield and its components, indicating that these genotypes could be considered the promising ones.

1-Heterotic effects:

1.A.Heterobeltiosis :

Heterobeltiosis term is thé true heterosis due to the heterozygous situation of the loci in F_1 hybrid between completely homozygous and high distantly related parents. Then the superiority of F_1 resulted from the sum of the dominance deviations of the loci that have different alleles in the two parental lines.

Data presented in Table(3) indicated that negative and highly significant useful heterosis relative to the earliest parent (heterobeltiosis) was observed towards earliness in the seven cross combinations;(P_1 x P_4),(P_2x P_3),(P_2x P_4),(P_2x P_6), (P_3 x P_4), (P_3 x P_5) and (P_4 x P_5) with specific superiority by about-2.82,-2.55 and-2.45 days in the three crosses (P_3 x P_5),(P_2 xP_6) and (P_3 xP_4),in the same respective order. Significantly negative heterotic effect for shortness was recorded in the crosses (P_3xP_6),(P_4xP_6)and (P_5xP_6).Otherwise, the best combinations for tallness were, (P_1xP_3), (P_1xP_4), (P_1xP_5), (P_2xP_3) (P_2xP_4) ,(P_3xP_4) and (P_3xP_5). Positive and highly significant heterobeltiosis for broader flag leaf area was recorded in twelve crosses, with maximum values of 24.88, 24.35, 22.79,22.63,20.72 and 20.44% in the six wheat crosses (P_1xP_4) ,(P_2xP_4),(P_4xP_5) ,(P_1xP_2), (P_2xP_6) and (P_5xP_6) ,respectively.True heterosis for spike length was expressed; 11.24, 7.91, 5.83, 5.75, 3.64 and 3.25% in the six wheat crosses (P_3xP_6), (P_3xP_5) ,(P_1xP_2), (P_1xP_4) ,(P_1xP_6) ,and(P_4xP_6) , respectively. Moreover, the most promising crosses exhibited maximum positive and significant heterobeltiosis for grain yield/plant, number of

Table (2) : Mean performance of parental wheat genotypes, F_1 and F_2 generations for the studied characters.

Parents or crosses and generations		Days to heading	Flag leaf area (cm²)	Plant height (cm)	Spike length (cm)	No. of spikes/plant	No. of grains/spike	1000-grain weight(gm)	Grain yield/ plant(gm)
Parents:									
Sakha 61	(P_1)	89.20	34.740	89.43	11.17	4.17	51.67	47.130	10.033
Giza 168	(P_2)	91.67	36.188	94.00	12.35	4.70	60.66	46.330	11.230
H.D 1220	(P_3)	93.20	39.439	88.66	10.77	4.50	58.33	43.330	9.367
Gemmeiza 3	(P_4)	90.33	37.091	92.33	12.01	5.00	48.02	50.210	13.400
BR 12	(P_5)	92.10	33.902	88.67	11.00	4.10	53.00	47.680	8.670
Pvn"S"/Sprew "S	(P_6)	99.00	30.218	110.67	11.83	5.10	61.11	48.120	12.833
Crosses:									
P_1 X P_2	(F_1)	90.65	44.378	99.40	13.07	4.50	57.33	53.410	11.567
	(F_2)	87.67	32.067	95.07	13.03	4.20	52.03	44.067	7.067
P_1 X P_3	(F_1)	92.66	45.648	101.13	11.83	5.01	52.67	54.230	12.300
	(F_2)	90.47	44.100	99.13	12.10	3.98	50.86	49.983	12.133
P_1 X P_4	(F_1)	88.20	46.318	112.25	12.70	5.07	53.33	56.330	13.370
	(F_2)	87.83	46.133	98.87	12.50	4.41	57.12	54.066	11.600
P_1 X P_5	(F_1)	90.67	33.331	96.50	10.90	4.01	55.12	51.230	9.566
	(F_2)	91.27	32.167	100.27	10.80	4.00	58.23	55.433	10.133
P_1 X P_6	(F_1)	92.30	40.675	114.66	12.26	5.00	58.67	50.130	12.067
	(F_2)	96.37	34.200	110.03	12.07	3.90	55.30	50.166	8.067
P_2 X P_3	(F_1)	91.15	45.965	108.33	12.06	5.30	47.33	63.000	14.133
	(F_2)	90.40	43.233	104.10	11.40	3.80	54.40	60.233	12.500
P_2 X P_4	(F_1)	89.20	46.123	105.53	12.10	5.89	52.01	58.430	16.366
	(F_2)	89.17	48.267	103.17	12.03	4.20	50.80	59.400	14.672
P_2 X P_5	(F_1)	92.40	35.567	91.33	12.16	5.20	60.00	48.200	13.066
	(F_2)	91.53	33.200	91.90	11.70	4.50	64.20	51.800	12.767
P_2 X P_6	(F_1)	89.33	43.686	111.31	11.90	5.90	49.33	60.000	15.833
	(F_2)	91.30	34.466	110.30	11.06	5.07	48.27	64.133	14.100
P_3 X P_4	(F_1)	88.12	42.608	105.13	9.20	5.10	58.12	48.000	11.466
	(F_2)	86.23	35.067	100.53	8.97	4.30	57.26	50.367	10.120
P_3 X P_5	(F_1)	89.50	41.826	100.20	11.87	4.56	46.34	53.330	8.367
	(F_2)	87.47	40.300	97.17	8.80	4.41	58.20	54.733	11.767
P_3 X P_6	(F_1)	94.80	42.379	97.65	13.16	4.67	52.10	57.330	12.966
	(F_2)	93.53	39.233	98.23	13.07	4.03	56.13	49.433	8.900
P_4 X P_5	(F_1)	89.33	45.544	95.40	11.73	4.27	62.67	58.200	16.267
	(F_2)	87.07	32.267	94.30	11.30	5.20	65.10	53.133	14.400
P_4 X P_6	(F_1)	93.66	32.616	97.67	12.40	5.82	54.67	53.670	15.400
	(F_2)	91.93	25.767	100.13	11.77	3.90	62.06	55.967	15.166
P_5 X P_6	(F_1)	94.30	40.831	98.89	11.97	5.42	59.66	51.520	15.200
	(F_2)	91.07	28.033	96.07	11.50	5.02	49.70	52.200	13.400
F.test		**	**	**	**	*	**	**	**

* And ** Signficant at 0.05 and 0.01 levels of probability, respectively.

spikes/plant and 1000-grain weight were (P_2xP_3) , (P_2xP_6), (P_1xP_3), (P_2xP_4) and (P_5xP_6) as well as for grain yield/plant, number of grains/spike and 1000-grain weight in the wheat cross (P_4xP_5).

It is evident to mention that, the cross combinations (P_2xP_3), (P_2xP_6) and (P_2xP_4), were superior in high yielding ability, earliness and broadest flag leaf area, hereby these crosses are of great value in practical wheat breeding programs for gathering the earliness, flag leaf area and high yielding ability in one genotype or more, especially the promising wheat cross (P_2xP_3) which yielded more than the high performing parent by about 25%. This superiority may be due to the difference between their parents in geographical origin (Table 1). Thus, heterosis was greater in crosses of more distantly related parents and it usually occurred with significant dominance and one or more significant epistatic effects (Sun *et al.*, 1972)and confirmed the results of {h} parameter. The previous results are in agreement with those reported by Walia *et al* .(1993), Khan *et al.* (1995), Perenzin *et al.* (1996) and Salama (2000) .

1.B.{h} - parameter:

The {h}-parameter which indicate dominance deviations was estimated. Significant {h} value, suggest the presence of heterotic effects and dominance and /or dominance x dominance gene effects were involved. As given in Table(3),negative and significant desirable {h} values relative to the mid-parents have been detected towards earliness in eleven cross combinations, with specific superiority by about -6.01 , -3.65 and -3.15 days in the three crosses (P_2xP_6) ,(P_3xP_4) and (P_3xP_5),respectively.Significantly negative {h} values for shortness -2.02 and -3.83cm were recorded in the cross combinations(P_3xP_6) and(P_4xP_6),respectively.However, positive and significant {h} estimates were recorded for both broader flag leaf area and plant height in the wheat crosses (P_1xP_2), (P_1xP_3), (P_1xP_4), (P_1xP_6), (P_2xP_3), (P_2xP_4), (P_2xP_6), (P_3xP_4), (P_3xP_5)and(P_4xP_5) . Also, positive and significant {h} values were observed for spike lengthe in eight crosses with maximum heterotic effects 1.86, 1.31 and 1.11cm in the cross combinations,(P_3xP_6),(P_1xP_2)and (P_1xP_4), respectively. Positive and significant {h} estimates were recorded for wheat grain yield/plant and its components in the crosses (P_1xP_4)and(P_5xP_6)as well as grain yield/plant, number of spikes/ plant and 1000-grain weight in the crosses (P_1xP_3), (P_2xP_3) ,(P_2xP_4),(P_2xP_6),(P_4xP_6) and (P_5xP_6). These results provide evidence for the presence of overdominance gene effects

Table (3): Heterobeltiosis (BP⁻%) and {h} parameters for the studied characters in 6x6 diallel cross of bread wheat.

Character Cross	Days to heading		Flag leaf area		Plant height		Spike length		No. of spikes/plant		No. of grains/spike		1000-grain weight		Grain yield/plant	
	BP⁻	{h}	BP⁻	{h}	BP⁻	{h}	BP⁻	{h}	BP⁻	{h}	BP⁻	{h}	BP⁻	{h}	BP⁻	{h}
$P_1 \times P_2$	1.63*	0.22	22.632**	8.910**	5.75*	7.69*	5.83**	1.31*	-4.26*	0.07	-5.49*	1.17	13.325**	6.68**	3.001*	0.936
$P_1 \times P_3$	3.88**	1.46*	15.743**	8.560**	13.08**	12.09**	-5.91**	0.86*	11.33**	0.68*	-9.70**	-2.33	16.065**	9.00**	22.595**	2.600*
$P_1 \times P_4$	-1.12*	-1.57*	24.877**	10.400**	21.58**	21.37**	5.75**	1.11*	1.40	0.49*	3.21*	3.49*	12.189**	7.66**	-0.224*	1.654*
$P_1 \times P_5$	1.65*	0.02	-4.056**	-0.990	7.91**	7.45*	-2.42	-0.19	-3.84*	-0.13	4.00*	2.79	7.445**	3.825*	-4.655**	0.215
$P_1 \times P_6$	3.48**	-1.80*	17.084**	8.190**	3.61	14.46**	3.64*	0.76*	-1.96	0.37*	-3.99*	2.28	4.177**	2.505	-5.969**	0.634
$P_2 \times P_3$	-0.57*	-1.29*	16.547**	8.150**	15.25**	17.00**	-2.35	0.50*	12.77**	0.70*	-21.98**	-12.17**	35.981**	18.170**	25.850**	3.835**
$P_2 \times P_4$	-1.25*	-1.80*	24.351**	9.480**	12.27**	12.37**	-2.02	-0.08	17.80**	1.04*	-14.11**	-2.33	16.371**	10.160**	22.134**	4.051**
$P_2 \times P_5$	0.79*	0.52	-1.716	0.520	-2.84	-0.005	-1.54	0.49	10.64**	0.80*	-1.09	3.17*	1.091**	1.195	16.349**	3.116**
$P_2 \times P_6$	-2.55*	-6.01**	20.719**	10.480**	0.58	8.98*	-3.64*	-0.19	15.69**	1.00*	-19.28**	-11.56**	24.688**	12.775**	23.377**	3.802**
$P_3 \times P_4$	-2.45*	-3.65*	8.035**	4.340*	13.86**	14.64**	-23.39**	-2.19**	2.00*	0.35*	-0.36	4.95*	-4.402**	1.230	-14.433**	0.083
$P_3 \times P_5$	-2.82*	-3.15*	6.052**	5.160*	13.00**	11.54**	7.91**	0.99*	1.33	0.16	-20.56**	-9.33**	11.849**	7.825**	10.676**	-0.652
$P_3 \times P_6$	1.72*	-1.30*	7.455**	7.550**	-11.77**	-2.02*	11.24**	1.86*	-8.43**	-0.13	-14.74**	-7.62**	19.139**	11.605**	1.063*	1.866*
$P_4 \times P_5$	-1.11*	-1.89*	22.789**	10.050**	3.33	4.90*	-2.33	0.23	-14.60**	-0.28	18.25**	12.16**	15.913**	9.255**	21.396**	5.232**
$P_4 \times P_6$	3.69**	-1.01*	-12.065**	-1.040	-11.75**	-3.83*	3.25*	0.48	14.12**	0.77*	-10.54**	0.11	6.891**	4.505*	14.925**	2.284*
$P_5 \times P_6$	2.39*	-1.25*	20.438**	8.770*	-10.64**	-0.78	1.18	0.56*	6.28**	0.82*	-2.37	2.61*	7.066**	3.620*	18.445**	4.449**

* And ** significant at 0.05 and 0.01 levels of probability, respectively

with positive heterotic effects. Thus the increasing alleles were more frequent in the genetic makeup of wheat parental genotypes. Therefore, hybrid breeding. method has been advocated on the basis of overdominance gene effects of crosses. Similar conclusion was reported by Eissa and Awaad (1993)and Awaad (1996).

In conclusion, heterobeltiosis (BP) results coupled with {h} parameter, showing that the most promising crosses exhibited a great potential for hybrid wheat production , or produce new recombinant lines after "n" of selfing generations were (P_2xP_3), (P_2xP_6)and (P_2xP_4).

2-F_2 deviations :

F_2 deviations exhibited adequate amount of genetic variability which could be useful for isolation transgressive segregants in pedigree procedure.

Significant F_2 deviations, indicate the presence of epistatic effects (Marani, 1968 and Sun *et al.*, 1972). As presented in Table (4), negative and significant F_2 deviations have been recorded for earliness in the cross combinations (P_1xP_2), (P_3xP_4), (P_3xP_5), (P_4xP_5), (P_4xP_6)and (P_5xP_6) ; narrow flag leaf area (P_1xP_2), (P_2xP_6), (P_3xP_4), (P_4xP_5), (P_4xP_6)and (P_5xP_6); shortness (P_1xP_4)and (P_5xP_6); short spikes (P_2xP_6),(P_3xP_4) and (P_3xP_5); fewer number of spikes /plant (P_1xP_3),(P_1xP_6) ,(P_2xP_3) ,(P_2xP_4), (P_3xP_4). (P_3xP_6) and (P_4xP_6); fewer number of grains /spike (P_1xP_2). (P_2xP_6) and (P_5xP_6); 1000-grain weight (P_1xP_2) as well as for grain yield/plant in the wheat crosses (P_1xP_2). (P_1xP_6), (P_3xP_4) and (P_3xP_6). The previous results indicated the presence of epistatic effects, and the accumulation of decreasing alleles in the genetic constitution of the parental populations. These results are in agree well with those reported by Sun *et al.* (1972), Hassan (1997) and Salama (2000).

The higher positive and significant F_2 deviations were recorded towards latness in the cross combination (P_1xP_6); broader flag leaf area (P_1xP_4) and (P_2xP_4); tallness (P_1xP_3), (P_1xP_5), (P_2xP_3),(P_2xP_4) and (P_2xP_6); long spikes (P_1xP_3) and (P_3xP_6); greater number of spikes/plant (P_4xP_5); greater number of grains/ spike (P_1xP_4),(P_1xP_5). (P_2xP_5), (P_3xP_5),(P_4xP_5) and (P_4xP_6); heaviest 1000-grain weight (P_1xP_5), (P_2xP_3), (P_2xP_4) ,(P_2xP_5), (P_2xP_6),(P_3xP_4),(P_3xP_5) ,(P_4xP_6) and (P_5xP_6) as well as for grain yield/plant in the cross combinations (P_1xP_3),(P_2xP_5) and (P_3xP_5) . The forementioned results confirming the importance of epistatic gene effects (dominance and /or dominance x dominance), also indicate the accumulation of inceasing alleles in the genetic makeup of these

Table (4): F_2 deviation for the studied characters in 6x6 diallel cross of bread wheat.

Character / Cross	Days to heading	Flag leaf area	Plant height	Spike length	No. of spikes/ plant	No. of grains/ spike	1000-grain weightz	Grain yield/ plant
$P_1 \times P_2$	-2.87*	-7.854**	-0.49	0.62	-0.27	-4.72*	-6.003**	-4.032*
$P_1 \times P_3$	-1.46	2.731	4.049**	0.70*	-0.69*	-2.98	0.253	1.133*
$P_1 \times P_4$	-1.15	5.016*	-2.69*	0.36	-0.42	5.53*	1.566	-0.943
$P_1 \times P_5$	0.61	-1.659	7.49**	-0.19	-0.07	4.50*	6.116**	0.674
$P_1 \times P_6$	3.17**	-2.377	2.68	0.19	-0.92*	-2.23	1.289	-3.683*
$P_2 \times P_3$	-1.39	1.344	4.27**	-0.41	-1.15*	0.99	6.318**	0.284
$P_2 \times P_4$	-0.93	6.886**	3.82**	-0.11	-1.17*	-2.38	6.050**	0.332
$P_2 \times P_5$	-0.61	-2.106	0.57	-0.22	-0.30	5.79*	4.198*	1.259*
$P_2 \times P_6$	-1.03	-3.979*	3.48**	-0.94*	-0.33	-6.84**	10.521**	0.168
$P_3 \times P_4$	-3.71**	-5.369*	2.72	-1.33*	-0.63*	1.61	2.982*	-1.305*
$P_3 \times P_5$	-3.61**	1.052	2.74	-2.58**	-0.02	7.19**	5.316*	3.074*
$P_3 \times P_6$	-1.92	0.629	-0.43	0.84*	-0.71*	0.22	-2.095	-3.133*
$P_4 \times P_5$	-3.20**	-8.253**	1.35	-0.32	0.79*	8.51**	-0.439	0.749
$P_4 \times P_6$	-2.23*	-7.368**	0.55	-0.39	-1.54**	7.44**	4.549*	0.908
$P_5 \times P_6$	-3.86**	-8.413**	-3.21**	-0.19	0.01	-8.66**	2.490*	0.424

populations, which considered to be useful for isolation new promising recombinant lines falling outside F_1 hybrid or parental range .In this connection, positive and highly significant F_2 deviations were reported for kernel weight by Sun *et al.* (1972) as well as yield and its attributes by Hassan (1998). In this repect, population improvement through pedigree method may be given a good response. Thus, crossing and selection may lead to produce wheat genotypes had desirable alleles responsible for earliness and high yield potentiality.

3- Genetic components of variance and heritability :

Assessment of the genetic components of variance using second degree statistic (Table 5) revealed that both additive (D) and non additive (H_1 and H_2) gene effects were significant for days to heading, plant height, number of spikes / plant, number of grains/ spike and grain yield/ plant in the F_1 and F_2 generations. Both types of gene action could be exploited simultaneously through crossing and selection (pedigree method) to make the utmost of the two types of gene effects.

Meanwhile, the additive and dominance (H_1 and H_2) gene effects were significant in the F_1 only for flag leaf area and spike length.But dominance(H_1 and H_2) genetic variance was the main component controlling the inheritance of 1000-grain weight in the F_1 and F_2 generations, and flag leaf area and spike length in F_2 generation only .

The dominance genetic variances were higher in its magnitudes as compared to additive ones, resulting in $(H_1/D)^{0.5}$ more than unity for the most studied characters in both generations. Therefore , hybrid breeding method would be an effective procedure, if the exploit of heterobeltiosis in wheat become feasible. In this connection, overdominance gene effects played an important role in the genetic system controlling flag leaf area (Singh *et al* .,1986 and Awaad, 1996a), plant height (Eissa ,1993) as well as grain yield and its components (Awaad ,1996a and Salem *et al* ., 2000).

Whereas, the additive genetic variance was the main type controlling days to heading in F_1 and F_2 as well as spike length in F_1 generation, resulting in $(H1/D)^{0.5}$less than unity. The prevalence of additive gene effects could be effectively exploited through individual phenotypic selection and thus early heading and long spikes genotypes could be identifying directly from its phenotypic expression. Similar conclusion was reported by Salem *et al.* (2000).

Theortically, both dominance components; (H_1) and (H_2) will be exactly similar in magnitude if positive and negative alleles at loci exhibiting dominance are in equal proportion in the parents (Mather and Jinks, 1982), in this respect . the dominance component (H_1) was approxi -mately equal to (H_2) for plant height, number of spikes / plant, 1000-grain weight and grain yield/plant in F_2 generation as well as flag leaf area in F_1 only and confirming the findings of $H_2/4H_1$ which approximately equal to 0.25. Whereas for the remaining characters, the (H_1) was significantly larger than (H_2), suggesting assymmetrical distribution of positive and negative alleles among parents.

Positive and significant "F" value was recorded for the most studied characters, indicated excess of dominant alleles in the parental genotypes, while negative "F" value for flag leaf area and number of spikes/plant in F_1 hybrid, indicated excess of recessive alleles between the parents. These results confirm the ratio of dominance to recessive alleles (KD / KR) in the parents which was >1 for the studied characters, suggesting the preponderance of dominant alleles in both generations, except flag leaf area and number of spikes/plant in F_1 hybrid (KD/ KR<1), showing an excess of decreasing alleles among parental genotypes.

The overall dominance effects of heterozygous loci "h^2" indicated directional dominance for days to heading, flag leaf area, plant height, number of grains/spike, 1000-grain weight and grain yield / plant in the F_1 and F_2 generations, and number of spikes/plant in F_2 generation only. But no trend for dominance could be identified for the other cases. It is important to note that the "h^2"values in F_2 generation were higher rather than F_1, suggesting that genes controlling the studied characters were in heterozygous phase and still segregated.

The correlation coefficient of (Wr+Vr) with P (Table 5) was positive and significant for flag leaf area in F_1 ($r=0.69^*$) and number of grains/ spike in F_2 ($r=0.63^*$) generation, this means that dominance was unidirectional i.e. increasing alleles were associated with one parent , whereas the decraesing alleles were presented in the second one. However, the correlation coefficient was found to be negative and significant ($r= - 0.87^*$) for 1000-grain weight in F_1 hybrid, suggesting that dominant genes controlling this character was unidirectional i.e. decreasing alleles were associated with one parent, whereas the increasing alleles were presented in the other one. However, the correlation coefficient of (Wr+Vr) with P was insignificant for the other characters, indicating that dominant genes were ambidirectional. Similar interpretations were reported by Kearsey and Pooni (1996).

Heritability in narrow sense showed an increase with advanced generations for days to heading (from 61 to 63%); plant height (from 28 to 54%); number of grains / spike (from 11 to 25%)as well as 1000-grain weight (from 6 to 7%). Similar conclusion was reported by Awaad (1996a). High heritability estimate (>50%)was recorded for days to heading in F_1 and F_2 generations; spike length in F_1 as well as plant height in F_2 generation. These results indicate that substantial progress can be made using standard selection schemes in the development of pure line genotypes. In this connection, Awaad (1996a) and Salem *et al.* (2000) recorded high heritability value (> 50 %) in narrow sense for days to heading, plant height and spike length .

However, low to moderate heritability values were reported for grain yield/plant and its components, indicating that selection should be delayed to later segregating generations. In this respect, moderately low'"Tn" values were reported for yield and its components (Salem *et al.*, Table (5) : Additive (D) , dominance (H)genetic variances and their derived parameters for yield and its attributes in 6 x 6 diallel wheat crosses.

Character Parameter	Days to heading		Flag leaf area		Plant height		Spike length		Number of spikes/plant		Number of grains/spike		1000-grain weight		Grain yield/plant	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
D	22.61**± 3.49	19.85**± 3.12	8.86*± 4.12	6.67± 5.85	86.68**± 19.82	48.06**± 10.90	3.15*± 0.56	0.94± 0.72	0.84**± 0.09	0.57**± 0.13	32.25*± 14.26	25.81*± 10.52	2.98± 8.07	2.44± 5.22	2.86*± 1.309	1.66*± 0.80
H_1	20.02**± 8.86	17.42**± 8.45	90.23**± 11.87	92.77*± 5.23	259.16**± 50.33	53.49*± 27.21	2.81*± 1.41	3.41*± 1.63	2.73**± 0.23	1.40**± 0.30	213.12*± 86.97	150.75**± 38.78	102.29**± 20.49	58.99*± 23.24	8.88*± 4.50	8.35*± 3.72
H_2	15.87**± 7.92	14.58**± 7.11	87.11**± 10.60	85.24*± 35.94	209.78**± 44.95	53.25*± 24.73	2.43*± 1.16	2.97*± 1.43	0.86**± 0.20	1.32**± 0.32	144.78*± 71.69	84.64**± 27.39	94.74**± 18.30	59.00*± 29.13	8.26*± 4.07	8.31*± 3.32
F	12.81 ± 8.44 ±	5.50± 6.04 ±	-1.54± 11.30	15.50± 8.30	93.33*± 47.21	23.53± 26.35	0.96± 1.34	0.19± 1.74	-0.43*± 0.21	0.19± 0.29	90.46± 82.80	45.32± 30.26	6.86± 19.51	8.50± 22.54	2.48± 4.34	2.12± 3.54
h^2	291.06**± 5.33	643.30**± 5.00	157.69** 7.10	500.00**± 24.12	321.85**± 30.10	675.00**± 16.64	-0.12± 0.85	0.46± 1.10	0.24± 0.14	0.90**± 0.20	409.34**± 52.30	869.90**± 19.03	534.74**± 12.00	955.40**± 23.12	12.30**± 2.70	122.52**± 2.55
E	0.39 ± 1.32	2.54± 1.26	0.91 ± 1.77	2.50± 1.99	1.93± 2.49	9.55*± 4.12	0.25± 0.21	0.51*± 0.25	1.49**± 0.03	1.07**± 0.05	2.94± 2.95	15.37**± 4.73	1.41± 3.05	5.10*± 2.41	1.4*± 0.68	3.12**± 0.55
Derived parameters																
$(H_1/D)^{0.5}$	0.940	0.468	3.190	1.865	1.730	0.527	0.94	0.952	1.803	0.784	2.570	1.208	5.860	2.458	1.762	1.121
$(H_2/4H_1)$	0.189	0.209	0.241	0.230	0.200	0.249	0.216	0.220	0.078	0.236	0.170	0.140	0.230	0.250	0.232	0.249
KD/KR	1.861	1.840	0.947	4.307	1.900	1.600	1.380	1.110	0.751	1.540	3.400	6.099	1.490	5.862	1.653	3.645
$r = W_r + V_r/p$	0.37	0.57	0.69*	-0.03	0.17	0.20	0.01	-0.10	0.60	0.31	0.58	0.63*	-0.87*	0.28	0.14	0.06
Tn	0.61	0.63	0.23	0.21	0.28	0.54	0.59	0.25	0.47	0.11	0.11	0.25	0.06	0.07	0.13	0.11

2000 and Hassan, 2002).

4-Graphical analysis of F_1 hybrid:

The relationships between Wr-Vr (Figs.1-8) illustrated that the regression coefficients were deviated significently from zero but not from unity for flag leaf area, plant height, spike length, number of spikes/ plant and 1000-grain weight, suggesting that additive- dominance genetic model was satisfactory to explain the inheritance of these characters. However the regression coefficient for grain yield/plant was deviated significantly from zero and more than unity (b=1.16±0.27), revealing that complex genetic model was appropriate to explain the genetic mechanism of that character.

The regression line intersect the Wr axis above the point of origin for spike length, suggesting the importance of additive gene effect and degree of dominance in the range of partial dominance. However, for days to heading , flag leaf area, number of spikes/plant and 1000-grain weight, the regression lines cuts the Wr axis below the point of origin, indicating predominance of non-additive gene effect and degree of dominance in the range of overdominance for these characters, which mainly due to complementary gene effects, while the regression line pass the point of origin in plant height, number of grains/ spike and grain yield/ plant, indicating complete dominance.

The relative position of array points on Wr-Vr graph indicated that the parental genotypes; Sakha 61 (P_1) contained high frequency of recessive alleles for earliness and shortness. Meanwhile, the local wheat cultivars; Sakha 61(P_1), Gemmeiza 3 (P_4)and the imported one H.D1220(P_3) possessed excess of dominant alleles for broader flag leaf area. Giza 168 (P_2) had more dominant alleles for tallness, spike length , number of spikes/ plant and number of grains/pike . Whereas, Gemmeiza 3(P_4) showed high frequency of dominant alleles for spike length, number of spikes/plant, 1000-grain weight and grain yield/plant. The remaining parental genotypes, exhibited different frequenceis of both recessive and dominant alleles.

Such result suggested that crossing involving Sakha 61 or Gemmeiza 3 and H.D1220 may result in high level of heterozygosity and transgressive segregants characterized by earliness, broader flag leaf area, longe spike as well as higher yield and its components.

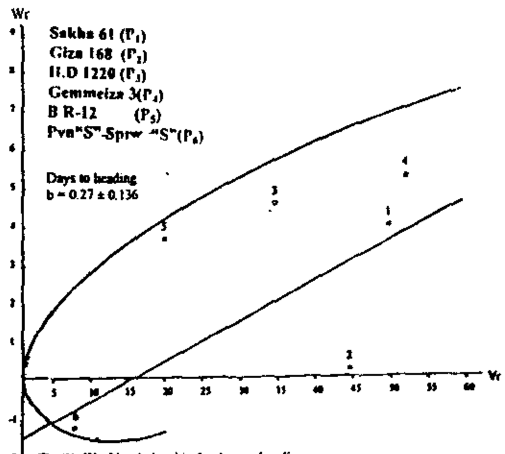

Fig (1): Wr - Vr relationship for days to heading

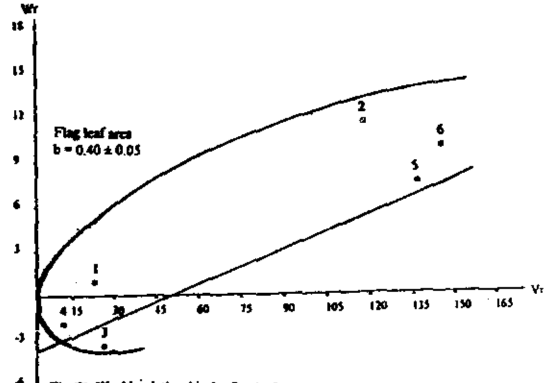

Fig (2): Wr - Vr relationship for flag leaf area

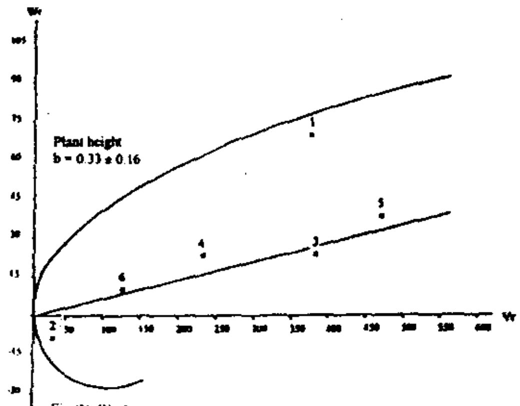

Fig (3) Wr - Vr relationship for plant height

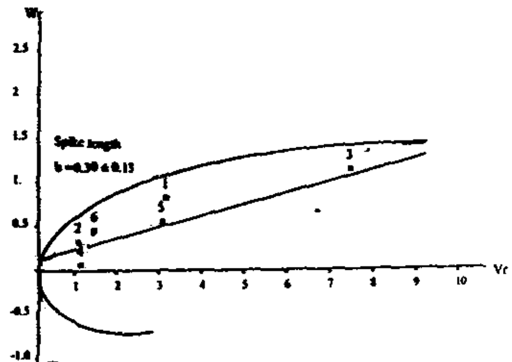

Fig (4): Wr - Vr relationship for spike length

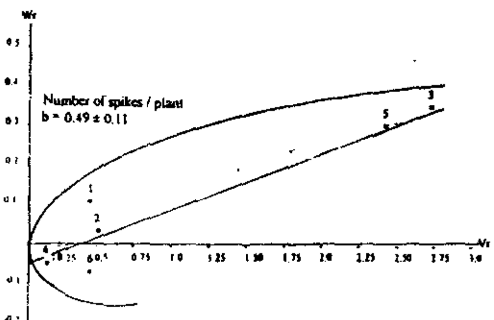

Fig (5) Wr - Vr relationship for number of spikes / plant

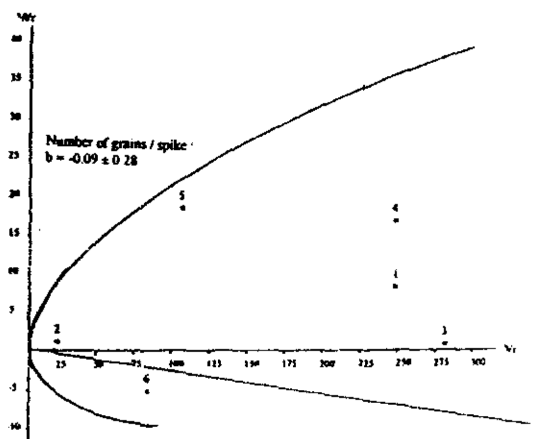

Fig (6) Wr - Vr relationship for number of grains / spike

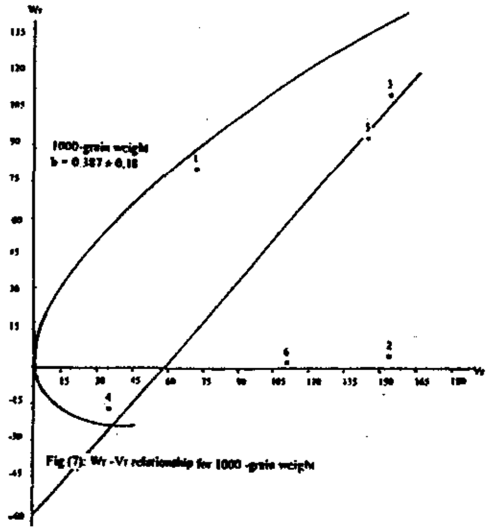

Fig (7): Wr -Vr relationship for 1000 -grain weight

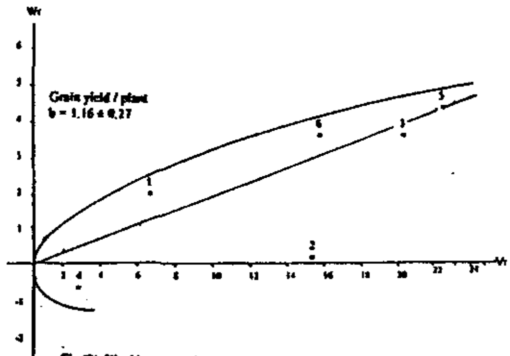

Fig (8): Wr -Vr relationship for grain yield / plant

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تقدير بعض المعالم الوراثية بإستخدام نظام الدياليل وتطبيقاتها فى برامج تربية قمح الخبز

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أجريت هذه الدراسة بالمزرعة التجريبية بكلية الزراعة - جامعة الزقازيق فى الموسم الشتوى لأعوام ١٩٩٩ / ٢٠٠٠ ، ٢٠٠٠ / ٢٠٠١ و ٢٠٠١ / ٢٠٠٢ مستخدماً نظام الدياليل Diallel بين ستة تراكيب وراثية من قمح الخبز مستبعداً الهجن العكسية منها ثلاثة أصناف محلية وهى سخا ٦١ ، جيزة ١٦٨ ، وجميزة ٣ وثلاثة تراكيب وراثية أجنبية هى H.D 1220 ، BR-12، Pvn"S"/Sprw"S" وتم تقييم الآباء والجيل الأول والثانى فى الموسم الشتوى لعام ٢٠٠١ / ٢٠٠٢، بهدف دراسة قوة الهجين للجيل الأول وإنحراف نباتات الجيل الثانى وتقدير مكونات التباين الوراثى وكفاءة التوريث فى الجيلين الأول والثانى والتحليل البيانى للآباء فى الجيل الأول ،وذلك لصفات : عدد الأيام حتى طرد السنابل ، مساحة ورقة العلم ، طول النبات ، طول السنبلة ، والمحصول ومكوناته . ويمكن تلخيص أهم نتائج البحث فى النقاط الآتية :

* أظهرت النتائج وجود إختلافات عالية المعنوية بين الآباء الداخلة فى الدراسة وهجنها فى الجيل الأول والثانى للصفات المدروسة .
* أشارت النتائج أن أعلى قوة هجين حقيقية قد سجلت لصفات المحصول ومكوناته ، التبكير فى النضج ومساحة ورقة العلم فى توليفات هجن القمح
(Giza168 xGemmeiza 3), (Giza 168 x Pvn "S"/ Sprw"S"), (Giza168 x H.D1220)
وقد حقق هجين القمح (Giza 168 xH.D 1220) أعلى زيادة معنوية فى محصول الحبوب بمقدار ٢٥٪ مقارنة بالأب الأعلى ، كما أمكن الحصول على أقصى قوة هجين موجبه وعالية المعنوية لصفة طول السنبلة فى هجينى القمح (H.D1220 x Pvn "S"/ Sprw "S"),(H.D1220 x BR-12) ومن ثم يمكن أعتبارها كهجن مبشرة لعزل تراكيب وراثية جديدة عالية المحصول .
* كانت مقادير المقياس {h} والتى تشير الى قيم الجيل الأول مقارنة بمتوسط الآباء ، موجبه وعالية المعنوية للمحصول ومكوناته ، ومرغوبة للتبكير فى النضج ومساحة ورقة العلم فى الهجن
(Giza 168 x Pvn "S"/ Sprw"S") ,(Giza168 xGemmeiza 3), (Giza168 x H.D1220) ,
(BR-12 X Pvn"S"/ Sprw"S") , (Gemmeiza 3 x BR-12), مشيراً الى وجود تأثيرات قوة هجين مرغوبة
* كان إنحراف قيم نباتات الجيل الثانى سالبة وعالية المعنوية تجاه التبكير فى هجن القمح
(Gemmeiza 3 x BR-12) ،(H.D1220 x BR-12),(H.D1220 XGemmeiza3)
(BR-12 X Pvn"S"/ Sprw"S") ولقصر الساق فى الهجينين (Sakha 61xGemmeiza 3) ،
(BR-12 X Pvn"S"/ Sprw"S") ، مشيراً الى تراكم الأليلات السالبة فى هذه الهجن . فى حين

كانت أعلى انحرافات موجبة وعالية المعنوية للجيل الثانى قد سجلت لصفات مساحة ورقة العلم فى الهجينين (Sakha 61x Gemmeiza3) و(Giza168 xGemmeiza 3) والمحصول وصفتى عدد حبوب السنبلة ووزن الألف حبة فى الهجينين (Giza168 xBR-12) و (H.D1220xBR-12) ، مشيراً إلى تجميع الأليلات الموجبة فى الجيل الثانى لهذه الصفات .

* أظهرت النتائج أهمية كل من الفعل الجينى المضيف والسيادى فى وراثة صفات : عدد الأيام حتى طرد السنابل ، طول النبات ، عدد السنابل / نبات ، عدد حبوب السنبلة ومحصول حبوب / النبات فى الجيلين الأول والثانى ومساحة ورقة العلم وطول السنبله فى الجيل الأول فقط ، وعلى ذلك فإن التهجين المتبوع بالإنتخاب يكون مفيداً فى عزل سلالات متفوقة . بينما كان التباين الوراثى السيادى هو المتحكم فى وراثة صفة وزن الألف حبه فى الجيلين الأول والثانى ومساحة ورقة العلم وطول السنبلة فى الجيل الثانى فقط ، وكانت قيم التباين الراجع الى الفعل الجينى السيادى أكبر من نظيره المضيف . ومن ثم كانت قيم متوسط درجة السيادة أعلى من الوحدة فى معظم الحالات ، مشيراً الى أهمية التربية بالتهجين فى تحسين هذه الصفات عندما تكون امكانية استغلال قوة الهجين ميسرة . فى حين كان المكون الوراثى المضيف هو الأكثر أهمية فى وراثة صفات عدد الأيام حتى طرد السنابل فى الجيلين الأول والثانى وطول السنبلة فى الجيل الأول ، مشيراً الى فعالية الإنتخاب المظهرى فى تحسين هاتين الصفتين .
* ارتبطتَ قيم F مع قيم KD / KR ، فى دلالة على زيادة تكرار الأليلات السائدة المتحكمة فى وراثة جميع الصفات المدروسة ، عدا مساحة ورقة العلم وعدد السنابل / نبات فى الجيل الأول .
* اتجهت قيم كفاءة التوريث بالمعنى المحدود إلى الزيادة من الجيل الأول إلى الجيل الثانى : لصفات عدد الأيام حتى طرد السنابل ، طول النبات ، عدد حبوب / السنبلة ووزن الألف حبة . وكانت تقديرات كفاءة التوريث مرتفعة (> ٥٠ ٪) لصفات ،عدد الأيام حتى طرد السنابل فى الجيلين الأول والثانى وطول السنبلة فى الجيل الأول وطول النبات فى الجيل الثانى ، فى دلالة على امكانية تحسين هذه الصفات من خلال برامج التربية ، فى حين كانت منخفضة لمحصول حبوب النبات ومساهماته فى الجيلين الأول والثانى .
* أظهرت نتائج التحليل البيانى للآباء فى الجيل الأول ، أحتواء صنف القمح المحلي سخا ٦١ على تكرار عالى من أليلات التبكير وقصر الساق . وقد أحتوي الصنفان المحليان سخا ٦١ وجميزة ٣ والأجنبى H.D1220 على تركيز عالى من الأليلات السائدة لمساحة ورقة العلم والصنف المحلى جيزة ١٦٨ على تركيز عالى من الأليلات السائدة المزيده لطول النبات ، طول السنبله وعدد السنابل / نبات وعدد حبوب السنبلة ، وكذلك جميزة ٣ على معظم الأليلات السائدة والمرغوبة لصفات عدد السنابل / نبات ، وزن الألف حبه ومحصول الحبوب ، مما يؤكد أهمية استخدام هذه التراكيب الوراثية فى إنتاج هجن متميزة أو عزل سلالات متفوقة فى المحصول ومساهماته .