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ESTIMATION OF GENETIC VARIANCE FOR YIELD AND YIELD COMPONENTS IN TWO BREAD WHEAT CROSSES

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ABSTRACT

Two experiments were designed at Etay El-Baroud Agricultural Research Station during four successive seasons, from 2002/2003 to 2005/2006 seasons. The crosses evaluated were i.e., Sakha 93 x Davon.2 and Giza 168 x Gemmeiza 9. Five populations (P_1, P_2 , F_1, F_2 and F_3) were used in this concern.

Significant F_2 mean values were obtained for all studied traits in both two crosses. Then, various biometrical parameters in this study could be estimated.

Significant positive heterotic effects towards better parents were detected in each of 100-kernel weight and grain yield/plant in the two studied crosses and only for number of kernels/spike in the first cross.

Over dominance towards highest parent was obtained for all studied traits in both two crosses except for number of spikes/plant in the first cross wherease partial dominance was resulted. On the other hand, complete dominance towards the highest parent value was shown for number of kernels/spike in the second cross.

Inbreeding depression estimates were found to be significantly positive in the first cross for ; number of spikes/plant, number of kernels/spike and grain yield/plant. The same direction was obtained only in the second cross for 100-kernel weight.

Additive type of gene effect resulted that, it was significant positive in the second cross for; number of spikes/plant, number of kernels/spike and grain yield/plant. Meantime, dominance gene effect showed that most of studied traits in both crosses were significantly positive.

Heritability as a broad sense gave high value estimates and significant for all studied traits in both two crosses while , heritability as a narrow sense showed the same direction except for , number of spikes / plant and number of kernels / spike in the first cross whereas estimated low values .

Additive and additive X dominance type of gene action showed significant for 100-kernel weight . On the other hand , dominance X dominance (e) type of gene effect had an important role in the inheritance of number of kernels / spike . Also , plant breeder can depends on the expected values when make the selection that it were approximately equal to the actual one .

The obtained results indicated that the selection for the studied traits may be actually in the early generation but it may be more effective if past poned to late one . Also , these study concluded that , it can be take in consideration the second cross (Giza 168 X Gemmeiza 9) to improve the breeding program in the National Wheat Research Program .

INTRODUCTION

In Egypt, wheat *(Triticum aestivum L)* is the most important cereal crop. However, the gab between the local production and consumption is continuously increase due to increasing the country population with limited cultivated area. Wheat breeders are always looking for mean and sources of genetic improvements in grain yield and its components and in other agronomic characters.

The Egyptian wheat cultivars have somewhat narrow genetic background. Hybridization between the Egyptian wheat cultivars and exotic materials may be carried out to increase the genetic variability. Knowledge of the genetic relationship among individuals or populations is essential to breeders for planning crosses to gain better selections for high yielding and developing new promising lines.

Abul-Naas *et al* (1991) and Al-Kaddoussi *et al* (1994) reported that, dominance component of gene action played an important role in the genetic control for, number of spikes/plant, number of kernels/spike, 100 kernel weight and grain yield/plant. On the other hand, Crumpacker and Allard (1962) reported that, the efficiency in breeding of self-pollinating crop plants depended firstly, on accurate identification of hybrid combinations that had the potentiality of producing maximum improvements and secondly, on identifying, in early segregating generations, the superior lines among the progeny of the most promising hybrids. Therefore, maximum progress in improving a character would be expected with a carefully designed pedigree selection program when the additive gene action is the main component.

El-Hosary *et al* (2000) found that, grain yield and its components in diallel cross mating among eight parents, were controlled by both, additive and non-additive gene effects. In addition, concerning the heritability as narrow sense, Gouda *et al* (1993) showed that, it was ranged from 14 to 71 % for grain yield. Moustafa (2002), Hendawy (2003), El-Sayed (2004) and Abdel-Nour *et al* (2005) reported that heritability estimates for yield and its components were medium to high.

This work was conducted to study the genetic variance, gene action, heritability and comparison between actual and expected genetic gain of two bread wheat crosses derived from four parental bread wheat genotypes using five populations of each cross.

MATERIALS AND METHODS

Two crosses were used in the present study derived from four wide diverse parental bread wheat cultivars. The names , pedigree and origin of these parental genotypes are given in Table (1). These genotypes were used to obtain the following two crosses; Sakha 93 × Dovin 2 and Giza 168 × Gemmiza 9 to study the yield and its main components i .e ., number of spikes/ plant, number of kernels/ spike , 100-kernel weight (g) and grain yield/ plant (gm) .

Table (1): Names, pedigree and origin of the parental cultivars and lines.

Cultivar	Pedigree	Origin
Sakha 93	Sakha 92/TR810328 S8871-1s-2s-1s-0s.	EGYPT
Dovin 2	CM84655-02AP- 300AP-300L-3AP-300L-3AP-OL-OAP	ICARDA
Giza 168	MRL/BUC/SERI CM933046-8M-OY-OM-2Y-OB-OGZ.	EGYPT
Gemmiza 9	ALD"S"/HUAC CMH74A.630/SX. CGM 4583-5GM-1GM-OGM	EGYPT

The experimental work of the present study was carried out at Etay El-Baroud Agricultural Research Station, El-Behera Governate, during four successive seasons from 2002/2003 to 2005 /2006. In the first season (2002 / 2003), the parental genotypes were crossed to obtain F_1 seeds. In the second season (2003 / 2004), the hybrid seeds of the two crosses were sown to give F_1 plants, at the same time, these plants were selfed to produce F_2 seeds. Moreover, the same parents were crossed to have enough F_1 seeds. The new hybrid seeds and part of seeds whereas obtained from F_1 selfed plants (F_2 seeds) were kept in refrigerator to planted in the final experiment. In the third season (2004 / 2005), two F_1 hybrid seeds were sown to produce F_1 plants, each of F_1 plants were selfed to produce F_2 seeds. In addation, F_1 and F_2 plants were selfed to produce F_2 and F_3 seeds, respectively. In the fourth season (2005 / 2006), the obtained seeds for the five populations (P_1 , P_2 , F_1 , F_2 , and F_3) of the two crosses were evaluated using randomized complete block design with three replications. The experimental unit was two rows for each of parents and F_1 progenies totaling 20 plants from each of them, 20 rows for F_2 generation totaling 200 plants and five rows for F_3 families totaling 50 plants. Each row was 2m.long and 20cm. apart between rows. The plants within the same row were 10cm.apart. The data were recorded on an individual guarded plants for number of spikes/plant, number of kernels/spike, 100 kernel weight (g) and grain yield/plant (g).

Various biometrical parameters in this study would only be calculated if the F_2 genetic variance was found to be significant. In this concern, F_2 genetic variance were found to be significant. Heterosis % was expressed as percentage deviation of F_1 mean performance from better parent values (heterobeltiosis). Potence ratio (P) was also calculated according to Peter and Frey (1966). Inbreeding depression % was calculated as the difference between the F_1 and F_2 means expressed as percentage of the F_1 mean.

The estimates of mean effect parameter (m), additive-additive × dominance (d^{*}), dominance (h), dominance × dominance (e) and additive × additive (i) were obtained by five parameters model illustrated by Hayman model according to Singh and Chaudhary (1985).

Heritability was calculated as both broad and narrow senses according to Mather s procedure (1949) and parent off-spring regression according to Sakai (1960). On the other hand, the expected and actual genetic advance (Δg) was computed according to Johansen *et al* (1955). Similarly, the genetic gain percentage of the F_2 and F_3 mean performance (Δg %) was estimated using the method of Miller *et al* (1958).

RESULTS AND DISCUSSION

The choice of the parents to be used in crossing in breeding programs are the most important problem facing the breeder .If the parents are precisely selected. The disered recombinations will be found in the segregated generations (Mahrous, 1998) . Parental differences in response to their genetic background were found to be significant in most characters under investigation. The F_2 populations were also significant for all studied characters in the two crosses. Thus, different biometrical parameters used in this study were estimated. Means and variances of five populations i.e., (P_1 , P_2 , F_1 , F_2 , and F_3) for the studied characters in two crosses are presented in Table (2). Heterosis, potence ratio (P), inbreeding depression percentage and different gene actions for the four studied characters are given in Table (3).

In self pollinated crops such as wheat , plant breeders have been investigated the possibility of developing hybrid cultivars . The feasibility of growing hybrid cultivars depends on the economic production of large quantitative of hybrid seeds and significant superiority in yield as well as best performance of hybrids compared to the current commercial cultivars (Mahrous, 1998) . On the other hand, heterosis over better parent may be useful in identifying the best hybrid combinations but these hybrids can be immense practical value if they involve the best cultivar of the area (Prasad et.al., 1998) .

Significant positive heterotic effect was found for all characters except for number of spikes/plant in the first and second crosses and, for number of kernels/spike in the second cross where it was significantly negative. These results are similarly as those reported by Moshref (1996)Hendawy (1998), El-Hosary *et al*(2000), Moustafa (2002), Hendawy (2003),El Sayed (2004),Abdel-Nour Nadya *et al* (2005), Abdel-Nour, Nadya and Moshref(2006).

Number of spikes/plant, number of kernels/spike and 100 kernel weight are the main components of grain yield. So, increasing heterosis, if it found in one or more of these attributes may be lead to favorable yield increasing in hybrid.

The absence of significance in heterosis for number of spikes/plant in the first and second crosses may be due to the lower magnitude of the non additive gene action. These results are in agreement with Keteta *et al*. (1976) and El-Rassas and Mitkess (1985). The pronounced heterotic effect for 100 kernel weight in the first cross (Sakha 93 × Dovin 2) and second one (Giza 168 × Gemmiza 9) may be take in consideration in a breeding program for high yielding ability by selecting for this character.

Potence ratio (P) whereas indicated the overdominance was resulted for all studied characters except for, number of kernels/spike in the second cross which showed complete dominance towards the higher parent. On the other hand, number of spikes/plant showed partial dominance in first cross. These results are in agreement with those obtained by Rady *et al* (1981), Moustafa (2002),Hendawy (2003), Al- Kaddoussi *et al* (1994), Mosaad *et al* (1990) and Abdel-Nour, Nadya and Moshref (2006).

Inbreeding depression values obtained in the two crosses illustrated that all studied characters show significant values except for; number of spikes/plant, number of kernels per spike and grain yield per plant in the second cross . On the other hand, 100 kernel weight in the first cross significant negative inbreeding depression value was detected.

Table (2): Means (x) and variances (s^2) for the studied characters using the five Populations for the two bread wheat crosses.

Characters	Parameters	Sakha 93 x Dovin 2					Giza 168 x Gemmiza 9				
		P_1	P_2	F_1	F_2	F_3 bulk	P_1	P_2	F_1	F_2	F_3 bulk
Number of spikes/plant	x	22..40	24.90	24.45	21.22	22.79	21.10	19.90	22.59	21.08	18.62
	s^2	5.79	6.51	5.62	24.21	21.93	5.81	3.60	5.44	33.60	23.89
Number of kernels/spike	x	73.10	81.90	93.30	71.10	67.30	80.55	68.10	67.95	67.98	63.41
	s^2	10.90	27.92	18.72	191.25	171.22	20.30	16.82	18.30	251.20	171.70
100 kernel weight (g)	x	4.46	4.58	4.95	5.23	4.79	4.46	5.02	5.38	5.27	5.71
	s^2	0.04	0.06	0.08	0.42	0.26	0.04	0.03	0.03	0.24	0.14
grain yield/plant (g)	x	59.90	64.50	70.50	63.45	63.25	55.70	51.30	60.52	58.62	55.40
	s^2	11.25	22.41	28.10	441.21	275.41	18.80	17.25	16.90	294.92	182.20

Table (3) : Heterosis, potence ratio, inbreeding depression and gene action parameters for the two bread wheat crosses.

Characters	*Cross*	*Heterosis % over B.P*	*Potence ratio (P)*	*Inbreeding depression %*	*Gene action parameters* m	d'	h	e	i
Number of spikes/plant	I	-1.807	0.64	13.21**	21.22**	-1.25**	-2.033	16.987**	-5.334*
	II	7.06	3.50	6.68	21.08**	0.595*	7.567**	-9.09*	6.672**
Number of kernels/spike	I	13.92**	23.79**	23.58	71.10**	-0.06	0.977**	-3.053**	0.427**
	II	-15.64**	1.024	-0.044	67.98**	2.20**	9.853*	-12.107	7.234*
100 kernel weight (g)	I	8.08**	7.167	-5.56**	5.23**	-4.40**	24.93**	38.933**	0.334
	II	7.17**	3.25	2.045*	5.27**	-0.28**	-1.1**	2.64**	-2.3**
grain yield/plant (g)	I	9.302**	3.609	10.00**	63.45**	-2.3**	5.233	17.733	-7.667
	II	8.65**	3.19	3.14	58.62**	6.225**	12.167**	-24.45*	30.992**

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

These results, since the expression of heterosis in the F_1 may be followed by reducing in F_2 performance. The obtained results for most crosses were in harmony with those obtained by Khalifa *et al* (1997). Significant positive heterosis and significant inbreeding depression were obtained for grain yield/plant and for number of kernels per spike in the first cross and for 100-kernel weight in the second one. On the other hand, significant positive heterosis and significant negative inbreeding depression for 100-kernel weight in the first cross were detected. The contradiction between heterosis and inbreeding depression estimates values may be due to the presence of linkage between genes in these materials, Van der Veen (1959).

The choice of the most effect of breeding procedures depends to a large extent on the knowledge of the genetic system contributing the selected characters . Therefore , the nature of gene action was also computed by using five parameters analysis (Hayman modle) according to Singh and Chaudhary (1985) and presented in Table (3).

The estimated mean effects of F_2 (m), which reflects the contribution due to overall means plus the locus effects and interactions of the fixed loci, was found to be highly significant for all the studied characters. Additive gene effect (d*) was positively significant for; number of spikes/plant, number of kernels/spike and grain yield/plant in the second cross. On the other hand, (d*) was negatively significant for; number of spikes/plant, and grain yield/plant in the first cross and for 100 kernel weight in the two studied crosses. These results suggested that, the potential for obtaining further improvement for the former characters could be realized by appling pedigree selection program. These results were greatly agreed with those obtained by Amaya *et al.* (1972), Hendawy (1998), El Hosary *et al* (2000), Moustafa (2002), Hendawy (2003),El Sayed (2004), Abdel-Nour, Nadya and Moshref (2006).

Dominance gene effect (h) was significantly positive for number of kernels/spike in the two crosses, and for number of spikes/plant and grain yield/plant in the second cross only. The same direction was detected for 100 kernel weight in the first cross. On the other hand, 100 kernel weight showed significantly negative (h) in the second cross. Significance of these components indicated that, both additive and dominance gene effects are important in the inheritance of these characters. Hence , selection of the desired characters may be practiced in the early generations but may be more effective in latest one , Shehab El-Din (1993).

Dominance × dominance (e) type of gene action was significantly positive for 100 kernel weight in the two crosses and number of spikes/plant in the first cross. At the same time, number of spikes/ plant and grain yield per plant showed significant negative (e) component for cross П . On the other hand, positive significant additive × additive type of spistasis (i) was detected in both of two studied crosses for , number of kernels/spike and in the second cross for number of spikes/plant, and grain yield/plant. Also, significant negative (i) values were detected for number of spikes/plant in the first cross and 100-kernel weight in the second one.

Table (4): Heritability and expected versus actual gain for all studied characters in two crosses of bread wheat.

Characters	Cross	Heritability			Expected gain		Actual gain	
		broad sense	narrow sense	Parent off spring regression	Δg	% of F_2	Δg	% of F_3
Number of spikes/plant	I	76.79	17.39	46.37	1.76	8.31	4.47	19.63
	II	83.81	59.25	72.26	7.08	33.56	7.28	39.07
Number of kernels/spike	I	90.21	20.71	55.34	5.90	8.30	14.92	22.17
	II	92.71	63.23	77.94	20.64	30.37	21.04	33.17
100 kernel weight (g)	I	85.51	81.71	83.61	1.09	20.90	0.88	18.30
	II	85.77	80.75	83.47	0.86	16.38	0.65	11.39
grain yield/plant (g)	I	93.63	76.86	86.10	33.28	52.42	29.44	46.54
	II	94.27	76.19	85.10	26.95	45.98	23.66	42.71

The important role of both additive and non - additive gene actions in certain studied characters indicated that , selection procedure based on the accumulation of additive effects may be very successful in improving these characters. Similar approaches were reported by Gouda *et al* (1993), Al-Kaddoussi *et al* (1994), El Hosary *et al* (2000), Moustafa (2002) and Hendawy (2003).

Heritability in both broad and narrow senses between generations (parent off-spring regression) are presented in Table (4). High heritability values as a broad sense were detected for all the studied characters. High to moderate estimates of narrow sense heritability and parent off-spring regression were found for all the studied characters in the two studied crosses. The difference in magnitude of both narrow sense and parent off-spring regression heritability estimates for all the studied characters may be assure the existence of both, additive and non - additive gene effects in the inheritance of these characters. Similarly, Jatasra and Paroda (1980), Mosaad *et al* (1990), Moshref (1996), El Sayed (2004), Abdel-Nour Nadia *et al* (2005) reported these conclusions. Also, expected genetic gain and actual gain for all studied characters are shown in Table (4).

The expected genetic advance (Δg % of F_2) and actual genetic advance (Δg % of F_3) ranged from moderate to high values for all the studied characters except for , 100-kernel weight in the two studied crosses. These results indicated the possibility of practicing selection in early generations to be assure that these characters and hence, selecting high yielding genotypes. Dixit *et al* (1970) recorded that, high heritability was not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with high genetic gain.

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تقدير التباين الوراثي للمحصول ومكوناته في هجينين من قمح الخبز

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أجرى هذا البحث في محطة البحوث الزراعية بايتاى البارود لمدة أربعة مواسم من موسم ٢٠٠٣/٢٠٠٢ إلى موسم ٢٠٠٦/٢٠٠٥ على هجينين من قمح الخبز وهو (سخا ٩٣ x نوفن ٢) و (جيزة١٦٨ x جميزة ٩) وقد اشتملت الدراسة على كل من الأبوين والأجيال الأول والثاني والثالث . وقد تمت دراسة صفات عدد السنابل على النبات وعدد حبوب سنبلة الساق الرئيسية ووزن المائة حبة ووزن حبوب النبات الفردي . ويمكن تلخيص نتائج الدراسة كالتالي :-

- أظهرت الدراسة أن متوسطات قيم الجيل الثاني كان معنويا" في جميع الصفات تحت الدراسة في كل من الهجينين .
- كانت قوة الهجين موجبة وعالية المعنوية في صفتي وزن الحبة وكذلك محصول الحبوب للنبات الفردي في كلا الهجينين تحت الدراسة وكذلك في صفة عدد حبوب السنبلة في الهجين الأول .
- أوضحت الدراسة وجود سيادة فائقة تجاه الأب الأعلى في جميع الصفات تحت الدراسة في كلا الهجينين ما عدا صفة عدد السنابل على النبات في الهجين الأول حيث كانت السيادة جزئية تجاه الأب الأعلى وكذلك كانت السيادة تامة تجاه الأب الأعلى أيضا" في صفة عدد حبوب السنبلة في الهجين الثاني .
- كان تأثير التربية الداخلية موجبا" ومعنويا" في الهجين الأول في صفات عدد السنابل على النبات الفردي وعدد الحبوب في السنبلة ومحصول حبوب النبات الفردي كما أظهرت صفة وزن المائة حبة نفس الاتجاه في الهجين الثاني فقط .
- أوضحت الدراسة كذلك أن تأثير الفعل الجيني المضيف كان موجبا" ومعنويا" في الهجين الثاني في صفات عدد السنابل على النبات وعدد حبوب السنبلة ومحصول حبوب النبات الفردي .
- كان تأثير الفعل السيادي للجين موجبا" ومعنويا" في معظم الصفات تحت الدراسة في كلا الهجينين .
- أعطت دراسة الكفاءة التوريثية بمعناها الواسع قيما" عالية ومعنوية في جميع الصفات تحت الدراسة في كل من الهجينين وكذلك أعطت الكفاءة التوريثية بمعناها الضيق نفس القيم العالية في جميع الصفات تحت الدراسة ما عدا صفتي عدد السنابل على النبات وعدد حبوب السنبلة في الهجين الأول حيث أعطت قيما" منخفضة .
- أظهرت دراسة تأثير التفوق السيادي والمضيف أن لهذا النوع من التفاعل دورا" هاما" في وراثة صفة وزن المائة حبة بينما كان لتأثير التفاعل السيادي x السيادي دورا" هاما" كذلك في وراثة صفة عدد الحبوب في السنبلة .
- كانت قيم التحسين الوراثي الفعلي المتحصل علية متطابقة مع تلك القيم المتنبا بها لدرجة أو نسبة التحسين المتوقع الناتج عن الانتخاب لتحسين المحصول ومكوناته وبذلك يمكن لمربى القمح الأخذ في الاعتبار والاعتماد على القيم المتنبأ بها عند ممارسة الانتخاب لهذة الصفات تحت الدراسة .
- أظهرت الدراسة أن لتاثيرى الفعل الجيني المضيف والغير مضيف دورا" هاما" في وراثة جميع الصفات تحت الدراسة .
- توصى الدراسة بالأخذ في الاعتبار الاستفادة من الهجين الثاني (جيزة ١٦٨ x جميزة ٩) عند عمل برنامج تربية لتحسين محصول القمح في مصر ويؤيد هذا الاتجاه وجود دراسات سابقة تؤكد وجود تباعد وراثي كبير بين الأصناف الداخلة في هذا الهجين .