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ESTIMATION OF GENETIC PARAMETERS FOR YIELD AND YIELD COMPONENTS AND SOME AGRONOMIC CHARACTERS IN TWO CROSSES OF BREAD WHEAT (*Tritium aestivum* L.)

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ABSTRACT

Three cultivars of bread wheat; Sakha 69, Sakha 93 and Sakha 94 were crossed in all six generations. P_1, P_2, F_1, F_2, BC_1 and BC_2 were obtained for two crosses;(Sakha 69 × Sakha 93) and (Sakha 93 × Sakha 94) to determine genetic parameters for number of days to heading and maturity, plant height, number of spikes per plant, number of kernels per spike, 100-kernel weight and grain yield per plant. The experiment was conducted at Sakha Agricultural Research Station during the growing seasons 2005/06, 2006/07 and 2007/08. Data revealed the presence of highly significant differences among crosses, among populations within crosses as well as among populations within each cross for all studied characters. The calculated values of A, B and C scaling tests for all studied characters in the two crosses were significant except for plant height in the second cross. The additive effect was more important and greater than the dominance effect for 100- kernels weight and grain yield per plant for the two crosses, while the dominance effect was more important and greater than the additive effect for days to heading and maturity for the two crosses and also for number of spikes per plant in the first cross. Heritability in broad and narrow sense indicated the importance of the non-additive variance components in the inheritance of the all studied characters except 100-kernel weight in the first cross. Heritability estimates in narrow sense were low to moderate for all the studied traits in the two crosses, ranged from 22.88% for grain yield per plant in the second cross to 69.10% for 100 kernels weight in the first cross. The expected genetic advance estimates in the F_2 were low for number of days to heading, number of days to maturity, number of spikes per plant and 100-kernel weight in two crosses. The same trend were found for, plant height, number of kernels per spike and grain yield per plant in the second cross. While, indicated high for plant height, number of kernels per spike and grain yield per plant in the first cross.

INTRODUCTION

The success of any breeding program depends on the genetic variability and types of gene action involved in the inheritance of different characters in the used materials. Grain yield is a complex character made up of the interaction between different yield components under different environmental conditions. Because of this complex interaction, yield components could be also investigated to improve grain yield (Novoselovic *et al.*, 2004). The importance of wheat is increasing day by day due to increased human population in the country. An understanding of genetic factors determining of agronomic characters of yield components is a primary step for breeding studies

The additive, dominance and epistatic gene effects were important in controlling the inheritance of number of kernels per spike and grain yield (Abdel-Rahman and Hammad, 2009). Additive and dominance gene effects were important in the inheritance of number of spikes/plant, number of kernels/spike and grain yield/plant (Awaad, 2002). On the other hand, Salem *et al*. (2000) reported that the dominance gene effects were of great importance in controlling the genetic system of grain yield and its components.

Moderate to high broad and narrow senses heritability estimates were obtained for most studied traits (Abd El-Aty *et al*., 2005). The expected genetic advance estimates were moderate for number of kernels per spike and grain yield per plant (El-Hag, 2006), while it was low for days to heading and maturity dates, plant height, number of grain per spike, 100 kernels weight and grain yield per plant (Abd El-Aty *et al*.,2005).

The present investigation aimed to study the type of gene action and estimate some genetic parameters in the two wheat crosses derived from three parental wheat genotypes using the six populations of each cross.

MATERIALS AND METHODS

The present study was carried out at the experimental farm of Sakha Agricultural Research Station Kafr El-Sheikh, Egypt, through the three wheat growing seasons of 2005/06, 2006/07 and 2007/08. In the growing season of 2005/06, pair crossing was performed between three wheat genotypes to obtain F_1 hybrid grains for the following pair crosses Sakha 69 × Sakha 93 (cross 1) and Sakha 93 × Sakha 94(cross 2). In 2006/07 growing season the F_1 of each cross was crossed back to its parents to produce BC_1 ($F_1 \times P_1$) and BC_2 ($F_1 \times P_2$), the F_1 plants were selfed to produce the seeds of F_2 generations. In 2007/08 season the obtained seeds of the six populations of the two wheat crosses (P_1, P_2, F_1, BC_1, BC_2 and F_2) were evaluated using a randomized complete block design with four replications. Each plot consisted of 15 rows (Eight rows for F_2 generation, one row for P_1, P_2 as well as F_1 and two rows for BC_1 and BC_2). The row was 3.0 m. long spaced 0.30cm. apart and seeds were spaced 0.15 cm. within the row. Estimated data were recorded on individual plant represented by 30 plants for each parent and F_1, 90 plants for each backcross, and 200 plants for each F_2. The names and pedigrees of the three spring wheat genotypes that were used in this study are presented in Table 1.

Table 1. Names and pedigrees of three parental wheat genotypes

Name	Pedigree
Sakha 69	Inia / RL 4220 // 7c / Yr "S" CM 15430 –2S-6S-0S-0S
Sakha 93	Sakha 92/ TR 810328 S 8871-1S-2S-1S-0S
Sakha 94	Opata / Rayon // Kauz CMBW 90Y3180 -0TOPM-3Y-010M-10M-010Y-6M-0S

The studied characters were; days to heading, days to maturity, plant height, number of spikes per plant, number of kernels per spike, 100-kernel weight and grain yield per plant. Simple scaling tests (A, B and C) were applied according to Mather and Jinks (1982) formula to test the presence of non- allelic interactions. The six parameters model proposed by Gamble (1962) was used to estimate different gene effects.

Heritability in broad and narrow sense were calculated according to Mather (1949) and the predicted genetic advance under selection was computed according to Johanson *et al.* (1955)

RESULTS AND DISCUSSION

Population means:

The mean of parents, F_1 and segregating generations of the two crosses are presented in Table 2. The results showed that the t-tests of differences between parents of each cross were significant or highly significant in all cases in the two studied crosses.

Table 2. Mean of the six populations (P_1, P_2, F_1, F_2, BC_1, and BC_2) for all the studied characters in the two bread wheat crosses.

Characters	Crosses	P_1	P_2	F_1	F_2	BC_1	BC_2	t-test
Days to heading	1	96.53	95.83	97.03	95.56	96.47	105.88	**
	2	95.83	103.07	99.03	97.95	97.90	101.37	**
Days to maturity.	1	150.33	152.33	151.20	151.79	152.33	170.19	**
	2	152.33	153.30	154.33	153.10	154.01	154.34	**
plant height (Cm)	1	115.50	100.00	110.67	110.57	15.20	125.83	**
	2	100.00	115.83	110.50	108.75	102.61	112.44	**
No. of spikes/ plant	1	18.80	19.43	15.17	15.30	16.51	15.57	*
	2	19.43	18.10	17.73	16.52	17.69	15.27	**
No. of kernels/ spike	1	55.10	63.36	63.83	60.08	53.16	53.36	**
	2	63.36	76.97	74.07	67.47	66.76	70.01	**
100-kernel weight (g)	1	3.88	4.74	3.54	4.11	3.87	3.59	**
	2	4.74	4.90	6.07	5.19	4.96	4.61	**
grain yield per plant (g)	1	39.54	43.52	40.70	37.81	35.63	19.18	**
	2	43.52	48.90	52.36	41.94	41.39	35.83	**

***,** Significant at 0.05 and0.01 levels, respectively.**

The mean performance of days to heading in the two crosses indicated that Sakha 93 was the earliest. Sakha 94 had the highest number of spikes per plant, number of kernels per spike, 100-kernel weight and grain yield per plant. The F_1 mean values exceeded the mid- values of the two parental means for all the studied traits in the two crosses except the number of spikes per plant in the two crosses,100 kernel weight (g) and grain yield per plant in the first cross indicating the presence of partial dominance.

In addition, the mean values of F_2 were intermediate between the two parents and less than the F_1 mean values indicating the importance of non-additive components of genetic variance for the studied crosses.

The genetic variance among F_2 plants was genetically different for all studied traits in the two crosses. However, both BC_1 and BC_2 mean values

varied according to the trait itself, it was tended toward the mean of recurrent parent for the studied traits with some exceptions.

Table 3: Scaling test and t-test of the studied traits in the two wheat crosses

Characters	Crosses	Scaling test			t- test
		A	B	C	
Days to heading	1	-0.63	19.12**	-3.98**	**
	2	0.93	1.67*	-4.15	**
Days to maturity	1	3.13**	38.18**	3.43**	**
	2	1.36*	4.13**	1.16	**
Plant height (cm)	1	-195.77**	41.00**	5.43**	**
	2	-5.28	-3.28	-3.67	**
No. of spikes/ plant	1	174.22**	1.18	0.24	*
	2	1.79	-9.17**	-10.79**	**
No. of kernels/ spike	1	-12.62**	-16.85**	-2.19	**
	2	-3.91	-11.41**	-18.99**	**
100-kernel weight (g)	1	0.32	0.44	2.28**	**
	2	-0.90**	-2.36**	-1.64**	**
Grain yield per plant (g)	1	-8.97*	-38.53**	-5.89	**
	2	-13.11**	-39.03**	-38.81**	**

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

Types of gene action: Types of gene action for all studied traits in the two crosses are presented in Table 4. For all studied traits, the mean parameters (m) effect was significant in two crosses, indicating the potentiality of improving performance of these traits by using pedigree selection program.

Table 4. Gene action parameters of the studied traits in the two wheat crosses.

Characters	Crosses	Gene action					
		m	a	d	aa	ad	dd
Days to heading	1	95.56**	-9.41**	23.43**	22.47**	-9.88**	-40.96**
	2	97.95**	-3.47**	6.85**	6.75**	-0.37	-9.35**
Days to maturity.	1	151.79**	-17.86**	38.42**	37.88**	-17.52**	-79.20**
	2	153.10**	-0.33	7.38**	4.32**	-1.38**	-9.81**
plant height (cm)	1	110.57**	-110.63**	-157.28**	-160.20**	-118.38**	314.97**
	2	108.75**	-9.83**	-3.22	-	-	-
No. of spikes/ plant	1	16.21**	88.89**	174.59**	175.16**	86.52**	-350.56**
	2	16.52**	2.42**	-3.14	-0.17	3.69**	11.12**
No. of kernels/ spike	1	60.08**	-0.20**	-20.87**	-27.29**	2.12**	56.76**
	2	67.47**	-3.26	7.37	3.67	3.75	11.66
100-kernel weight (g)	1	4.11**	0.28*	-1.53**	-1.52**	-0.06	0.76
	2	5.19**	0.34**	-0.68	-1.62**	0.73**	4.87**
grain yield per plant (g)	1	37.81**	16.45**	-38.78**	-41.61**	14.78**	89.12**
	2	41.94**	5.56*	-11.88	-13.32*	12.96**	65.45**

m = Mean effects, a = additive effects, d = dominance effects
***, ** = significant at 0.05 and 0.01 levels of probability, respectively.**

Highly significant and negative additive effects were obtained for days to heading and plant height in the two crosses, days to maturity and number of kernels per spike in the first cross, indicating that the additive effects were less important in the inheritance of these traits. Meanwhile,

additive was highly significant and positive for number of spikes per plant, 100 kernel weight and grain yield per plant in the two crosses, suggesting the possibility of obtaining further improvements of these traits by using a pedigree selection program. These results are in close agreement with those of El-Hosary *et al*.,(2000) and Abd El-Aty *et al*.,(2005).

The estimates of dominance effects were highly significant and negative for plant height, number of kernels per spike, 100 kernel weight and grain yield per plant in the first cross. On the other hand, highly significant and positive dominance effects were shown by days to heading and maturity in the two crosses and number of spikes per plant in the first cross, indicating the importance of dominance gene effects in the inheritance of these traits. Similar results were also reported by Abd El-Aty (2002), Darwish and Ashouch (2003), Abd El-Aty *et al*., (2005) and Abd El-Aty *et al*., (2007).

Highly significant positive additive × additive types of epistasis was detected for days to heading and maturity in the two crosses, while it was detected for number of spikes per plant trait only in the first cross.

The results showed also that highly significant negative additive × additive for 100 kernels weight and grain yield per plant in the two crosses and plant height and number of kernels per spike in the first cross.

In addition, highly significant positive additive × dominance types of epistasis was detected for number of spikes per plant, grain yield per plant in the two crosses, number of kernels per spike in the first cross and 100 kernels weight in the second cross. While, highly significant negative additive × dominance were found for days to maturity in the two crosses and days to heading and plant height in the first cross. Also, dominance × dominance epistasis type were highly significant positive for most traits in the two crosses except for days to heading and maturity in the two crosses and number of spikes per plant and plant height in the first cross.

Among the epistatic components, the dominance × dominance was greater in magnitudes than additive × additive and additive × dominance in the most traits. These findings are in harmony with those previously obtained by Abd El-Aty *et al*., (2005).

The results of heritability and expected genetic advance are included in Table 5.

The estimates of heritability in broad and narrow senses indicated the importance of non-additive variance components in the inheritance of all studied traits except 100-kernel weight in the first cross. These results suggested that selection for these characters should be delayed to later generations. Heritability estimates were equal in each of broad and narrow senses because non-additive components were negatives (an estimate to zero) indicating the importance of the additive genetic effects in the genetic control for 100-kernel weight in the first cross. Similar results have been reported by Hammad (2003) and El-diasty *et al.* (2008).

Table 5. Estimates of heritability and expected genetic advance (G.S) for studied characters in the two wheat crosses.

Characters	Crosses	Heritability		Expected genetic advance (Δg)
		h^2(b)	h^2(n)	
Days to heading	1	86.83	61.57	4.06
	2	93.46	56.68	4.55
Days to maturity.	1	90.54	61.85	4.29
	2	89.26	68.46	4.84
plant height (cm)	1	89.20	56.98	18.63
	2	97.85	53.20	7.02
No. of spikes/ plant	1	45.55	27.94	2.82
	2	82.03	60.20	6.88
No. of kernels/ spike	1	91.56	41.76	12.54
	2	87.50	30.97	9.51
100-kernel weight (g)	1	69.10	69.10	1.45
	2	61.32	50.88	1.05
grain yield per plant (g)	1	89.99	41.40	14.02
	2	88.57	25.88	9.84

The expected genetic advance estimates (G.S) from selection in the F_2 (Table 5) were low for days to heading, days to maturity, number of spikes per plant and 100-kernel weight in two crosses. Also, the (G.S) estimates were low for plant height, number of kernels per spike and grain yield per plant in the second cross. While, these estimates were high for plant height, number of kernels per spike and grain yield per plant in the first cross. Consequently, it could be concluded that selection for these traits could be effective in early generations. These results are in general agreement with those obtained by Darwish and Ashoush (2003).

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تقدير الثوابت الو راثية للمحصول ومكوناته وبعض الصفات المحصولية في هجينين من قمح الخبز

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أجريت هذه الدراسة بمزرعة محطة البحوث الزراعية بسخا خلال ثلاثة مواسم ٢٠٠٥/٢٠٠٦ ، ٢٠٠٦/٢٠٠٧، ٢٠٠٧/٢٠٠٨ بهدف تقدير طبيعة التأثير الجيني ومحاولة الحصول على تراكيب وراثية جديدة يمكن الانتخاب من خلالها في الأجيال الانعزالية التالية للحصول على تراكيب جديدة من القمح متفوقة في صفاتها المحصولية على الأصناف التجارية المنزرعة.

وقد أستخدم لذلك ثلاثة أباء متباينة في صفاتها وهى سخا ٦٩،سخا ٩٣ و سخا ٩٤ وتم عمل هجينين من هذه الإباء وهما (سخا ٦٩× سخا ٩٣) و (سخا ٩٣× سخا ٩٤) وكذلك الحصول على العشائر الستة من كل هجين (الأب الأول والثاني والجيلين الأول والثاني والهجينين الرجعيين

الأول والثاني) وزرعت جميعها في تجربة قطاعات كاملة العشوائية ذو ثلاث تكررات في الموسم الأخير وتمت دراسة الصفات الآتية : عدد الأيام حتى الطرد، عدد الأيام حتى النضج، طول النبات، عدد السنابل للنبات، عدد الحبوب للسنبلة، وزن المائة حبة ومحصول الحبوب للنبات.

وقد أظهرت النتائج وجود اختلافات عالية المعنوية بين الهجن وبين العشائر داخل الهجن في كل الصفات المدروسة، وأوضحت نتائج اختبارات الـ Scaling وجود معنوية لكل الصفات ماعدا طول النبات في الهجين الثاني. وكان تأثير الفعل الجيني المضيف أكثر أهمية من الفعل الجيني السيادي لصفات وزن الـ ١٠٠ حبة ومحصول حبوب النبات في الهجينين في حين كان تأثير الفعل الجيني السيادي أكثر أهمية لصفات تاريخ الطرد والتزهير للهجينين وعدد سنابل النبات في الهجين الأول. كما أظهرت النتائج معنوية التأثيرات الجينية السائدة والمتفوقة لعدد الأيام حتى النضج في الهجين الثاني. وكانت قيم معامل التوريث بمعناه الضيق منخفضة إلى متوسطة للصفات المدروسة في كلا الهجينين وتراوحت ما بين ٢٥,٨٨ % لصفة محصول حبوب النبات في الهجين الثاني إلى ٦٩,١٠ % لصفة وزن المائة حبة في الهجين الأول. وكانت تقديرات التحسين الوراثي المتوقع فى الجيل الثالث من الانتخاب في الجيل الثاني منخفضة لصفات عدد الأيام حتى الطرد وعدد الأيام حتى النضج وعدد السنابل في النبات ووزن المائة حبة في الهجينين تحت الدراسة وأيضاً بالنسبة لصفة ارتفاع النبات في الهجين الثاني. بينما كانت مرتفعة لكل من ارتفاع النبات وعدد حبوب السنبلة ومحصول الحبوب للنبات في الهجين الأول.