Egypt. J. Plant Breed. 10(2):217-231 (2006)

INHERITANCE OF GRAIN YIELD AND SOME OTHER TRAITS IN THREE BREAD WHEAT CROSSES

Hayam S. Mahgoub and S. Hamad

National Wheat Program - Field Crops Research Institute- Agricultural Research Center.

ABSTRACT

Three crosses were made among three bread wheat cultivars; Giza 163, Giza 168, and Sids 6 to estimate the genetic variance, gene action and heritability, grain yield and its components as for resistance to stripe, leaf and stem rusts. The final experiment conducted in 2005/2006 season included the five populations P_1, P_2, F_1, F_2 and F_3, of each cross. Results showed significant positive heterotic effects relative to better parents for most characters under investigation. Meanwhile, for maturity date, significant negative (favorable) heterosis relative to earlier parent was detected in the three crosses. Overdominance towards the higher parent was found for number of spikes / plant in the first cross and for plant height and grain yield / plant in the third cross. On the other side, over dominance towards the lower parent was detected for maturity date and kernel weight for the three crosses and for number of kernels / spike in the first and second cross as well as for grain yield / plant in the second one. Moreover, complete dominance towards the lower parent was detected for grain yield / plant in the first cross. Meanwhile, partial dominance toward the lower parent was observed for number of spikes / plant and number of kernels / spike in the second and third cross, respectively. Also , significant positive values of inbreeding depression were detected for all studied characters except for plant height in the three crosses, maturity date in the first and third cross and kernel weight in the fist one for which significance negative values were evident. In general, estimates of heritability in broad sense were high to moderate for all studied characters in the three crosses. On the other hand, moderate values of narrow sense heritability were detected for most studied characters. In addition, for wheat rusts reaction estimates of broad sense heritability were high to medium and were high to low in narrow sense, reflecting that resistance to the three rusts is simply inherited. Also, it was concluded that selecting resistant plants could be successively practiced in the early generations but would be more effective if selection is practiced in the advanced ones.

Key words: ***Wheat, Triticum aestivum, Heterosis, Heritability, Gene action, Stem rust, Stripe rust, Leaf rust***

INTRODUCTION

Understanding the nature and magnitude of gene effects on yield components may greatly help the wheat breeder in formulating an efficient breeding program to achieve desired genetic improvement in wheat. Assessment and quantifying the type of gene action were studied by many investigators. Additive and dominance gene effects with additive × additive epistasis were found to control many traits such as days to heading and maturity (Menshawy 2000 and Abd El-Aty 2002). Also additive × dominance gene effects were important in the inheritance of plant height, number of spikes/plant, number of kernels/spike and grain yield/plant (Awaad 2002 and Hammad 2003). On the other hand, Salem *et al* (1991) reported that dominance gene effects were of great importance in controlling the genetic system of grain yield and its components.

Heritability estimates in broad and narrow senses are very useful breeding program. Realized heritability is a useful to evaluate the response to selection and to determine when selection should be started. However, Dixit *et al* (1970) stated that high heritability is not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with high genetic gain (Mahgoub 2006). However, Ashoush *et al* (2001) reported that heritability estimates for plant height, heading date and yield components were medium to high (more than 50%).

Stripe rust of wheat caused by *Puccinia striiformis*, leaf rust caused by *Puccinia reccondita* and stem rust caused by *Puccinia graminis tritici* are the most destructive diseases of bread wheat in Egypt. However, wheat stripe rust is considered to be the most dangerous wheat disease in Egypt, since it causes great losses in grain yield in the Delta region in some seasons (El-Daoudi *et al* 1996). The inheritance of resistance is controlled by few genes oligogenic (Shehab El-Din *et al* 1996) or polygenes (Aglan 2003 and Hammad 2003).

The present research aims to study the genetic variance, type of gene action, heritability, and the predicted genetic gain from selection for earliness, grain yield and its components as well as resistance to stripe, leaf and stem rusts for three crosses of wheat.

MATERIALS AND METHODS

The field experiments were carried out at Sakha Agricultural Research Station from 2002/2003 through 2005/2006. Three diverse bread wheat cultivars in their time to heading were selected and used (Table 1).

In 2002/2003 season, the parental genotypes were sown at three planting dates and crossed to secure enough hybrid seeds among the parents.

Table 1. Name and pedigree of the studied parental bread wheat cultivars.

Par.	Name	Pedigree	Maturity	Kernel weight	Tillering
1	Giza 163	*T.aestivum*/Bon//Cno/7c.	Medium	Light	Medium
2	Giza 168	MRL/BUC//Serei CM93046-8M-OY-OM-2Y-OB	Medium	Medium	High
3	Sids 6	Maya"S"/Mon"S"/cmh47.A.592/3/Sakha8*2 SD10002-4SD-1SD-Osd.	Early	Heavy	low

The 3 F_1 crosses produced were

Cross 1 : Giza 163 x Giza 168

Cross 2: Giza 163 x Sids 6

Cross 3: Giza 168 x Sids 6

In 2003/2004 season, F_1 plants were sown and left to produce the F_2 seeds of the three crosses. In 2004/2005 season, 20 and 60 seed from F_1 and F_2, respectively for each cross were grown in order to obtain F_2 and F_3 seeds. Moreover, the three parents were planted and the same crosses were repeated to obtain additional and / or fresh F_1 seeds.

The evaluation experiment was carried out in 2005/2006 season. The experiment included the five populations P_1, P_2, F_1, F_2, and F_3 of each cross and was planted at the third week of November, using the randomized complete block design with three replications. Each replicate consisted of 50 rows for each cross (one row for each parent and F_1; 6 rows for F_2 generation and 41 rows for F_3 families). Each row was 3 meters long and 30 cm apart. Plants within rows were 20 cm apart, so each row included fifteen plants. The experiment was surrounded by 2m width spreader grown with a mixture of highly susceptible wheat genotypes to stripe, leaf, and stem rusts i.e. Giza 139, Giza 144, Giza 163, Sakha 92, Sids 7, *Triticum spelta*, and Baart to help in the dissemination of the pathogen's uredeniospores. The spreader was artificially inoculated using a mixture of fresh uredeniospores of each of the three pathogens mixed with talcum powder at rate of 1:20. The inoculum of stripe rust was sprayed soon after the sun set in the last week of January using the method of Travet and Cassel (1951). In addition, the region was naturally subjected to severe attack from stripe rust causal agent. Furthermore, the artificial inoculation took place in the third week of February for both leaf and stem rusts. Finally the infection types were recorded for plants according to the scale of Chen and Line (1992). All recommended cultural practices for the region were applied.

Data were recorded on the following characters :

Maturity date; detected as number of days from planting to the beginning of changing the color of main stem from green to yellow.

Plant height (cm) measured from soil surface to the top of the main spike excluding awns.

A samples of 10 individual guarded plants from each row, grain yield/plant, number of spikes/plant, number of kernels/spike and 100 kernels weight were recorded.

Various biometrical parameters were calculated for the characters for which the F_2 genetic variances were significant. The amount of heterosis were expressed as the performance of F_1's over better parent values. Meanwhile, inbreeding depression was calculated as the difference between F_1 and F_2 means in term of percentage of the F_1 mean. The T- test was used to determine the significance of these deviations according to Peter and Fery (1966). Moreover, potence ratio (P) was calculated according to Peter and Frey (1966). In addition, F_2 deviation (E1) and F_3 deviation (E2) were measured as suggested by Mather and Jinks (1980).Type of gene effects was estimated according to Hayman (1958) as described by Singh and Chaudhary (1980). Heritability was calculated in broad sense (h^2b) according to Mather (1949) and in narrow sense (h^2n) in F_3-families using parents offspring regression according to Lush (1949).

For the quantitative analysis, field reaction was converted into an average coefficient of infection (ACI) according to the method developed by of Stubbs *et al* (1986) and adjusted by Shehab EL-Din and Abdel-Latif (1996) . In this method, the (ACI) could be obtained by multiplying infection severity by an assigned constant value namely, 0.25, 0.50, 0.2, 0.4, 0.6, 0.8 and 1 for 0,0;, R, MR, M, MS, and S infection types, respectively.

Type of gene effects was estimated according to Hayman model as described by Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

Performance and gene action

The mean ($\overline{X}$) and variance (S^2) of five populations (P_1, P_2, F_1, F_2, and F_3) of the studied characters in the three crosses are presented in Table (2). At the beginning, parental mean differences and genetic variance among F_2 population were calculated and tested for statistical significance. All studied characters showed significant genetic variance in the three crosses, indicating the presence of genetic variability for these characters in these

Table 2. Means and variances (S^2) for studied characters using the five populations (P_1, P_2, F_1, F_2 and F_3families) for three bread wheat crosses.

Characters	Cross	Parameter	P_1	P_2	F_1	F_2	F_3
Days to maturity	1	Mean	149.8	145.8	142.13	143.36	146.11
		S^2	1.24	1.72	0.41	7.39	2.14
	2	Mean	150.5	144.4	143.63	143.11	144.73
		S^2	3.25	4.44	5.11	13.49	10.13
	3	Mean	147.07	143.4	142.8	144.5	144.95
		S^2	2.61	3.24	2.08	8.72	10.32
Plant height (cm)	1	Mean	114.33	96.67	109.67	113.63	107.82
		S^2	2.33	2.33	4.33	8.52	7.5
	2	Mean	103	88	101.17	111.05	113.1
		S^2	7	3	3.08	16.74	8.49
	3	Mean	101.33	93	104	105.72	109.16
		S^2	2.33	4	9	19.54	15.54
Number of spikes / plant	1	Mean	16.33	25.33	25.87	20.75	18.5
		S^2	4.57	4.21	4.41	24.18	8.52
	2	Mean	20.5	3.67	15.2	14.48	13.2
		S^2	2.17	2.81	5.08	22.53	19.33
	3	Mean	23.89	4.2	12.57	8.41	8.46
		S^2	2.81	2.08	3.66	5.98	5.15
Number of kernels/ spike	1	Mean	65.47	71.6	80	76.98	75.51
		S^2	4.21	2.56	2.08	13.75	10.63
	2	Mean	64.5	81.33	82.82	77.17	65.48
		S^2	2.73	2.29	5.38	10.02	7.56
	3	Mean	69.87	99.27	96.87	81.05	76.33
		S^2	1.77	2.57	4.49	8.49	4.85
100 kernels weight (g)	1	Mean	3.92	4.95	5.26	5.53	5.48
		S^2	0.11	0.01	0.27	0.57	0.37
	2	Mean	3.71	5.23	5.59	5.08	4.76
		S^2	0.2	0.15	0.21	0.82	0.39
	3	Mean	4.77	5.46	5.53	4.91	5.3
		S^2	1.86	0.9	1.04	6.11	5.83
Grain yield Plant (g)	1	Mean	40.58	47.94	48.16	45.47	36.17
		S^2	4.09	6.47	4.45	10.53	1.05
	2	Mean	24.56	36.48	42.5	34.35	32.26
		S^2	5.96	5.37	2.47	19.03	4.89
	3	Mean	47.27	36.51	50.33	43.57	43
		S^2	0.66	3.23	1.77	18.61	24.44

material and therefore, detailed analysis of gene action was calculated. Likewise, heterosis percentage over better parent (BP), potance ratio (P) and inbreeding depression for the three wheat crosses are presented in Table (3). Significant positive hetrotic effects relative to better parents would be of interest for most characters under investigation. Meanwhile, for maturity date, negative values would be very useful from the breeder's view point. In this respect, significant negative heterosis to earlier parent was detected for maturity date in the three crosses. In addition, the first and second cross revealed negative heterotic effects for plant height and number of kernels /spikes. Moreover, the second and third cross showed negative heterotic effects for number of spikes per plant. On the other hand, significant positive heterosis was detected for kernel / spike, 100kernel weight and grain yield / plant in the three crosses.

Table 3. Heterosis, potence ratio, inbreeding depression F_2 and F_3 deviation and heritability for studied characters of three bread wheat crosses.

Characters	cross	Heterosis % over B.P	Potence ratio (P)	Inbreeding depression	F_2 deviation E_1	F_3 deviation E_2	Heritability	
							Broad sense	Narrow sense
Days to maturity	1	-2.52*	-2.84	-0.87*	-3.21*	2.29*	87.06	62.87
	2	-0.53*	-1.25	0.36*	-4.86*	-1.62*	68.96	58.30
	3	-0.42*	-1.33	-1.19*	0.965*	1.86*	70.20	57.35
Plant height	1	-4.08*	0.47	-3.61*	12.09*	0.47*	66.41	51.56
	2	-1.78*	0.76	-9.77*	25.43*	29.53*	76.05	68.93
	3	2.63*	1.64	-1.65*	10.275*	17.16*	77.63	63.92
Number of spikes/plant	1	2.13*	1.12	19.79*	-5.2*	-9.7*	81.85	66.07
	2	-25.85*	0.37	4.74*	1.675*	-0.89*	86.08	33.73
	3	-47.38*	-0.15	33.09*	-9.8*	-9.7*	53.63	54.25
Number of kernel/spike	1	22.19*	-3.74	-3.74	5.425*	2.49*	79.51	38.71
	2	28.40*	-1.18	6.82*	-1.395*	24.78*	67.82	40.35
	3	38.64*	-0.84	16.33*	-19.34*	-28.78*	67.84	54.42
100 kernel weight (g)	1	34.18*	-1.60	-5.13*	1.365*	1.27*	88.226	62.38
	2	50.67*	-1.47	9.12*	0.1*	-0.54*	77.44	41.95
	3	15.93*	-1.20	11.21*	-0.825*	-0.04*	80.31	59.19
Grain yield/plant(g)	1	18.68*	-1.06	5.59*	-1.48*	-20.08*	53.53	46.05
	2	73.05*	-2.01	19.18*	-4.32*	-8.50*	77.48	49.75
	3	6.47*	1.57	13.43*	-5.08*	-6.22*	91.64	66.52

The potence ratio indicated overdominance towards the higher parent for number of spikes/plant in the first cross and for plant height and grain yield/plant in the third cross. On the other side, overdominance towards the lower parent was detected for maturity date and kernel weight in the three crosses and for number of kernels / spike in the first and second cross as well as for grain yield/plant in the second one. On the other hand, complete dominance towards the lower parent was detected for grain yield/plant in the first cross. Meanwhile, partial dominance toward the lower parent was observed for number of spikes/plant and number of kernels/spike in the second and third cross, respectively.

In general, significant positive values were detected for inbreeding depression in all studied characters except for plant height in the three crosses, maturity date in the first and third cross and kernel weight in the fist one for which significance negative values were evident (Table 3). However, these results are expected, since the high expression of heterosis in F_1 could be followed by considerable reduction in F_2 performance. The obtained results are in harmony with those reported by EL-Seidy and Hamada (1997), and Kheiralla *et al* (2001).

On the other side, significant positive F_2 deviation (E1) was detected for plant height in all crosses, number of kernels/spikes, and kernel weight in the first cross, number of spikes/plant and kernel weight in the second cross. Also, E1 was detected for maturity date in the third one. Whereas, significant E1 negative values were obtained for maturity date, number of spikes/plant, and grain yield/plant in the first cross, maturity date, number of kernels/spike and grain yield/plant in the second cross, and number of spikes/plant, number of kernels/spike, kernel weight and grain yield/plant in the third one. These results may refer to the contribution of epistatic gene effects in the performance of these characters.

F_3 deviation (E2) was significantly positive for plant height, maturity date, number of kernels/spike and kernel weight in the first cross, plant height and number of kernels/spike in the second cross, and for plant height and maturity date in the third one. Meanwhile, significant negative E2 values were detected for number of spikes/plant and grain yield/plant in the first cross, and for maturity date, number of spikes/plant, kernel weight, and grain yield/plant in the second cross; and number of spikes/plant, number of kernels/spike, kernel weight, and grain yield/plant in the third one. These results proved the magnitude of epistasis that warrant great deal of attention in breeding programs.

Heritability estimates in both broad and narrow sense are presented in Table (3). In general, high to moderate(more than 50%) heritability values in broad sense were detected for all studied characters in the three crosses. On the other hand, moderate values of narrow sense heritability were detected for all studied characters except for number of kernels / spike in the first two crosses; number of spikes/plant and kernel weight in the second cross and grain yield / plant in the first one.

Narrow sense heritability reflects the importance of the proportion of the variation due to additive gene effects in the inheritance of these characters. Therefore, selection for the desirable characters could be useful in early generations but would be more effective if delayed to later ones (Shehab EL-Din 1993 and El-Seidy and Hamada 1997).

Types of gene action calculated according to Hayman (1958) are presented in Table (4). The estimated mean effect of F_2 (m), which reflects the contribution due to the over all mean plus the locus effect and interactions of the fixed loci, was found to be highly significant. The additive gene effect (d) was significant and positive for most studied characters. Meanwhile, it was significant and negative for number of kernels / spike and kernel weight in the three crosses, and grain yield / plant in the first and second cross.

Table 4. Gene action parameters for studied characters in the three crosses of bread wheat.

Character	Cross	m	d	h	l	i
Days to maturity	1	143.36*	2.00*	-8.15	11.39	1.52
	2	143.11*	3.05*	-3.96	9.96	5.97
	3	144.50*	1.83*	-2.34	-2.10	3.76
Plant height	1	113.63*	8.83*	12.85	-41.52	26.34
	2	111.05*	7.50*	-12.05	-15.43	-2.72
	3	105.72*	4.17*	-10.31	13.72	-8.81
Number of spikes/plant	1	20.75*	4.5*	9.40	1.67	13.37
	2	14.48*	8.42*	3.88	-4.86	17.59
	3	8.41*	9.84*	2.63	11.38	23.79*
Number of kernels/spike	1	76.98*	-3.07*	5.93	0.24	-11.67
	2	77.17*	-8.042*	34.94*	-47.23	8.19
	3	81.05*	-14.7*	23.13	16.98	-18.57
100 kernels weight (g)	1	5.53*	-0.51*	-0.04	-1.03	-1.89*
	2	5.08*	-0.76*	1.21	-0.40	-1.43
	3	4.91*	-0.35*	-0.63	3.73	-1.74
Grain yield / plant (g)	1	45.47*	-3.68*	26.59*	-42.39	15.32
	2	34.35*	-5.96*	11.02	10.54	-12.88
	3	43.57*	5.38*	6.03	14.95	8.36

m = Mean effects, d= additive effects, h= dominance effects

These results suggest the possibility of obtaining further improvement for the characters in which d values were positive. They prove also that using pedigree selection program would be more effective. Similar results were obtained by Moustafa (2002), and El-Sayed (2004).

Dominance gene effect (h) was significant only for number of kernels /spike, and grain yield / plant in the second and first cross, respectively, indicating the importance of dominance gene action in the inheritance of these characters. Therefore, selecting desired characters could be practiced in the early generations but would be more effective in late ones (Shehab EL-Din 1993).

Estimates for epistatic gene effects i.e. dominance X dominance (l), and additive X additive (i) are presented in Table (3). Dominance X dominance gene effects were significant only for number of spikes / plant, and kernel weight in the third and first cross, respectively. These results are in general agreement with those obtained by Shehab EL-Din (1993), El-Seidy and Hamada (1997), Kheiralla *et al* (2001).

Stripe rust reaction

The population means and variances of the reaction of five populations (P_1, P_2, F_1, F_2, and F_3) for the three wheat crosses; Giza163 x Giza168, Giza163 x Sids 6, and Giza 168 x Sids 6 to the inoculation with uredeniospores of *P. striiformis* at the adult stage under field conditions are shown in Table (5). Furthermore, Table (6) presents the estimates of gene action components for stripe rust reaction in the three crosses.

In addition, heritability values in broad and narrow senses, for the infection type character, are given in Table (6). The broad sense heritability estimate were 92, 99, and 68% while heritability in narrow sense values were 78, 37, 54% in the three crosses, respectively. These values being high to medium in broad sense and high to low in narrow sense indicate that wheat resistance to stripe rust is a high heritable character and that selecting resistant plants could be practiced in early generations but selection would be more effective if postponed to the later ones would be more effective. These results are in accordance with those obtained by Shehab EL-Din *et al* (1991), Shehab EL-Din and Abdel-Latief (1996), and Abdel- latif and Boulot (2000) and Mahgoub, (2001).

Leaf rust reaction

The population means and variances of the reaction of five populations (P_1, P_2, F_1, F_2, and F_3) for the three wheat crosses to the inoculation with the uredeniospores of *P. recondite*; the causal agent of leaf rust, at the adult stage under field conditions are shown in Table (7). Moreover, Table (8) presents the estimates of gene action components for the three crosses.

The estimated mean effect of F_2 (m), for leaf rust was significant. The different types of gene effects indicated that d effects of the three crosses and h effects in the first and third ones were significant. Moreover, l effect in the first and third cross and i effect in the first cross were the most important in the expression of the inheritance of wheat resistance to stem rust.

Table 5. Means ($\overline{X}$) and variances (S^2) for the reactions of the five populations (P_1, P_2, F_1, F_2 and F_3 families) for the three bread wheat crosses to the stripe rust.

Cross name	Parameters	P_1	P_2	F_1	F_2	F_3
Giza 163 x Giza 168	$\overline{X}$	62.17	0.25	55.33	58.39	51.71
	S^2	16.08	0.001	2.33	28.11	24.81
Giza 163 x Sids 6	$\overline{X}$	38.00	55.00	16.28	20.06	24.00
	S^2	7.00	1.00	0.40	68.83	42.57
Giza 168 x Sids 6	$\overline{X}$	0.25	32.33	12.33	18.83	18.09
	S^2	0.001	10.33	5.77	18.06	0.35

Table 6. Gene action parameters in the three crosses of bread wheat for the stripe rust reaction.

Cross Name	m	d	h	l	i	Heritability%	
						Broad sense	Narrow sense
Giza 163 x Giza 168	58.39*	-30.96*	15.77	-43.71	-70.29	92	78
Giza 163 x Sids 6	20.06	8.50	-13.03	10.92	34.20	99	37
Giza 168 x Sids 6	18.83*	-16.04*	-2.35	-21.27	-30.48	68	54

m = Mean effects, d= additive effects, h= dominance effects

Table 7. Means (X) and variances (S^2) for the reactions of the five populations (P_1, P_2, F_1, F_2 and F_3 families) for the three bread wheat crosses to the leaf rust reactions.

Cross name	Parameters	P_1	P_2	F_1	F_2	F_3
Giza 163 x Giza 168	$\overline{X}$	0.23	0.17	0.23	0.34	0.85
	S^2	0.001	0.02	0.001	0.03	0.13
Giza 163 x Sids 6	$\overline{X}$	0.25	18.15	25.87	20.74	55.50
	S^2	0.001	0.02	4.41	24.19	4.07
Giza 168 x Sids 6	$\overline{X}$	0.22	8.43	5.60	13.40	9.04
	S^2	0.001	0.004	1.44	1.34	1.05

Table 8. Gene action parameters for the leaf rust reaction in the three crosses of bread wheat.

Cross Name	m	d	h	l	i	Heritability %	
						Broad sense	Narrow sense
Giza 163 x Giza 168	0.34*	0.03*	-1.43*	2.42*	1.40*	90.9	43.4
Giza 163 x Sids 6	20.74*	-8.95*	9.40*	1.68	-25.17	99.8	77.6
Giza 168 x Sids 6	13.40*	-4.11*	6.42*	-	-3.08	97.1	51.9

m = Mean effects, d= additive effects, h= dominance effects

Heritability values in broad and narrow sense, for the infection type with leaf rust are given in Table (8). The broad sense estimates were 90.9, 99.8, and 97.1% while in narrow sense the estimates were 43.4, 77.55, 51.90% in the three crosses, respectively. These values, being high in broad sense and medium to low in narrow sense, indicate that wheat resistance to leaf rust is a simple inherited character and that selecting resistant plants could be successively practiced in the early generations but would be more fruitful if selection practiced in the advanced ones. These results are in accordance with those obtained by Shehab EL-Din *et al* (1991), Shehab EL-Din and Abdel-Latief (1996), , Abdel- Latif and Boulot (2000) and Mahgoub, (2001).

Stem rust reaction

The population means and variances for the reaction of the five populations (P_1, P_2, F_1, F_2, and F_3) of the same three wheat crosses, to inoculation with the uredeniospores of *P. g. tritici* the causal agent of stem rust, at the adult stage under field conditions are shown in Table (9). Moreover, Table (10) presents the estimates of different types of gene action for the three crosses.

The estimated mean effect of F_2 (m), for stem rust reaction was significant. The different types of gene effects indicated that d effects of the three crosses was the most important..

Heritability values in broad and narrow senses, for the stem rust reaction type character, are given in Table (10). The broad sense estimate were 99.1, 81.9, and 95.8% while in narrow sense estimates were 34.4, 77.6, 55.9% in the three crosses, respectively. These values being high in broad sense and high to low in narrow sense indicate that wheat resistance to stem rust is an inherited character and that selecting resistant plants could be successively practiced in the early generations but would be more effective if selection is practiced in the advanced ones. These results are in accordance with those obtained by Shehab EL-Din *et al* (1991), Shehab EL-Din and Abdel-Latief (1996), Abdel- latif and Boulot (2000)and Mahgoub, (2001).

In conclusion, the presence of additive effects would suggest the potentiality for obtaining plants having high yielding ability and resistance to the three studied rusts if selection of such characters took place in the studied materials.

Table 9. Means (X) and variances (S^2) for the reactions of the five populations (P_1, P_2, F_1, F_2 and F_3 families) of the three bread wheat crosses to the stem rust.

Cross name	Parameters	P_1	P_2	F_1	F_2	F_3
Giza 163 x Giza 168	$\overline{X}$	0.25	0.34	0.52	1.39	1.73
	S^2	0.001	0.001	0.22	0.73	2.56
Giza 163 x Sids 6	$\overline{X}$	0.33	13.37	6.54	8.53	5.65
	S^2	0.001	0.22	4.65	0.56	2.77
Giza 168 x Sids 6	$\overline{X}$	0.25	17.73	4.16	11.96	10.80
	S^2	0.001	6.41	4.64	7.40	5.88

Table 10. Gene action parameters for all characters in the three crosses of bread wheat to the stem rust reactions.

Cross Name	m	d	h	l	i	Heritability%	
						Broad sense	Narrow sense
Giza 163 x Giza 168	1.39*	-0.04*	-1.49	-0.52	-1.80	99.1	43.4
Giza 163 x Sids 6	8.53*	-6.52*	6.34	-20.59	-6.39	81.9	77.6
Giza 168 x Sids 6	11.96*	-8.74*	-2.10*	-26.95	-14.77	95.8	51.9

m = Mean effects, d= additive effects, h= dominance effects

REFERENCES

Abd El-Aty, M.S.M. (2002). Heterosis, gene effect, heritability and genetic advance in two wheat crosses (*T. aestivum* L.). J. Agric. Sci. Mansoura Univ. 27 (8): 5121-5129.

Abdel- Latif, A.H. and O.A. Boulot (2000). Inheritance of wheat stem rust resistance adult stage under field conditions. J.Agric. Sci. Mansoura Univ. 25 (6): 3727-3733

Aglan, M.A.A. (2003). Breeding studies on wheat resistance to leaf and stem rusts and its association with yield and its components. M.Sc. Thesis, Minufiya Uni., Egypt.

Ashoush, H.A.; A.A.Hamada and I.H.Darwish (2001). Heterosis and combining ability in F_1 and F_2 diallel croses of wheat (*Triticum aestivum* L.) J.Agric. Sci. Mansoura Univ., 26(5): 2579-2592.

Awaad, H.A. (2002). Assessment of some genetic parameters using diallel cross fashion and their implications in breeding programs of bread wheat (*T. aestivum* L.) Zagazig J. Agric. Res. 29:1123-1141.

Chen, X.M. and R.F. Line (1992). Identification of stripe rust resistance genes in wheat genotypes used to differentiate North American races *of Puccinia striiformis*. Phytopathol. 82:1428-1434. Cited by Shehabel-Din *et al.* J. Agric. Sci. Mansoura Univ. 21 (10) : 3461-3467 (1996).

Dixit, P.K, P.D.Saxena and L.K. Bhatia (1970). Estimation of genotypic variability of some quantitative characters in groundnut. Indian J.Agric.Sci.40 : 197-201.

El-Daoudi, Y.H., Ikhlas S. Shenoda, Enayat, H. Ghanem, S.A. Abu El-Naga, R.A. Mitkees, Sherif, M.M. Khalifa and A.A. Bassiouni. (1996). Stripe rust occurrence in Egypt and assessment of grain yield loss in 1995. Proceeding du Symposium Regional Sur les Maladies des Cereals et des Legumneuses Alimentaries 11-14 Nov., Rabat, Maroc, pp 341-351.

El-Sayed,E.A.(2004). A diallel cross analysis for some quantitative characters in bread wheat (*Triticum aestivum* L.). Egypt J.Agric. Res. 82 (4) 1665 – 1679.

El-Seidy, E.H. and A.A.Hamada (1997). Genetical studies on some economic characters in some wheat crosses. Annals of Agric. Sci. Moshtoher 35(1):49-62.

Hammad, S.M. (2003). Traditional and molecular breeding of wheat in relation to rusts resistance. Ph.D. Thesis, Tanta Uni., Egypt.

Hayman, B.I. (1958). The separation of epistatic from additive and dominance variation in generation means. Heredity 12: 371-390.

Kheiralla, K.A.; M.A. EL-Morshidy and M.M. Zakeria (2001). Inheritance of earliness and yield in bread wheat under favourable and late sowing dates. 2nd pl. Breed. Conf., Fac. of Agric., Assuit Univ. Egypt.(2): 219-239.

Lush, J.L.(1949). Heritability of quantitative characters in farm animals weber. Agron. J. 44:202-209.

Mahgoub, S. Hayam (2001). Quantitative determination of the gene action of stripe, stem and leaf rust resistance in a- 6- parent diallel cross of wheat. J. Agric. Sci. Mansoura Univ. 26(1): 147-155.

Mahgoub, S. Hayam (2006). Genetic studies on grain yield and other agronomic traits in three crosses of bread wheat. Egypt.J.Agric.Res.(in the press)

Mather, K. (1949). Biometrical Genetics. Dover Publications Inc., London.

Mather, K. and J.L.Jinks (1980). Biometrical Genetics. 3rd Ed. Chapman and Hall, London.

Menshawy, A.M.M., (2000). Genetical studies on spring wheat. Ph.D. Thesis, Zagazig Univ., Egypt.

Moustafa, A.K.(2002). Diallel crosses analysis for yield and yield components in wheat. J.Agric. Sci. Mansoura Univ. 27(1):7621-7630.

Peter, F.C. and K.J.Frey (1966) Genotypic correlation, dominance and heritability of quantitative characters in oats. Crop Sci. 6:259-262.

Salem, A.H. and E.E.Hassan (1991). Estimate of some breeding parameters for yield and its attributes in wheat line x tester analysis. Zagazig J. Agric. Res., 18(5): 1357-1368.

Shehab EL-Din, T,M,(1993). Response of two spring wheat cultivars (*Triticum aestivum* L. Em Thell) to ten seeding rates in sandy soil. J.Agric. Sci.Mansoura Univ. 18:2235-2240.

Shehab EL-Din, T.M. and A.H. Abdel-Latif (1996). Quantitative determination of gene action of stripe rust resistance in a 6- parent diallel cross of wheat. J. Agric. Sci. Mansoura Univ. 21(10): 3461-3467.

Shehab El-Din, T.M.; M. A. Guad; S.A. Abouel- Naga, S.A. and M.M. El-Shami (1991) Quantitative study on wheat resistance to stem rust caused by *Puccinia graminis tritici*. J. Agric. Sci. Mansoura Univ., 16: 1298-1303.

Shehab EL-Din, T.M.; M.M. ELShami and A.H.Abd EL-Latif (1996). Qualitative and quantitive genetic studies on T*riticum aestivum*: *Puccinia recondita* interaction. J. Agric. Sci. Mansoura Univ., 21(10):3461-3467.

Singh, R.K. and B.D.Chaudhary (1985). Biometrical Methods in Quantitative Genetic Analysis. Kalyani Puplisher, New Delhi, Ludhiana,India.

Stubbs, R.W., J.M Prescott, E.E.Saari, and H.J.Dubin, (1986). Cereal disease methodology manual. CIMMYT, Mexico 9922.

Travet, Ian and R.C. Cassell (1951). The use of cyclone separation in race identification of cereal rusts. Phytopathol. 41:282-285.

توارث محصول الحبوب وبعض الصفات الأخرى فى ثلاث هجن من قمح الخبز

هيام سيد محجوب- سعيد حماد

البرنامج القومى لبحوث القمح – معهد بحوث المحاصيل الحقلية مركز البحوث الزراعية –

تـم عمل الثلاثة هجن الممكنة بين ثلاثة أصناف من قمح الخبز؛ جيزة ١٦٣- جيزة ١٦٨- سـدس ٦ فى موسم ٢٠٠٢/٢٠٠٣ بمزرعة محطة البحوث الزراعية بسخا لدراسة التباين الوراثى والفعـل الجينى ومعامل التوريث للمحصول ومكوناته بالاضافة الى مقاومة القمح لأمراض الأصداء الـثلاثة. وفـى المواسم التالية تم انتاج كميات كافية من بذور الجيل الأول، والثانى وعائلات الجيل الثالـث. وقـد اقيمت التجربة النهائية فى موسم ٢٠٠٥/٢٠٠٦م. حيث زرعت الآباء والجيا الأول والجـيل الثانى والجيل الثالث لكل هجين . فى تجربة بتصميم القطاعات الكاملة العشوائية (RCBD) فى ثلاث مكررات.

وقد أظهرت جميع الصفات المدروسة تبايناً وراثياً معنوياً فى الثلاثة هجن. وأوضحت النتائج تبكـير ميعاد النضج للهجن الثلاثة معنوياً عن الأب الأكثر تبكيراً مما يدل على أن قوة الهجين لهذه الصـفه فى هذه الهجن سالبة (مرغوبة). بينما أوضحت النتائج وجود قوة هجين معنوية موجبة لمعظم الصفات المدروسة الأخرى للهجن الثلاثة . كما أوضحت النتائج أن السيادة كانت سيادة فائقة تجاه الأب الأعلى لعدد السنابل / نبات فى الهجين الأول ولطول النبات ومحصول حبوب النبات فى الهجين الثالث. فـى حين كانت هناك سيادة فائقة تجاه الأب الأقل لصفة ميعاد النضج ووزن الحبوب فى الهجن الثلاثة ولطـول النبات فى الهجين الأول. وكذلك أوضحت النتائج وجود سيادة تامة بالنسبة للأب الأقل بالنسبة

لصــفة محصـــول الحبوب فى الهجين الأول. وأوضحت النتائج وجود سيادة جزئية بالنسبة للأب الأقل بالنســبة لصــفة عـــدد السنابل / نبات وعدد الحبوب للسنبلة فى الهجين الثانى والثالث على التوالى . وأكــدت النتائج أن تأثير التربية الداخلية فى F_2 كان موجباً ومعنوياً فى كل الصفات المدروسة ماعدا طول النبات فى الهجن الثلاثة وتاريخ النضج فى كل من الهجين الأول والثالث بينما أظهرت صفة وزن الحــبوب قيماً معنوية سالبة فى الهجين الأول. وأظهرت درجة التوريث بمعناها الواسع قيما عالية الى متوسطة بينما أظهرت درجة التوريث بمعناها الضيق قيماً متوسطة لجميع الصفات المدروسة فى الهجن الثلاثة.

وقــد أظهرت نتائج التحليل الكمى لصفات المقاومة للأصداء الثلاثة أن قيم المكافىء الوراثى بمعناه الواسع كانت عالية إلى متوسطة بينما بمعناه الضيق تراوحت ما بين متوسطة الى منخفضة مما يـــدل على أن صفة المقاومة للأصداء الثلاثة هى صفة عالية التوارث . لذا فإن إنتخاب نباتات مقاومة لأى مـــن الأصـــداء الـــثلاثة يمكن أن يتم بفاعلية فى الأجيال الانعزالية إضافة إلى الإنتخاب لمحصول الحبوب المرتفع.