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HETEROSIS AND TYPE OF GENE ACTION FOR YIELD, YIELD COMPONENTS AND RESISTANCE TO LEAF AND STEM RUSTS IN TEN BREAD WHEAT CROSSES

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ABSTRACT

Two models of analyses (Hayman's 1954 and Griffing's 1956 methods) were used to study the genetic behavior of grain yield and its components as well as leaf and stem rust resistance in a 5-parent diallel cross during 2002/2003, 2003/2004 growing seasons. Results proved the importance of additive gene effects for all studied characters and dominance effects for heading date, grain yield and stem rust reaction. The estimates of heritability in broad sense were high for all studied characters indicating that most phenotypic variations were due to genetic variance. Whereas, the values of heritability in narrow sense were intermediate to high indicating the importance of both additive and dominance gene action. Therefore, selection for these characters may be useful in early generation and could be more effect if postponed to later ones. Significant negative heterosis (favorable) to earlier parent was detected for heading date. The three crosses (P1 x P2), (P3 x P5)and (P4 x P5) as well as the two crosses (P2 x P3) and (P3 x P5) showed significant negative heterosis for heading and maturity dates, respectively. These results indicated that these crosses possessed desirable non-additive gene effects for earliness in heading and maturity. On the other, hand for plant height, (P1 x P5) and (P4 x P5) exhibited significant positive specific combining ability (SCA) and (P1 x P5) showed significant positive SCA effects for number of spikes / plant indicating that they had considerable non-additive gene effects. The two crosses (P3 x P4) and (P4 x P5) exhibited positive and significant SCA effects for kernel weight. Mean while, The crosses (P1 x P4), (P1 x P5), (P2 x P3) and (P4 x P5) could be considered as promising hybrids for improving grain yield . These results suggested that these crosses had non-additive gene action for increasing grain yield / plant and could also be used in the segregating generations for selecting new recombination of high grain yield/plant.

General and specific combining ability were also estimated for leaf and stem rust reactions. Giza 168, Gemmeiza 9 and Gemmeiza 7 were the best general combiners for leaf and stem rust resisntance, respectively. On the other hand, Sakha 93 followed by Sakha 61 were the poorest general combiners for leaf rust resistance and Sakha 61 was the poorest general combiner for stem rust resistance. SCA effects were significant and negative (favorable) for leaf rust reaction in five crosses (P1 x P2, P1 x P4, P1 x P5, P2 x P3 and P3 x P4). In addition two crosses (P1 x P2 and P1 x P3) showed negative and significant SCA effects for stem rust reaction. These results indicated the presence of dominance

and epistatic gene action in the inheritance of leaf and stem rust resistance character and confirmed that delaying selection of resistant plants to the later segregating generations would be more profitable.

Key words: **Wheat *Triticum aestivum*, Gene action, Heterosis, Grain yield, Leaf rust, Stem rust, Resistance**

INTRODUCTION

Developing new genotypes of high yield potentiality is the ultimate goal of most wheat (*Triticum aestivum* L) breeding programs all over the world. Hence, great efforts are made for producing high yielding cultivars. Genetic diversity among crossed parents enables the breeder to develop new promising lines. Crumpacker and Allard (1962) reported that efficiency in breeding of self- pollinated crops depends on accurate identification of hybrid combinations that have the potentiality of producing maximum yields and identifying useful genotypes in the segregating generations. Therefore, information about the genetic behavior of breeding materials could ensure high selection gains and more genetic improvement.

Assessment and quantifying the type of gene action in wheat were studied by many investigators. Additive genetic variance was the prevalent type controlling days to heading, plant height and spike length (EL-Seidy and Hamada 1997 and Mosaad *et al* 1990). Meanwhile, wheat grain yield and its components were controlled by both additive and non additive gene effects as indicated by Elhosary *et al* (2000) and Moustafa (2002). On the other hand, Salem and Hassan (1991) revealed that non additive gene effects were more important for grain yield/plant and number of spikes/plant. Similarly, Abul-Naas *et al* (1991) and Al Kaddoussi *et al* (1994) reported that, dominance component played an important role in the genetic control of number of spikes/plant, number of kernels / spike, kernel weight and grain yield/plant.

Diallel analysis offers estimates for the relative magnitude of general (GCA) and specific (SCA) combining ability. Same investigators revealed that GCA was more important than SCA for number of spikes/plant (Al-Kaddoussi and Hassan 1991 and Eissa 1993). Meanwhile, other researchers found that additive (GCA) and non– additive (SCA) genes effects were detected for number of kernels/spike, kernel weight, number of spikes/plant and grain yield (Saadalla and Hamada 1994). On the other side, mean squares associated with GCA and SCA were significant for heading and maturity dates, plant height, number of spikes/plant, number of kernels/spike, 100 kernel weight and grain yield/plant (Shehab El-Din and Abd El- Latif 1996, El-Beially and El-Sayed 2002, Mostafa 2002, Hamada

2003, EL-Sayed 2004, Abd El- Mjeed *et al* 2004, El-Sayed and Moshref 2005 and Moshref 2006). In addition, the ratios of GCA / SCA were more than unity in yield and yield components indicating that additive gene effects were more important than dominance in the expression of these characters.

Heritability estimates in broad and narrow senses are useful tools 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. However, many investigators (Shehab El-Din 1993, Ashoush *et al* 2001, Hamada, 2002, El- Sayed and Moshref 2005, Moshref 2006 and Mahgoub 2006) reported that heritability estimates for plant height, heading date and yield components were medium to high.

Understanding the genetic behavior of wheat resistance to rusts are essential for deciding the breeding method that maximizes the genetic improvement of this trait (Shehab El-Din *et al* 1991a). Wheat resistance to rusts has been documented to be simply inherited character governed by one, two or a few number of major gene pairs (Singh and Mcintosh 1984, Millus and Line 1986, and Abd Latif and Boulot2000). Moreover, additive gene action was more predominant in others (Shehab El-Din *et al* 1991b, Shehab El-Din and Abdel-Latif 1996 and Mahgoub 2001)

The present research aimed at studying the nature of gene action and heritability in a five-parental diallel cross system of bread wheat for grain yield, other agronomic traits, and rust resistance.

MATERIALS AND METHODS

The fieldwork of this study was conducted at Sakha Agricultural Research Station, Agricultural Research Center (ARC), Egypt. during the two successive seasons 2002/2003 and 2003/2004. Five different bread wheat cultivars representing a wide range of genetic diversity were selected for this study. The name and pedigree of these cultivars are presented in Table (1).

In 2002/2003 wheat growing season, all possible crosses among the five selected parents (except reciprocals) were made to produce the hybrid seeds of ten crosses.

Table 1. Name and pedigree of the five bread wheat cultivars used in this study as parents.

Parent	Name	Pedigree
1	Sakha 61	Inia / RI 4220//7c / Yr "S" CM15430-2S-5S-0S-0S
2	Giza 168	MRL/BUC//Seri CM93046-8M-oY-oB
3	Sakha 93	Sakha 92 / TR810328 S 8871-1S-2S-1S-0S
4	Gemmeiza 7	CMH 74A. 630/SX//SERI 82/AGENT CGM 4611-2GM-3GM-1GM-OGM
5	Gemmeiza 9	Ald "S" / Huac // Cmh 74A. 30 / Sx CGM 4583-5GM-1GM-0GM

In the second season, (2003/2004) the 15 genotypes (10 F_1's and 5 parents) were planted in the field using the randomized complete block design with four replications according to Steel and Torrie (1980). Each entry was planted in a plot of three rows; 4.2m long and 30 cm apart. Every row contained 22 seed hills spacing 20cm. The experiment was surrounded by 2m width spreader grown with a mixture of highly susceptible wheat genotypes to leaf, and stem rusts i.e. Giza 139, Giza 144, Giza 163, Sakha 92, Sids 7,*Triticum spelta*, and Baart. The spreader was subjected to an artificial inoculation with the uredenispores of the two pathogens causing leaf and stem rusts mixed with talcum powder at a rate of 1:20. The artificial inoculation took place in the third week of February for both leaf and stem rusts. The recommended cultural practices were implemented to the evaluation experiment.

The infection types were recorded on 10 plants located in the middle row of each plot according to the scale of Chen and Line (1992). For the quantitative analysis, field reaction was converted into an average coefficient of infection (ACI) according to the method 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, 0.025, 0.05, 0.20, 0.4, 0.6, 0.8 and 1 for 0, 0; R, MR, M, MS, and S infection types, respectively.

plant height (cm), number of days to heading, number of days to physiological maturity, number of spikes / plant, number of kernels/ spike, kernel weight(g), and grain yield / plant (g). were recorded on 10 individual guarded plants chosen at random from each plot.

To estimate the general and specific combining ability, Griffing's (1956) diallel cross analysis Method 2 Model 1 was used. Heterosis effect was computed as percentage increase of the F_1 over the better parent according to Wynne *et al* (1970). The genetic analyses were carried` out by procedures described by Hayman (1954).

RESULTS AND DISCUSSION

The analysis of variance and regression coefficient obtained from the 15 entries (10 F_1's + 5 parents) for heading and maturity dates, plant height, number of spikes / plant, number of kernels / spike, kernel weight and grain yield/plant as well as the reaction of leaf and stem rusts are presented in Table (2). Significant differences among the genotypes for all studied characters were detected. These data indicated the existence of considerable amount of variability among the tested parents and their hybrids, which increases the chance of selecting new promising genotypes in the segregating generations. In addition, the major assumptions postulated for diallel analysis by Hayman (1954), were found to be valid since the t value was insignificant. Moreover, testing the hypothesis through regression was not significantly different from unity, comforting the validity of these assumptions. Furthermore, the significant deviation of b- value from zero revealed the absence of non allelic interactions for all studied characters.

Table.2. The t^2 value, regression coefficient (b) and their test of significance for five bread wheat cultivars and their 10 diallel crosses.

Character	t^2	b	SE (b)	H0: b=0	H0: b=1
No. days to heading	1.2^{--}	0.92	0.06	16.10^{**}	1.33^{--}
No. days to maturity	1.02^{--}	0.88	0.10	9.09^{**}	1.23^{--}
Plant height	0.46^{--}	0.83	0.20	4.16^{*}	0.83^{--}
No. spikes/plant	0.95^{--}	0.84	0.10	11.87^{**}	2.55^{--}
No. kernels/spike	2.22^{--}	0.82	0.12	10.16^{**}	1.9^{--}
100 kernels weight	0.99^{--}	0.77	0.16	4.70^{*}	1.39^{--}
Grain yield	0.45^{--}	0.92	0.12	8.00^{**}	0.65^{--}
Leaf rust reaction	1.30^{--}	0.76	0.14	5.40^{*}	1.72^{--}
Stem rust reaction	0.07^{--}	0.90	0.22	4.04^{*}	0.43^{--}

--, *, ** indicate non-significant and significant at 5% and 1% levels of probability, respectively.

Table (3) shows the estimated variances of genetic components. Highly significant additive gene effects (D) were detected for all studied characters. Significant values of the environmental variance (E) were found only for heading and maturity dates, plant height and number of spikes / plant indicating that these characters were affected by environmental factors. Meanwhile, (H) value was significant and hence, reflecting the important role of dominance gene action for all studied characters in the inheritance of

Table.3. Components of variation and standard error (SE) for the yield and yield components and reactions to the leaf and stem rust of bread wheat genotypes.

Character	SOV	Components of genetic variation					E
		D	F	H1	H2	h^2	
No. days to heading	MS	19.83**	2.44**	5.46**	5.39**	2.75**	0.33*
	SE	0.31	0.78	0.85	0.77	0.52	
No. days to maturity	MS	13.81**	-5.19**	2.62*	2.15*	0.05--	0.44*
	SE	0.43	1.08	1.17	1.06	0.72	
Plant height	MS	48.31**	-29.2**	50.47**	34.97**	8.28--	3.06*
	SE	5.47	13.68	14.78	13.41	9.05	
No Spikes/plant	MS	4.58**	0.89--	6.20**	6.04**	0.47--	0.40*
	SE	0.40	1	1.08	0.98	0.66	
No kernels/spike	MS	27.31**	1.00--	27.12**	26.65**	5.72--	0.96--
	SE	1.97	4.92	5.32	4.83	3.26	0.80
100 kernels weight	MS	0.40**	0.25--	0.77*	0.74**	0.65**	6.02--
	SE	0.11	0.28	0.31	0.28	0.19	
Grain yield	MS	36.70**	9.76**	20.18**	18.21**	31.80**	0.44--
	SE	1.40	3.50	3.78	3.43	2.31	
Leaf rust reaction	MS	367.03**	-64.66--	178.8*	168.79*	1.16--	0.66--
	SE	34.16	85.32	92.25	83.67	56.49	
Stem rust reaction	MS	37.39**	28.42**	30.44**	23.53*	0.24--	3.08--
	SE	4.34	10.83	11.72	10.62	7.17	

--, *, ** indicate non-significant and significant at 5% and 1% levels of probability, respectively.

wheat. Moreover, the significant positive estimates of F value indicate the excess of dominant alleles for heading dates, grain yield and stem rust reaction. The measurement of the dominance variance over all heterozygous loci (H2) for all studied characters was positive and highly significant but smaller than H1. This proved that dominant genes were due to heterozygosity and dominance seemed to be acting in the positive direction.

As shown in Table (4), the estimated mean degree of dominance $(H1/D)^{1/2}$ which is the weighed measure of the average degree of dominance at each locus, was less than unity, for heading and maturity dates, grain yield, and leaf and stem rust reactions indicating the presence of partial dominance. Meanwhile, it equals almost unity for plant height and number of kernels / spike suggesting the presence of complete dominance. On the other hand, it was more than unity for number of spikes / plant and kernel weight revealed the presence of overdominance. The proportion of (H2/4H1) value was less than 0.25, indicating unequal distribution of positive and negative alleles among the parents. The value of (Dom./Rec.) being more than one for heading dates, number of spikes / plant, number of kernels/ spike, kernel weight, grain yield, and stem rust reaction revealing excess of dominant alleles in the parents. Number of effective factors, $(h^2/H2)$ which control the studied character were governed by at least one gene (or one group of genes).

Table 4. Estimates of genetic components and various ratios for the studied characters in a five parents half diallel crosses of bread wheat.

Character	$(H1/D)^{½}$	H2/4H1	Dom/Rec	$h^2/H2$	h^2_{bs}	h^2_{ns}
No. days to heading	0.52	0.24	1.27	0.51	0.97	0.84
No. days to maturity	0.44	0.21	0.40	0.02	0.95	0.91
Plant height	1.02	0.14	0.54	0.24	0.95	0.80
No. spikes/plant	1.16	0.25	1.18	0.07	0.90	0.50
No. kernels/spike	1.00	0.25	1.03	0.21	0.95	0.64
100 kernels weight	1.39	0.24	1.6	0.87	0.90	0.58
Grain yield	0.74	0.22	1.44	1.75	0.98	0.74
Leaf rust reaction	0.70	0.24	0.78	0.01	0.99	0.83
Stem rust reaction	0.90	0.19	2.43	0.01	0.82	0.47

Moreover, the estimates of heritability in broad sense (h^2_{bs}) were high for all studied characters indicating that most of phenotypic variation, was due to genetic variance. Whereas, the values of heritability in narrow sense (h^2_{ns}) were high to intermediate indicating the more importance of additive than dominance gene action. Therefore, selection for these characters may be useful in the early generation but would be more effective if postponed to later ones. These results are in accordance with those obtained by Shehab EL-Din *et al* (1991a), and Shehab EL-Din and Abdel-Latif (1996), Mostafa(2002) and Abo Elela (2006).

Combining ability effects

The analysis of variance and mean squares according to Griffing's model for all studied characters are presented in Table (5). Mean squares due to genotypes were highly significant for all studied characters, indicating the presence of wide genetic diversity among these materials. This diversity reflects good possibilities to improve these characters. Mean squares due to parents vs crosses were significant for all studied characters except for maturity dates and number of spikes / plant indicating the heterosis of F_1 hybrids. The estimates of GCA and SCA were significant for all studied characters except for those of SCA of maturity date. This indicated that both GCA and SCA were important in the expression of these characters. The ratio of GCA / SCA was more than unity in all studied characters indicating that additive and additive x additive gene actions were more important than dominance in the expression of the studied characters. These results are in harmony with those obtained by Abd El- Magied *et al* (2004), Mostafa (2002) and Moshref (2006).

Table 5. Mean squares and combining ability analysis for the studied characters in five- parents half diallel crosses of bread wheat.

SOV	df	Heading date	Maturity date	Plant height	No. spikes /plant	No. kernels /spike	100 kernels weight	Grain yield/ plant	Leaf rust reaction	Stem rust reaction
Genotypes	14	31.42**	28.80**	146.13**	10.17*	37.60**	1.49**	55.83**	722.42**	51.83**
Parents P	4	60.50**	42.73**	154.10**	14.93**	69.39**	1.38**	84.59**	1103.05**	121.40**
Crosses C	10	18.67**	23.12**	138.95**	7.98	22.41**	1.27**	25.48**	569.55**	23.14*
P vs C	1	11.17**	1.11	40.00**	2.83	24.76**	2.69**	188.36**	6.19**	8.64
Error	28	2.16	1.21	9.65	4.09	8.85	0.19	4.36	1.96	9.20
GCA	4	96.98**	377.09**	411.85**	22.08**	103.92**	3.27**	115.75**	2197.70**	115.49**
SCA	10	5.19**	26.16	39.85**	5.41*	11.07*	0.78**	31.85**	132.30**	26.36**
GCA/SCA		18.66	35.96	10.34	4.09	9.40	4.18	3.63	16.61	4.38

--, *, ** indicate non-significant and significant at 5% and 1% levels of probability, respectively.

The heterosis values for yield and its component as well as heading and maturity dates are presented in Table (6).

Table 6. Heterosis estimates (%) relative to the better parent for the studied characters in five-parents half diallel cross of bread wheat

Parent	Heading date	Maturity date	Plant height	No. spikes /plant	No. kernels /spike	100 kernels weight	Grain yield/ plant
P1 x P2	-0.18	0.69	5.17**	1.99	-3.11	6.01**	-7.05
P1 x P3	-0.14	0.23	0.35	-13.71**	1.07	3.49**	-3.93
P1 x P4	3.36**	1.39*	6.90**	0.43	-7.28**	-13.08	20.66**
P1 x P5	5.08**	3.70**	19.31**	16.46**	0.96	5.01**	-1.15
P2 x P3	1.07	0.68	1.05	4.31**	1.72	20.52**	3.02*
P2 x P4	0.00	0.90	-4.84**	· 7.97**	-3.29	-8.97	-1.46
P2x P5	2.17*	2.70**	6.45**	-6.37**	-3.33	4.32**	-0.77
P3x P4	2.28**	0.92	7.27**	-0.97	-9.77**	9.23**	10.62**
P3 x P5	2.89**	1.60*	12.46**	-16.45**	3.77*	1.13**	-0.02
P4 x P5	-0.66	2.00**	10.41**	-8.02**	-0.80	5.89**	3.73**

--, *, ** indicate non-significant and significant at 5% and 1% levels of probability, respectively.

Significant positive heterotic effects relative to the better parent were found for several characters under investigation. Meanwhile, for heading and maturity dates and plant height negative values are desired from the breeder's point of view. Only cross (P_2xP_4) showed highly significant heterosis toward shortness. It is clear from the tabulated data that (P_2 x P_3) seems to be a promising cross for grain yield, number of spikes / plant, and kernel weight comparing to the better parent. Meanwhile, the two crosses (P_3 x P_4 and P_4 x P_5) were promising for grain yield and kernel weight while, cross (P_1 x P_4) gave positive heterosis for grain yield only. On the other hand, three, one, eight and four crosses had significant heterosis values relative to the better parent for number of spikes per plant, number of kernels per spike kernel weight and grain yield, respectively, such useful heterosis in wheat was also recorded by El-Beially and El-Sayed (2002), Mostafa (2002), El-Sayed and Moshref (2005) and Moshref (2006).

The GCA effects for the studied characters are presented in Table (7). For heading and maturity dates, Sakha 61 (p1) and Sakha 93 (p3) showed negative and highly significant GCA effect. So, these parents could be considered as good general combiners for earliness in heading and maturity. With respect to plant height, Gemmeiza 9 (p5) had significant positive GCA effect while Sakha 61 (p1), Giza 168 (p2) and Sakha 93 (p3) had significant negative ones, suggesting that these parents were good general combiners to increase and decrease plant height, respectively of their crosses. For number of kernels per spikes Gemmeiza 7 (p4) had

Table 7. Estimates of general combining ability effects for the studied characters in five- parents half diallel crosses of bread wheat.

Parent		Heading date	Maturity date	Plant height	No. spikes /plant	No. kernels /spike	100 kernels weight	Grain yield/ plant	Leaf rust reaction	Stem rust reaction
P1		-2.531	-2.057	-2.352	-0.423	-2.480	-0.200	-3.186	4.77	3.97
P2		0.685	-0.010	-1.784	-0.035	0.104	-0.157	0.283	-8.220	-2.179
P3		-1.77	-1.867	-4.019	1.770	-0.678	0.314	-0.056	15.851	-0.609
P4		0.826	0.848	0.886	-0.532	3.590	-0.456	0.449	-6.477	-0.132
P5		2.79	3.086	7.267	-0.780	-0.536	0.501	3.408	-5.923	-1.050
L.S.D5 %	g_{ij}	0.59	0.44	1.24	2.56	1.19	0.17	0.83	0.56	1.21
	$g_i - g_j$	0.93	0.69	1.96	1.28	1.88	0.27	1.32	0.89	1.92

both Sakha 93 (p3) and Gemmeiza 9 (p5) showed significant positive GCA effects for kernel weight. In addition Gemmeiza 9 (p5) exhibited significant positive GCA effect for grain yield per plant.

Data presented in Table (7) indicated that Giza 168 (p2), Gemmeiza 9 (p5) and Gemmeiza 7 (p4) were in descending order, the best general combiners for leaf and stem rust resistance. On the other side, Sakha 93 (p3) followed by Sakha 61 (p1) were the poorest general combiners for leaf rust resistance. Meanwhile, for the stem rust resistance Sakha 61 (p1) was the poorest general combiner.

The estimates of SCA effects presented in Table (8) revealed that the three crosses (P1 x P2), (P3 x P5)and (P4 x P5) as well as the two crosses (P2 x P3) and (P3 x P5) exhibited significant negative SCA effects for heading and maturity dates, respectively. These results indicated that these crosses possessed a desirable non-additive gene effects for earliness in heading and maturity. On the other hand, for plant height (P1 x P5) and (P4 x P5) showed significant positive and (P1 x P5) showed significant positive SCA effects for number of spikes / plants, indicating that they had considerable non-additive gene effects for inheritance of these traits. The two crosses (P3 x P4) and (P4 x P5) had positive and significant SCA effects for kernel weight. Mean while, the crosses (P1 x P4), (P1 x P5), (P2 x P3) and (P4 x P5) that showed significant positive SCA effects for grain yield are considered to be promising hybrids for improving this trait . These results suggested that these crosses had non-additive gene action for increasing grain yield / plant and selection could be practiced in the segregating generations to obtained new pure lines of high grain yield/plant. Similar results were obtained by El-Beially and El-Sayed (2002), Mostafa (2002), El-Sayed and Moshref (2005) and Moshref (2006).

Table 8. Estimates of specific combining ability effects for the studied characters in a five parents half diallel crosses of bread wheat.

Parent		Heading date	Maturity date	Plant height	No. spikes /plant	No. kernels /spike	100 kernels weight	Grain yield/ plant	Leaf rust reaction	Stem rust reaction
P1 x P2		-2.563	-0.778	1.333	0.37	0.187	0.120	-0.133	-2.846	-3.944
P1 x P3		-0.075	0.413	-1.429	-0.668	1.502	0.236	-0.618	13.750	3.463
P1 x P4		0.663	-0.635	0.333	-0.599	0.567	-0.461	5.246	-4.823	-4.014
P1 x P5		0.333	0.460	5.952	2.448	0.936	0.405	3.119	-3.143	-3.006
P2 x P3		0.659	-1.302	-1.000	-0.473	2.117	0.206	2.54	-12.524	0.331
P2 x P4		0.347	0.651	-5.238	1.479	0.650	-0.280	-0.640	4.604	-0.951
P2 x P5		0.583	1.079	0.048	-0.673	-1.892	0.326	-0.183	2.017	2.186
P3 x P4		0.002	-0.159	2.000	2.075	-2.902	0.782	2.129	-1.671	0.798
P3 x P5		-1.379	-1.397	0.619	-0.878	1.124	-0.315	0.485	1.775	-0.834
P4 x P5		-2.091	0.556	4.048	-1.309	2.956	0.708	2.522	0.237	2.872
L.S.D5%	S_{ij}	1.52	1.13	3.21	2.09	3.07	0.44	2.15	1.45	3.13
	$S_{ij}-S_{ik}$	2.27	1.70	4.81	3.13	4.60	0.67	3.23	2.17	4.70
	$S_{ij}-S_{kl}$	2.08	1.55	4.39	2.86	4.20	0.61	2.95	1.98	4.29

The estimates of SCA effects for the leaf and stem rust reactions in the ten crosses were presented in Table (8). The results revealed that SCA effects were significant and negative for leaf rust reaction in five crosses (P1 x P2, P1 x P4, P1 x P5, P2 x P3 and P3 x P4). In addition out of ten crosses two crosses (P1 x P2 and P1 x P3) showed negative and significant SCA effects for stem rust reactions. These results suggested the presence of dominance and epistatic gene action in the inheritance of such resistance characters and confirmed that delaying selection of resistant plants to later segregation generations would be more profitable. Similar results were obtained by Shehab EL-Din *et al* (1991a), Shehab EL-Din and Abdel-Latif (1996) and Mahgoub (2001).

In conclusion, the cultivars (Sakha 61 and Sakha 93) are good combiners for earliness in heading and maturity. Gemmeiza 7 is a good cimbiner for number of kernels per spike. Further more, both Sakha 93 and Gemmeiza 9 are a good combiner for kernel weight. In addition Gemmeiza 9 exhibited significant positive GCA effect for grain yield.

Meanwhile, Giza 168, Gemmeiza 9 and Gemmeiza 7 are considered as best combiners for leaf and stem rust resistance. On the other side, Sakha 93 followed by Sakha 61 were the poorest general combiners for leaf rust resistance. Meanwhile, for both leaf and stem rust resistance Sakha 61 was the poorest general combiner.

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قوة الهجين ونوع الفعل الجينى للمحصول ومكوناته والمقاومة لصدأ الأوراق وصدأ الساق فى عشرة هجن من قمح الخبز

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

استخدم نموذجين للتحليل الإحصائى الوراثى (Hayman, 1954; & Griffing, 1956) لدراسة السلوك الوراثى لصفات المحصول ومكوناته والمقاومة لصدأ الأوراق ولصدأ الساق . وقد أجريت لذلك الهجن الممكنة بين الخمسة أباء التالية من القمح (سخا ٦١، جيزة ١٦٨، سخا ٩٦، جميزة ٧، جميزة ٩) فى محطة بحوث سخا خلال موسمى ٢٠٠٢/ ٢٠٠٣و ٢٠٠٣/٢٠٠٤. أوضحت النتائج أهمية كل من تأثير الفعل المضيف والسيادة فى وراثة كل الصفات المدروسة. وقد أظهرت النتائج أهمية تأثير فعل الجين من النوع المضيف لجميع الصفات المدروسة. وقد أظهرت النتائج تأثير فعل السيادة لصفات طرد السنابل والمحصول ومقاومة صدأ الساق. كما أكدت كفاءة التوريث بمعناها الواسع قيماً عالية لجميع الصفات المدروسة بينما أظهرت كفاءة التوريث بمعناها الضيق قيماً عالية الى متوسطة ولذا فإن الانتخاب لهذه الصفات يمكن أن يتم بفاعلية أكبر فى الأجيال الانعزالية المبكرة للهجن.

وقد أظهرت النتائج وجود قوة هجين للتبكير فى ميعاد طرد السنابل فى ثلاث هجن وهى (P1 x P2, P3 x P5, P4 x P5) وكذلك كانت للتبكير فى ميعاد النضج للهجينين (P2 x P3, P3 x P5) حيث أظهرت هذه الهجن قوة هجين معنوية للتبكير. بينما أكدت النتائج تفوق الهجينين (P1 x P5, P4 x P5) فى طول النبات والهجين (P1 x P5) فى عدد السنابل / نبات . وبالنسبة لقوة الهجين فى وزن الحبوب تفوق الهجينين (P3 x P4, P4 x P5) كما أكدت النتائج ووجود أربعة هجن مبشرة للمحصول وهى (P1 x P4, P1 x P5, P2 x P3, P4 x P5) أظهرت تفوقها فى محصول الحبوب بالمقارنة بالأب الأعلى مما يدل على أهمية اجراء الانتخاب فى الأجيال الانعزالية لهذه الهجن لعزل سلالات نقية عالية المحصول.

وبصفة عامة فقد أظهر الأصناف جيزة ١٦٨ و جميزة ٧ وجميزة ٩ قدرة تالف هجينية معنوية لمقاومة صدأ الساق بينما أظهرت خمس هجن تفوق فى القدرة الخاصة على الائتلاف بالنسبة لمقاومة صدا الأوراق (P1 x P2, P1 x P4, P1 x P5, P2 x P3 P3 x P4) وهجينين بالنسبة لمقاومة صدأ الساق (P1 x P2, P1 x P3).

لذلك يمكن من الدراسة التوصية بإستخدام الصنفين سخا ٦١ وسخا ٩٣ كاباء للتبكير فى ميعاد طرد السنابل والنضج والصنف جميزة ٧ بالنسبة لصفة عدد حبوب السنبلة بينما يمكن استخدام الصنفين سخا سخا ٩٣ وجميزة ٩ لصفة وزن الحبوب. بالاضافة الى تفوق الصنف جميزة ٩ كأب بالنسبة لصفة محصول الحبوب. كذلك يمكن من الدراسة التوصية بإستخدام الأصناف جيزة ١٦٨، جميزة ٩ وجميزة ٧ كآباء لصدأ الأوراق بينما أظهر الصنف سخا ٦١ شدة حساسية للإصابة بصدأ الأوراق والساق .

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