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GENETIC STUDIES ON STRIPE AND LEAF RUSTS OF BREAD WHEAT UNDER DIFFERENT SOWING DATES

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ABSTRACT

The present experiment was conducted at Sakha Agric. Res. Stn. during 2007/2008 and 2008/2009 wheat growing seasons to estimate the combining ability, type of gene action, heterosis and simple correlation coefficient for some agronomic characters and reaction to wheat stripe and leaf rusts using a diallel cross mating design of eight wheat parental genotypes. These genotypes are P_1- Attila-3, P_2- Gemmiza 9, P_3- Line 1, P_4- Sids 1, P_5- Sakha 94, P_6- Sakha 69, P_7- Sids 12 and P_8- Sakha 93. Days to heading, days to physiological maturity, plant height, number of spikes / plant, number of kernels / spike, weight of kernels / spike, kernel weight, grain yield / plant and reaction to rust were estimated. Significant mean squares were obtained for genotypes, parents, crosses and parents vs. crosses in all studied characters except for days to heading and number of spikes / plant for parents vs. crosses. The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were significant for all studied characters, indicating the presence of both additive and dominance types of gene effects. The ratio of GCA/ SCA was more than unity in all studied characters except for kernel weight, indicating the importance role of additive genetic effects. The crosses $P_3 \times P_4$ and $P_3 \times P_6$ gave the most positive significant heterosis values for grain yield / plant relative to mid and better parents, respectively. Moreover, the cross $P_1 \times P_7$ gave the most negative significant heterosis values for leaf rust resistance relative to mid and better parents. The correlation coefficient between grain yield / plant with each of number of kernels / spike, kernel weight / spike and kernel weight were significantly positive. Meanwhile, the correlation coefficients between leaf rust with each of number of kernels / spike and kernel weight / spike were significantly negative.

INTRODUCTION

Wheat (*Triticum aestivum L.*) is the most strategic cereal crop in Egypt. It is the most important source of stable food grain for urban and rural societies used in human nutrition and as a major source of straw fodder for animal feeding. National wheat production in Egypt, is insufficient to meet local consumption. The domestic wheat production was about eight million tons produced from three million Faddans. However, increased production per area unit appears to be the only possible mean of reducing the wheat gap. The required yield increase may be achieved by developing high-yielding cultivars and simultaneously implementing improved cultural practices. Such improved cultivars must be resistant to serious diseases such as wheat rusts, tolerant to the unfavorable environments and stable in a broad spectrum of environments.

Combining ability studies are usually used by wheat breeders to evaluate newly developed genotypes to be used as parents and to assess the gene action involved in various characters. However, the combining ability studies in a specific environment may not lead to precise information because environmental effects play an important role and greatly affect the combining ability values. As a matter of fact, information on combining ability analysis of wheat under varying environmental conditions is scanty. So, it is necessary to assess combining ability components of variance and combining ability x environment interaction for grain yield and its components as well as rust resistance to ensure better production and gain under selection. However, the present study deals with such endeavors to help wheat breeders in their identification of parents and selection strategies.

Stripe and leaf rusts caused by *Puccinia striiformis* and *Puccinia recondita*, respectively, are globally important wheat fungal diseases that cause significant grain yield losses. The use of resistance wheat cultivars is the most economic and environmentally safe way to reduce crop losses from rust diseases. However, understanding the genetic behavior of wheat resistance to these diseases are essential for deciding the breeding method that maximizes the genetic improvement of these characters (Shehab El-Din *et al.,* 1991). Wheat resistance to rusts has been documented to be a simple inherited character governed by one, two or a few number of major gene pairs (Dyck 1991and Bai *et al*., 1997). Also, several investigators indicated that resistance is a quantitative character controlled by many genes as well as the prevailing environmental conditions, (Shehab El-Din *et al*., 1991; Yadav *et al*., 1998 and Nawar *et al*.,2010). Furthermore, the resistance was dominant over susceptibility in most cases, (Shehab El-Din and Abd El-Latif., 1996 ; Bai *et al*., 1997 and Patil *et al*., 2000), and vice versa was true in others, (Singh *et al*., 1998 and Ganeva *et al*., 2001).On the other hand, some cases best fit a simple additive genetic model with no dominance or epistatic interactions, while dominance and / or epistasis were more pronounced and had important roles, (Shehab El-Din *et al*., l996; Singh *et al*., 1998; Zhang *et al*., 2001; Awaad *et al*., 2003 and Nawar *et al*.,2010).

The objectives of this research were to study the inheritance of wheat grain yield and some agronomic traits as well as the genetic behavior of stripe and leaf rusts resistance in two different sowing dates.

MATERIALS AND METHODS

This investigation was carried out at Sakha Agricultural Research Station during the two seasons, 2007/2008 and 2008/2009 using eight bread wheat (*Triticum aestivum L.*) genotypes, representing a wide range of diversity for several agronomic characters. The name and pedigree of these parental genotypes are presented in Table 1.

All possible parental combinations without reciprocals were made among the eight genotypes, giving twenty eight crosses. The parental genotypes and F_1 hybrids were planted in the two sowing dates. In each experiment, the genotypes were grown in a random complete block design with three replicates. Each genotype was grown in a single row , 2m long and 30cm apart. The experiment was surrounded by mixed wheat cultivars highly susceptible to strip and leaf rust as a spreader to help in spores decimation of the artificial and/or natural inoculations .

Measurements comprised: days to heading (DH), days to maturity (DM), plant height(PLH), number of spikes/plant(NS/P), number of kernels/spike (NK/S), weight of kernels / spike (WK/S), 100-kernel weight (100KW) and grain yield/plant(GY/P). For stripe and leaf rusts (LR) reactions, the formula of Stubbes *et al*. (1986) And adjusted by Shehab El-Din and Abd El-latif (1996) was used.

Table (1): Name, pedigree and leaf rust reaction for the parental genotypes.

Name	Pedigree	Stripe rust reaction	Leaf rust reaction
P1 (Attila-3)	ND/VG9144//KAL/BB/3/YACO/4/VEE#5	**R**	**MS**
P2 (Gemmiza 9)	Ald “S” / Huac // Cmh 74A. 630 / Sx CGM 4583-5GM-1GM-0GM	**R**	**R**
P3 (Line 1)	DVERD 2 / AE - SQUARROSA (214)// 2* BCN	**MS**	**MR**
P4 (Sids 1)	HD2172 / PAVON"S" // 1158.57 / MAYA74"S" SD 46-4SD-2SD-1SD-0SD	**R**	**S**
P5 (Sakha 94)	OPATA / RAYON // KAUZ CMBW90Y3180-0TOPM-3Y-010M-010M-010Y-10M-015Y-0Y-0AP-0S	**R**	**R**
P6 (Sakha 69)	Inia/RL4220//7C/Yr"S" CM15430-2S-6S-0S-0S	**S**	**S**
P7 (Sids 12)	BUC//7C/ALD/5/MAYA74/ON//1160.147/3/BB/GLL/4/CHAT"S"/6/MAYA/VUL//CMH74A.630/4*SX SD7096-4SD-1SD-1SD-0SD	**R**	**R**
P8 (Sakha 93)	Sakha 92/ TR 810328 S. 8871-1S-2S-1S-0S	**R**	**S**

R, resistance. MR, moderatly resistance. MS, moderatly and susceptable. S, susceptiple.

The data obtained for each character were analyzed on plot mean basis. An ordinary analysis of variance for each sowing date and combined analysis across the two sowing dates were performed according to Snedecor and Cochran (1980). The data were also analyzed using Griffing (1956) method 2 models 1 to estimate general combining ability (GCA) and specific combining ability (SCA) effect. The simple correlation coefficient (r) among all characters in each F_1 population were estimated according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Although Sakha Agricultural Research Station is a hot spot for stripe and leaf rusts, stripe rust disease was not observed in neither this experiment nor the whole wheat research program due to the non favorable environmental conditions during 2008/2009 wheat growing season. Thus, no reliable data of YR reaction were available and hence, this trait was canceled

Analysis of variance

The main square analysis for genotypes, parents, crosses and parents vs crosses indicated that difference among genotypes, parents, crosses and parents vs crosses were significant in all the studied characters except for days to heading and number of spikes / plant for parents vs. crosses. These results indicated that there were significant differences among parents, F_1 and the presence heterotic effects (Table 2). The differences among the two sowing dates were significant in all the studied characters except for grain yield / plant. The interaction G × SD, P × SD and C × SD was significant in all the studied characters except for plant height and kernel weight at P × SD. Moreover, the interaction P vs. .C × SD was significant for days to physiological maturity, kernel weight, grain yield / plant and leaf rust indicating that the tested genotypes varied from sowing dates to another. These results are in agreement with those obtained by Salama (2000), El-Beially and El-Sayed (2002), Menshawy *et al*. (2004), El-Borhamy (2005), Chowdhary *et al*. (2007) and Sharshar (2010).

Table (2): Mean squares of the genotypes for all studied characters.

S. O. V	D.F	DH	DM	PLH	NS/P	NK/S	KW/S	100KW	GY/P	LR
Sowing dates(SD)	**1**	327.57**	4826.12**	2172.34**	138.73**	181.71**	15.53**	38.98**	3.75	539.70*
Rep. within SD	**4**	1.52	0.94	7.06	3.70	1.08	0.02	0.31*	2.88	520.96**
Genotypes (G)	**35**	64.08**	11.55**	219.00**	18.69**	274.20**	0.95**	1.18**	187.79**	2701.17**
Parents (P)	**7**	20.27**	12.93**	482.07**	17.45**	124.19**	0.41**	0.42**	175.81**	2747.96**
Crosses (C)	**27**	77.66**	11.25**	152.12**	19.67**	322.55**	1.12**	1.38**	189.05**	2745.32**
P vs. .C	**1**	4.00	10.13**	183.54**	1.05	19.04*	0.23**	1.24**	237.75**	1181.89**
G × SD	**35**	9.85**	5.50**	29.72**	12.10**	115.53**	0.31**	1.05**	71.03**	661.74**
P × SD	**7**	3.61**	7.59**	6.47	16.49**	180.42**	0.42**	0.16	139.78**	367.42**
C× SD	**27**	11.83**	5.06**	36.68**	11.40**	102.96**	0.30**	1.27**	55.29**	750.00*
P vs. .C × SD	**1**	0.03	2.62**	4.37	0.05	0.90	0.08	1.29**	14.78*	338.79*
Error	**140**	1.29	1.11	6.82	1.64	3.30	0.02	0.11	3.63	172.55

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

Means performance

Mean performance of the parents and their hybrids of all characters are presented in Table 3. Among wheat genotypes, Saka 93 and the cross Sakha 69 × S akha 93 were the earliest in days to heading. Sakha 94 and cross Attila-3 × Sakha 93 were the earliest in days to maturity. For plant height, Sids 1 and the cross Gemmiza 9× Sakha 94 were the tallest genotypes. Sakha 94 and cross Line 1 × Sakha 69 had the highest number of spikes / plant. Among the parental genotypes, Sakha 94 and its cross with Sids had the highest mean values for number of kernels / spike. For kernel weight / spike, Gemmiza 9 and its cross with Sids 12 had the highest value. For kernel weight, Gemmiza 9 and cross Sakha 69× Sids 12 had the heaviest kernels. The highest grain yield was recorded for Sakha 94. Meanwhile, the cross Sids 1 × Sakha 94 exhibited the highest mean value. Among parents, Line 1 was the most resistant to leaf rust and among crosses Gemmiza 9 × Sids 12 was the most resistant for leaf rust.

Table (3): Mean performance of the parents and their F_1 diallel for all studied characters.

Genotype	DH	DM	PLH	NS/P	NK/S	KW/S	100KW	GY/P	LR
p1 (ATTILA-3)	99.7	152.0	115.8	17.3	50.9	2.3	4.7	27.1	60.0
p2 (Gemmiza 9)	97.0	155.2	115.0	15.1	54.9	3.0	5.2	29.6	4.8
p3 (Line 1)	95.3	152.5	108.3	15.4	55.5	2.8	5.0	24.5	0.9
p4 (Sids 1)	99.0	155.2	121.7	17.3	60.1	2.7	4.5	28.6	30.0
p5 (Sakha 94)	98.3	151.7	115.0	20.3	63.0	2.9	4.6	38.9	2.1
p6 (Sakha 69)	96.3	154.2	120.8	18.5	49.3	2.3	4.5	36.6	25.0
P7(Sids 12)	96.3	152.7	114.2	16.6	55.4	2.9	4.7	38.2	1.5
P8 (Sakha 93)	94.3	151.8	93.3	18.1	52.6	2.6	5.0	31.5	35.0
Mean of parents	97.0	153.1	113.0	17.3	55.2	2.7	4.7	31.9	19.9
P1×P2	105.0	153.3	111.7	18.6	41.7	2.3	5.7	31.1	58.3
P1×P3	98.8	152.7	117.5	18.6	44.9	2.3	5.1	31.1	16.7
P1×P4	95.7	152.8	113.3	17.9	58.2	2.8	4.9	36.4	48.3
P1×P5	104.2	155.0	118.3	18.0	59.6	2.7	4.6	33.8	26.7
P1×P6	95.7	153.0	111.7	18.8	57.9	3.2	5.5	42.7	51.7
P1×P7	95.2	153.5	115.0	16.2	59.9	2.8	4.6	33.6	2.5
P1×P8	94.8	151.0	117.5	17.5	46.5	2.5	5.5	30.2	46.7
P2×P3	106.8	156.7	115.0	16.0	58.1	2.8	4.9	34.6	51.7
P2×P4	98.8	154.5	118.3	15.4	58.0	2.0	3.5	28.1	56.7
P2×P5	104.7	153.2	125.0	14.2	61.7	2.9	4.8	36.3	4.2
P2×P6	95.7	155.0	120.0	15.7	57.7	2.6	4.4	29.2	48.3
P2×P7	95.3	153.2	110.8	15.2	63.8	3.6	5.7	43.1	0.7
P2×P8	96.8	151.7	115.0	15.2	54.2	2.4	4.5	32.2	6.8
P3×P4	95.3	154.5	121.7	19.6	61.0	3.5	5.7	37.4	9.7
P3×P5	99.2	153.8	120.8	18.5	45.7	2.3	5.1	31.4	6.8
P3×P6	95.8	152.8	116.7	21.9	49.7	2.5	5.0	43.2	31.7
P3×P7	100.2	154.0	105.0	15.7	63.9	3.0	4.7	31.0	36.7
P3×P8	96.0	152.3	104.2	18.4	48.0	2.3	5.0	25.4	4.7
P4×P5	95.5	152.0	120.0	15.4	70.5	3.5	5.0	47.3	4.7
P4×P6	95.3	155.2	116.7	14.5	64.5	3.1	4.9	33.4	40.0
P4×P7	95.2	152.8	112.5	18.2	52.2	2.5	4.7	32.5	26.7
P4×P8	96.7	156.7	113.3	17.6	50.6	2.4	4.8	37.2	55.0
P5×P6	96.0	154.7	123.3	17.1	54.3	2.6	4.8	27.7	9.8
P5×P7	95.8	153.2	117.5	18.2	63.3	3.2	5.0	37.7	1.8
P5×P8	95.2	155.5	108.3	18.5	55.6	2.5	4.6	29.6	4.2
P6×P7	94.7	152.8	111.7	17.9	57.7	3.2	5.7	45.2	2.5
P6×P8	93.0	153.3	115.0	17.0	43.5	2.2	4.6	30.4	51.7
P7×P8	95.0	153.5	110.8	14.5	63.1	3.2	5.1	31.3	10.3
Mean of F1	97.4	153.7	115.2	17.1	55.9	2.8	4.9	34.4	25.5
Over all mean	97.3	153.5	114.7	17.2	55.7	2.7	4.9	33.8	24.3
L.S.D 0.05	1.30	1.21	3.00	1.47	2.09	0.16	0.38	2.19	15.09
L.S.D 0.01	1.74	1.61	4.00	1.96	2.78	0.22	0.51	2.92	20.10

Combining Ability Analysis

Data in Table 4 show the mean squares of general combining ability (GCA) and specific combining ability (SCA) and their interactions with sowing dates were highly significant for all studied characters with some exception except for GCA×SD at 100-kernel weight . These findings indicate that GCA and SCA effects of parents and their F1s were in consistent across sowing dates. Also, the results reveal that both additive and non-additive gene effect were detected and responsible for expression of these characters. The ratios of GCA/SCA effects were more than unity for all the studied characters except for 100 – kernel weight . This means that additive effects played the major role in the inheritance of these characters. Consequently, additive type of gene action appeared to be the largest component of genetic variability for these characters. These results are in line with those obtained by Awaad *et al*. (2003), Darwish *et al*. (2006), Chowdhary *et al*. (2007), Shehab Eldeen (2008) and Sharshar (2010).

Table (4): Mean squares for general combining ability (GCA) and specific combining ability (SCA) for all studied characters.

S. O. V	D.F	DH	DM	PLH	NS/P	NK/S	KW/S	100KW	GY/P	LR
Genotypes (G)	35	64.08**	11.55**	219.00**	18.69**	274.20**	0.95**	1.18**	187.79**	2701.17**
G.C.A	7	46.89**	4.83**	197.21**	10.16**	180.59**	0.40**	0.24**	78.68**	2334.2**
S.C.A	28	14.98**	3.60**	41.95**	5.25**	69.11**	0.30**	0.43**	58.58**	541.9**
G × SD	35	9.85**	5.50**	29.72**	12.10**	115.53**	0.31**	1.05**	71.03**	661.74**
G.C.A × SD	7	6.13**	1.68**	9.43**	4.97**	42.25**	0.13**	0.08	25.42**	232.3**
S.C.A × SD	28	2.57**	1.87**	10.02**	3.80**	37.58**	0.10**	0.42**	23.24**	217.6**
ERROR	140	0.43	0.37	2.27	0.55	1.10	0.01	0.04	1.21	57.5
G.C.A/S.C.A	…..	3.13	1.34	4.70	1.94	2.61	1.35	0.56	1.34	4.31

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

General combining ability effects

Based on GCA estimates(Table 5), it could be concluded that the best combiners were Sakha 69 and Sakha 93 for days to heading; Sakha 93 and Attila-3 for days to maturity; Sids 1 and Sakha 94 for plant height; and Attila-3 and Sakha 94 for number of spike / plant ; Sids 1, and Sakha 94 for number of kernels / spike; Sakha 94 and Sids 12 for kernel weight/ spike; Attila-3 and Line 1 for 100 kernels weight as well as Sakha 69 and Sids 12 for grain yield / plant. In addition, for leaf rust, the best combiners were Sids 12 and Sakha 94 .

Table (5): Estimates of general combining ability effects of the parental genotype for all studied characters.

Parents	DH	DM	PLH	NS/P	NK/S	KW/S	100KW	GY/P	LR
P1	1.30**	-0.66**	0.40*	0.55**	-3.12**	-0.14**	0.13**	-1.15**	15.22**
P2	2.15**	0.59**	1.31**	-1.44**	0.31*	0.00	-0.03	-1.08**	1.77*
P3	0.72**	-0.01	-1.52**	0.48**	-1.95**	-0.03**	0.14**	-2.13**	-5.90**
P4	-0.52**	0.69**	2.65**	-0.16	3.32**	0.06**	-0.17**	0.50**	8.24**
P5	1.15**	-0.13	3.06**	0.58**	3.48**	0.10**	-0.11**	1.71**	-15.64**
P6	-1.68**	0.32**	2.40**	0.51**	-1.80**	-0.06**	-0.02	2.05**	6.70**
P7	-1.17**	-0.36**	-2.10**	-0.56**	3.28**	0.26**	0.08**	2.61**	-13.45**
P8	-1.95**	-0.43**	-6.19**	0.03	-3.52**	-0.18**	-0.01	-2.52**	3.07**
L.S.D.05 (gi)	0.15	0.14	0.35	0.17	0.24	0.02	0.04	0.26	1.77
L.S.D.01 (gi)	0.20	0.19	0.47	0.23	0.32	0.03	0.06	0.34	2.35
L.S.D.05(gi-gj)	0.29	0.27	0.67	0.33	0.46	0.04	0.09	0.49	3.36
L.S.D .01(gi-gj)	0.38	0.36	0.89	0.43	0.62	0.05	0.11	0.65	4.46

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

Specific combining ability effects

Based on the estimates of SCA (Table 6), the best crosses were Sids 1 × Sakha 94 and Gemmiza 9 × Sids 12 for days to heading, Gemmiza 9 ×

Sakha 93 and Sids 1 × Sakha 94 were the best crosses for days to maturity. For plant height Attila-3 × Sakha 93 and Gemmiza 9 × Sakha 94 showed positive and significant SCA. For number of spike / plant crosses Attila-3 × Gemmiza 9 and Line 1 × Sakha 69 showed positive and significant SCA. For number of kernels / spike the best crosses were Sids 1× Sakha 69 and Sids 1 × Sakha 94. For kernel weight / spike the best crosses were Attila-3 × Sakha 69, Gemmiza 9 × Sids 12 and Line 1 × Sids 1.For kernels weight the best cross was Attila-3× Gemmiza 9 and Line 1 × Sids 1 . For grain yield / plant the best crosses were Line 1 × Sakha 69 and Sids 1 × Sakha 94. For leaf rust the hybrids Gemmiza 9× Sakha 93 and Attila-3 × Sids 12 were considered to be the best among the studied crosses.

Table (6): Estimates of specific combining ability effects for F1 crosses for all studied characters.

Crosses	DH	DM	PLH	NS/P	NK/S	KW/S	100KW	GY/P	LR
P1×P2	4.25**	-0.14	-4.79**	2.29**	-11.3**	-0.25**	0.73**	-0.53	17.05**
P1×P3	-0.48	-0.21	3.88**	0.40	-5.74**	-0.25**	-0.01	0.57	-16.9**
P1×P4	-2.41**	-0.74	-4.45**	0.31	2.26**	0.16**	0.05	3.24**	0.58
P1×P5	4.42**	2.24**	0.13	-0.33	3.53**	0.04	-0.33**	-0.59	2.79
P1×P6	-1.25**	-0.21	-5.87**	0.56	7.08**	0.64**	0.51**	7.95**	5.45
P1×P7	-2.26**	0.97*	1.96*	-1.01*	4.01**	-0.10	-0.46**	-1.75*	-23.5**
P1×P8	-1.81**	-1.46**	8.55**	-0.27	-2.59**	0.12*	0.51**	0.02	4.09
P2×P3	6.67**	2.54**	0.46	-0.24	4.01**	0.12*	-0.12	4.00**	31.50**
P2×P4	-0.10	-0.33	-0.37	-0.20	-1.39*	-0.83**	-1.24*	-5.17**	22.36**
P2×P5	4.07**	-0.84*	5.88**	-2.17**	2.13**	0.12*	0.03	1.83*	-6.26
P2×P6	-2.10**	0.54	1.55	-0.60	3.41**	-0.11*	-0.41**	-5.60**	15.57**
P2×P7	-2.95**	-0.61	-3.12**	-0.04	4.45**	0.64**	0.72**	7.69**	-11.92*
P2×P8	-0.66	-2.04**	5.13**	-0.57	1.65*	-0.12*	-0.37**	2.00**	-22.3**
P3×P4	-2.16**	0.27	5.80**	2.06**	3.90**	0.70**	0.82**	5.18**	-16.9**
P3×P5	0.00	0.42	4.55**	0.29	-11.6**	-0.47**	0.14	-2.06**	4.07
P3×P6	-0.50	-1.03**	1.05	3.74**	-2.35**	-0.17**	-0.03	9.45**	6.57
P3×P7	3.32**	0.82*	-6.12**	-1.40**	6.76**	0.08	-0.43**	-3.32**	31.71**
P3×P8	-0.06	-0.78*	-2.87**	0.74	-2.25**	-0.17**	-0.07	-3.75**	-16.8**
P4×P5	-2.43**	-2.11**	-0.45	-2.24**	7.92**	0.61**	0.36**	11.26**	-12.2**
P4×P6	0.24	0.61	-3.12**	-3.00**	7.20**	0.42**	0.17	-3.01**	0.77
P4×P7	-0.45	-1.04**	-2.79**	1.73**	-10.2**	-0.59**	-0.08	-4.44**	7.58
P4×P8	1.84**	2.86**	2.13*	0.54	-4.99**	-0.19**	0.05	5.40**	19.40**
P5×P6	-0.76	0.92*	3.13**	-1.15*	-3.10**	-0.15**	0.05	-9.95**	-5.52
P5×P7	-1.45**	0.11	1.80	0.99*	0.75	0.06	0.11	-0.46	6.56
P5×P8	-1.33**	2.51**	-3.29**	0.69	-0.13	-0.11*	-0.14	-3.40**	-7.56
P6×P7	0.22	-0.68	-3.37**	0.73	0.42	0.26**	0.71**	6.69**	-15.0**
P6×P8	-0.66	-0.11	4.05**	-0.76	-6.97*	-0.32**	-0.23	-2.92**	17.60**
P7×P8	0.82	0.74	4.38**	-2.12**	7.58*	0.38**	0.10	-2.64**	-3.58
L.S.D.05(sij)	0.83	0.77	1.91	0.94	1.33	0.11	0.24	1.40	9.63
L.S.D.01(sij)	1.10	1.02	2.54	1.25	1.77	0.14	0.32	1.86	12.79
L.S.D.05(sij-sik)	1.23	1.14	2.83	1.39	1.97	0.16	0.36	2.07	14.25
L.S.D.01(sij-sik)	1.63	1.52	3.76	1.85	2.61	0.21	0.48	2.75	18.92
L.S.D.05(sij-skl)	0.41	0.38	0.94	0.46	0.66	0.05	0.12	0.69	4.75
L.S.D.01(sij-skl)	0.54	0.51	1.25	0.62	0.87	0.07	0.16	0.92	6.31

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

Heterosis percentages

For mid parent (Table 7), the result showed that 13 crosses had negative and significant heterosis estimates for heading date. However, the best crosses was Attila-3 × Sids 1. For maturity date, the cross Gemmiza 9 × Sakha 93 was negative and significant. For plant height, there were 11 positive significant crosses and the best cross was Attila-3 × Sakha 93 . For number of spike /plant, there were 11 positive significant crosses and the best cross was Line 1 × Sakha 69. For number of kernels / spike, there were 15 positive significant crosses and the best crosses was Sids 1 × Sakha 69. For kernel weight/ spike, there were 15 positive significant crosses and the best crosses was Attila-3× Sakha 69 . For kernel weight, there were 17 positive significant crosses and the best crosses was Sakha 69 × Sids 12 . For grain yield / plant, there were 15 positive significant crosses and the best crosses was Line 1× Sids 1. For leaf rust, there were 11 negative significant crosses and the best crosses was Attila-3 × P_7 Sids 12. These results are in harmony with those obtained by El-Borhamy (2005) and Shehab Eldeen (2008).

Table (7): Estimation of heterosis over mid parent (MP) for F1 crosses For all studied characters.

crosses	DH	DM	PLH	NS/P	NK/S	KW/S	100KW	GY/P	LR
P_1×P_2	6.78**	-0.16	-3.25	14.77**	-21.21**	-10.31**	16.49**	9.74**	79.95**
P_1×P_3	1.37*	0.27	4.83*	13.98**	-15.51**	-8.02**	6.33**	20.61**	-45.30**
P_1×P_4	-3.69**	-0.49	-4.56*	3.42**	4.95**	13.04**	7.39**	30.83**	7.41
P_1×P_5	5.22**	2.09**	2.53	-4.38**	4.76**	5.76**	-0.61**	2.42	-14.07
P_1×P_6	-2.38**	-0.05	-5.63**	5.14**	15.61**	38.16**	20.86**	34.01**	21.57*
P_1×P_7	-2.89**	0.77	0.00	-4.70**	12.74**	6.51**	-0.96**	2.85*	-91.87**
P_1×P_8	-2.23**	-0.60	12.35**	-1.27	-10.04**	4.27**	14.93**	3.17*	-1.75
P_2×P_3	11.09**	1.84*	2.99	5.07**	5.32**	-1.17**	-4.19**	27.99**	1690.87**
P_2×P_4	0.85	-0.43	0.00	-4.88**	0.91	-30.60**	-28.37**	-3.43*	225.36**
P_2×P_5	7.17**	-0.16	8.70**	-19.99**	4.66**	1.04**	-1.55**	5.96**	20.82*
P_2×P_6	-1.03	0.22	1.77	-6.59**	10.72**	-3.06**	-7.92**	-11.76**	224.02**
P_2×P_7	-1.38*	-0.49	-3.27	-4.41**	15.67**	24.07**	14.73**	27.14**	-77.86**
P_2×P_8	1.22	-1.19*	10.40**	-8.40**	0.88	-12.22**	-11.43**	5.67**	-65.69**
P_3×P_4	-1.89**	0.43	5.80**	19.98**	5.62**	26.48**	19.43**	40.68**	-37.51**
P_3×P_5	2.41**	1.15	8.21**	3.95**	-22.95**	-17.28**	5.49**	-1.20	355.05**
P_3×P_6	0.00	-0.33	1.82	29.68**	-5.25**	-2.62**	5.07**	41.25**	144.18**
P_3×P_7	4.52**	0.93	-5.62**	-1.72	15.11**	7.66**	-3.94**	-1.16	2866.96**
P_3×P_8	1.23	0.11	3.31	10.12**	-11.10**	-12.01**	-0.73**	-9.12**	-74.03**
P_4×P_5	-3.21**	-0.92	1.41	-18.20**	14.56**	24.91**	9.98**	40.06**	-70.68**
P_4×P_6	-2.39**	0.32	-3.78*	-18.62**	17.91**	25.04**	8.85**	2.32	45.45**
P_4×P_7	-2.56**	-0.70	-4.59*	7.38**	-9.67**	-12.35**	2.75**	-2.65	69.12**
P_4×P_8	0.00	2.06**	5.43**	-0.56	-10.19**	-8.38**	1.06**	23.94**	69.23**
P_5×P_6	-1.37*	1.14	4.59*	-11.63**	-3.22*	0.38**	6.66**	-26.81**	-27.34**
P_5×P_7	-1.54*	0.66	2.55	-1.48	6.86**	8.91**	7.17**	-2.21	-1.80
P_5×P_8	-1.21	2.47**	4.00*	-3.77**	-3.79**	-7.24**	-2.71**	-15.79**	-77.52**
P_6×P_7	-1.73**	-0.38	-4.96**	1.91*	10.10**	22.16**	23.51**	20.82**	-81.16**
P_6×P_8	-2.45**	0.22	7.39**	-7.24**	-14.66**	-11.47**	-1.69**	-10.55**	72.22**
P_7×P_8	-0.35	0.82	6.83**	-16.30**	16.86**	16.39**	4.82**	-10.11**	-43.43**

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

For better parent (Table 8), the result showed that 13 crosses had negative and significant heterosis estimates for heading date. However, the best crosses was Attila-3 × Sakha 93 . For maturity date, there were two crosses were negative and significant. However, the best cross was Gemmiza 9 × Sakha 93. For plant height, the cross Gemmiza 9× P_5 Sakha 94 and Line 1 × Sakha 94 were positive and significant. For number of spike /plant, there were seven positive significant crosses and the best cross was Line 1 × Sakha 69. For number of kernels / spike, there were 10 positive significant crosses and the best crosses was Gemmiza 9 × Sids 12. For kernel weight/ spike, there were 10 positive significant crosses and the best cross was Attila-3 × Sakha 69. For kernel weight, there were 14 positive significant crosses and the best cross was Sakha 69 × Sids 12. For grain yield / plant, there were 14 positive significant crosses and the best cross was Line 1 × Sakha 69. For leaf rust, there were 18 negative significant crosses and the best cross was Attila-3 × Sids 12. These results are in line with those obtained by Shehab Eldeen (2008) and Sharshar (2010).

Table (8): Estimation of heterosis over better parent (BP) for F1 crosses for all studied characters.

crosses	DH	DM	PLH	NS/P	NK/S	KW/S	100KW	GY/P	LR
$P_1×P_2$	5.35**	-1.18	-3.60	7.31**	-24.08**	-20.67**	10.70**	9.74**	-2.78
$P_1×P_3$	-0.84	0.11	1.44	7.51**	-19.03**	-16.14**	2.41**	20.61**	-72.22**
$P_1×P_4$	-4.01**	-1.50	-6.85**	3.27**	-3.06*	3.86**	5.36**	30.83**	-19.44
$P_1×P_5$	4.52**	1.97*	2.16	-11.44**	-5.31**	-5.50**	-1.59**	2.42	-55.56**
$P_1×P_6$	-4.01**	-0.76	-7.59**	1.91	13.82**	36.52**	18.42**	34.01**	-13.89
$P_1×P_7$	-4.52**	0.55	-0.72	-6.59**	8.10**	-5.10**	-1.53**	2.85	-95.83**
$P_1×P_8$	-4.85**	-0.66	1.44	-3.49**	-11.48**	-2.01**	11.38**	3.17*	-22.22*
$P_2×P_3$	10.14**	0.97	0.00	4.10**	4.72**	-4.44**	-5.53**	27.99**	968.97**
$P_2×P_4$	-0.17	-0.43	-2.74	-10.94**	-3.43*	-33.44**	-33.15**	-3.43*	88.89**
$P_2×P_5$	6.44**	-1.29	8.70**	-30.33**	-2.07	-0.10	-7.33**	5.96**	-13.76
$P_2×P_6$	-1.37	-0.11	-0.69	-15.15**	5.09**	-13.35**	-14.17**	-11.76**	93.33**
$P_2×P_7$	-1.72	-1.29	-3.62	-8.90**	15.09**	23.06**	9.63**	27.14**	-85.41**
$P_2×P_8$	-0.17	-2.26**	0.00	-16.15**	-1.25	-17.74**	-13.21**	5.67**	-80.48**
$P_3×P_4$	-3.70**	-0.43	0.00	13.32**	1.63	25.42**	12.95**	40.68**	-67.78**
$P_3×P_5$	0.85	0.87	5.07*	-8.76**	-27.52**	-19.12**	0.64*	-1.20	230.65**
$P_3×P_6$	-0.52	-0.86	-3.45	18.79**	-10.55**	-10.24**	-0.75**	41.25**	26.67**
$P_3×P_7$	3.98**	0.87	-8.03**	-5.50**	15.02**	4.94**	-6.96**	-1.16	2288.71**
$P_3×P_8$	0.70	-0.11	-3.85	1.66	-13.47**	-14.81**	-1.36**	-9.12**	-86.67**
$P_4×P_5$	-3.54**	-2.04*	-1.37	-24.34**	11.89**	21.13**	8.98**	40.06**	-84.33**
$P_4×P_6$	-3.70**	0.00	-4.11	-21.23**	7.35**	16.15**	8.70**	2.32	33.33**
$P_4×P_7$	-3.87**	-1.50	-7.53**	5.40**	-13.14**	-15.27**	0.25	-2.65	-11.11
$P_4×P_8$	-2.36*	0.97	-6.85**	-2.94**	-15.79**	-10.56**	-3.85**	23.94**	57.14**
$P_5×P_6$	-2.37*	0.32	2.07	-15.69**	-13.74**	-9.35**	5.54**	-26.81**	-60.67**
$P_5×P_7$	-2.54**	0.33	2.17	-10.42**	0.45	8.56**	5.51**	-2.21	-14.44
$P_5×P_8$	-3.22**	2.41**	-5.80**	-8.94**	-11.76**	-12.12**	-6.62**	-15.79**	-88.10**
$P_6×P_7$	-1.73	-0.86	-7.59**	-3.12**	4.01**	9.99**	20.34**	20.82**	-90.00**
$P_6×P_8$	-3.46**	-0.54	-4.83*	-8.04**	-17.30**	-15.86**	-6.58**	-10.55**	47.62**
$P_7×P_8$	-1.38	0.55	-2.92	-19.77**	13.84**	9.92**	2.16**	-10.11**	-70.48**

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

Correlation coefficient

The correlation coefficient between the studied characters are shown in Table 29. The results show that the correlation coefficient between grain yield / plant and number of kernels / spike, kernel weight / spike and kernel weight were positive and significant. Meanwhile, it was negative and significant between number of spike / plant and number of kernels / spike. In addition, the correlation coefficient between number of kernels / spike and kernel weight / spike were positive and significant, while it was negative and significant between number of kernels / spike and leaf rust. It was also positive and significant between kernel weight / spike and kernel weight, while it was negative and significant between kernel weight / spike and leaf rust. The obtained results are in general agreement with Awaad *et al*. (2003) and Sharshar (2010).

Table (9): Simple correlation coefficients among all studied characters.

characters	GY/P	HD	MD	PLH	NS/P	NK/S	KW/S	100-KW	LR
GY/P	1	-0.111	-0.136	0.133	0.218	0.403**	0.596**	0.372*	-0.148
HD		1	0.297	0.232	-0.081	-0.024	-0.170	-0.093	0.230
MD			1	0.248	-0.172	0.139	-0.012	-0.229	0.212
PLH				1	-0.051	0.101	0.002	-0.172	-0.044
NS/P					1	-0.421*	-0.236	0.209	0.075
NK/S						1	0.781**	-0.087	-0.322*
KW/S							1	0.512*	-0.428**
100-KW								1	-0.179
LR									1

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

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دراسات وراثيه على الصدأ الأصفر و البرتقالى فى قمح الخبز تحت مواعيد زراعه مختلفه

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أجريت هذه الدراسة في مزرعة محطة البحوث الزراعية بسخا خلال موسمي القمح 2008/2007و2009/2008لتقدير قوه الهجين و القدره على التآلف و نظام التحكم الوراثى و معامل الارتباط البسيط لبعض الصفات المحصوليه و كل من صفتى المقاومه للصدأ الاصفر و صدأ الورقه و قد استخدمت ثمانية آباء (سبعة أصناف و سلاله واحده) من قمح الخبز و تم التهجين فيما بينهما بنظام الهجن الدائريه مع استبعاد الهجن العكسيه و كانت التراكيب الوراثيه المستخدمه هى اتيلا-3، جميزه 9 ،سلاله1 ،سدس1 سخا 94، سخا69، سدس12و سخا93. وقد تم تسجيل البيانات على كل من صفة عدد الأيام حتى طرد السنابل، عدد الأيام حتى النضج الفسيولوجي، طول النبات، عدد السنابل للنبات ،عدد حبوب السنبلة ، وزن حبوب السنبله ، وزن المائة حبة ، محصول الحبوب للنبات و صفه المقاومه لصدأ الورقة.بينما استبعدت بيانات الصدأ الأصفر لعدم كفايتها نظرا لعدم ظهور المرض بصوره كافيه يمكن الاعتماد عليها. و أشارت النتائج وجود تباين معنوى لكل من التراكيب الوراثيه و الآباء و الهجن و الآباء مقابل الهجن فى جميع الصفات ماعدا الآباء مقابل الهجن فى صفتى طرد السنابل و عدد السنابل للنبات. كما أظهرت نتائج التحليل ان تباين كل من القدره العامه و الخاصه على التآلف كانت معنويه لجميع الصفات مما يدل على اهميه التباينات الوراثيه المضيفه و السائده و كانت نسبه القدره العامه الى نسبه القدره الخاصه للتآلف اكبر من الواحد لجميع الصفات ماعدا صفه وزن الحبه مما يدل على أهميه التباينات الوراثيه المضيفه. و اعطت الهجن سلاله1 × سدس1 و سلاله1× سخا69 أعلى قيمه معنويه موجبه لقوه الهجين لصفه وزن حبوب النبات نسبه الى متوسط الأبوين و أفضل الأبوين على الترتيب. بينما أعطى الهجين اتيلا-3 × سدس12 أعلى قيمه معنويه سالبه لصفه المقاومه لصدأ الورقه نسبه الى متوسط الأبوين و أفضل الأبوين. وأظهرت النتائج أن معامل الارتباط بين صفه محصول حبوب النبات و صفات عدد حبوب السنبله ، وزن حبوب السنبله و وزن الحبه كانت معنويه موجبه بينما كان معامل الارتباط بين صفه صدأ الورقه مع صفتى عدد حبوب السنبله و وزن حبوب السنبله سالبا ومعنويا.

قام بتحكيم البحث

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