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 ٢٠٠٧/٢٠٠٨ and ٢٠٠٨/٢٠٠٩ 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-٢, P_2- Gemmiza ٩, P_3- Line ١, P_4- Sids ١, P_5- Sakha ٩٤, P_6- Sakha ٦٩, P_7- Sids ١٢ and P_8- Sakha ٩٣. 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 $P_3 \times P_1$ 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.,* ١٩٩١). 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 ١٩٩١and Bai *et al.,* ١٩٩٧). 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.,* ١٩٩١; Yadav *et al.,* ١٩٩٨ and Nawar *et al.,*٢٠١٠). Furthermore, the resistance was dominant over susceptibility in most cases, (Shehab El-Din and Abd El-Latif., ١٩٩٦ ; Bai *et al.,* ١٩٩٧ and Patil *et al.,* ٢٠٠٠), and vice versa was true in others, (Singh *et al.,* ١٩٩٨ and Ganeva *et al.,* ٢٠٠١).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.,* I٩٩٦; Singh *et al.,* ١٩٩٨; Zhang *et al.,* ٢٠٠١; Awaad *et al.,* ٢٠٠٣ and Nawar *et al.,*٢٠١٠).

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, ٢٠٠٧/٢٠٠٨ and ٢٠٠٨/٢٠٠٩ 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 ١.

All possible parental combinations without reciprocals were made among the eight genotypes, giving twenty eight crosses. The parental genotypes and F₁ 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 , ٢m long and ٣٠cm 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), ١٠٠-kernel weight (١٠٠KW) and grain yield/plant(GY/P). For stripe and leaf rusts (LR) reactions, the formula of Stubbes *et al.* (١٩٨٦) And adjusted by Shehab El-Din and Abd El-latif (١٩٩٦) was used.

Table (١): Name, pedigree and leaf rust reaction for the parental genotypes.

Name	Pedigree	Stripe rust reaction	Leaf rust reaction
P١ (Attila-٣)	ND/VG٩١٤٤//KAL/BB/٣/YACO/٤/VEE#٥	R	MS
P٢ (Gemmiza ٩)	Ald "S" / Huac // Cmh ٧٤A. ٦٣٠ / Sx CGM ٤٥٨٣-٥GM-١GM-٠GM	R	R
P٣ (Line ١)	DVERD ٢ / AE - SQUARROSA (٢١٤)// ٢* BCN	MS	MR
P٤ (Sids ١)	HD٢١٧٢ / PAVON"S" // ١١٥٨,٥٧ / MAYA٧٤"S" SD ٤٦-٤SD-٢SD-١SD-٠SD	R	S
P٥ (Sakha ٩٤)	OPATA / RAYON // KAUZ CMBW٩٠Y٣١٨٠-٠TOPM-٣Y-٠١٠M-٠١٠M-٠١٠Y-١٠M-٠١٥Y-٠Y-٠AP-٠S	R	R
P٦ (Sakha ٦٩)	Inia/RL٤٢٢٠//٧C/Yr"S" CM١٥٤٣٠-٢S-٦S-٠S-٠S	S	S
P٧ (Sids ١٢)	BUC//٧C/ALD/٥/MAYA٧٤/ON//١١٦٠,١٤٧/٣/BB/GLL/٤/CHAT"S"/٦/MAYA/VUL//CMH٧٤A.٦٣٠/٤*SX SD٧٠٩٦-٤SD-١SD-١SD-٠SD	R	R
P٨ (Sakha ٩٣)	Sakha ٩٢/ TR ٨١٠٣٢٨ S. ٨٨٧١-١S-٢S-١S-٠S	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 (١٩٨٠). The data were also analyzed using Griffing (١٩٥٦) method ٢ models ١ to estimate general combining ability (GCA) and specific combining ability (SCA) effect. The simple correlation coefficient (r) among all characters in each F₁ population were estimated according to Snedecor and Cochran (١٩٨٠).

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 ٢٠٠٨/٢٠٠٩ 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, F₁ and the presence heterotic effects (Table ٢). 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 (٢٠٠٠), El-Beially and El-Sayed (٢٠٠٢), Menshawy *et al.* (٢٠٠٤), El-Borhamy (٢٠٠٥), Chowdhary *et al.* (٢٠٠٧) and Sharshar (٢٠١٠).

Table (٢): Mean squares of the genotypes for all studied characters.

S. O. V	D.F	DH	DM	PLH	NS/P	NK/S	KW/S	١٠٠KW	GY/P	LR
Sowing dates(SD)	١	٣٢٧,٥٧**	٤٨٢٦,١٢**	٢١٧٢,٣٤**	١٣٨,٧٣**	١٨١,٧١**	١٥,٥٣**	٣٨,٩٨**	٣,٧٥	٥٣٩,٧٠*
Rep. within SD	٤	١,٥٢	٠,٩٤	٧,٠٦	٣,٧٠	١,٠٨	٠,٠٢	٠,٣١*	٢,٨٨	٥٢٠,٩٦**
Genotypes (G)	٣٥	٦٤,٠٨**	١١,٥٥**	٢١٩,٠٠**	١٨,٦٩**	٢٧٤,٢٠**	٠,٩٥**	١,١٨**	١٨٧,٧٩**	٢٧٠١,١٧**
Parents (P)	٧	٢٠,٢٧**	١٢,٩٣**	٤٨٢,٠٧**	١٧,٤٥**	١٢٤,١٩**	٠,٤١**	٠,٤٢**	١٧٥,٨١**	٢٧٤٧,٩٦**
Crosses (C)	٢٧	٧٧,٦٦**	١١,٢٥**	١٥٢,١٢**	١٩,٦٧**	٣٢٢,٥٥**	١,١٢**	١,٣٨**	١٨٩,٠٥**	٢٧٤٥,٣٢**
P vs. .C	١	٤,٠٠	١٠,١٣**	١٨٣,٥٤**	١,٠٥	١٩,٠٤*	٠,٢٣**	١,٢٤**	٢٣٧,٧٥**	١١٨١,٨٩**
G × SD	٣٥	٩,٨٥**	٥,٥٠**	٢٩,٧٢**	١٢,١٠**	١١٥,٥٣**	٠,٣١**	١,٠٥**	٧١,٠٣**	٦٦١,٧٤**
P × SD	٧	٣,٦١**	٧,٥٩**	٦,٤٧	١٦,٤٩**	١٨٠,٤٢**	٠,٤٢**	٠,١٦	١٣٩,٧٨**	٣٦٧,٤٢**
C× SD	٢٧	١١,٨٣**	٥,٦**	٣٦,٦٨**	١١,٤٠**	١٠٢,٩٦**	٠,٣٠**	١,٢٧**	٥٥,٢٩**	٧٥٠,٠٠*
P vs. .C × SD	١	٠,٠٣	٢,٦٢**	٤,٣٧	٠,٠٥	٠,٩٠	٠,٠٨	١,٢٩**	١٤,٧٨*	٣٣٨,٧٩*
Error	١٤٠	١,٢٩	١,١١	٦,٨٢	١,٦٤	٣,٣٠	٠,٠٢	٠,١١	٣,٦٣	١٧٢,٥٥

* and ** significant at ٠,٠٥ and ٠,٠١ levels of probability, respectively.

Means performance

Mean performance of the parents and their hybrids of all characters are presented in Table ٣. Among wheat genotypes, Saka ٩٣ and the cross Sakha ٦٩ × S akha ٩٣ were the earliest in days to heading. Sakha ٩٤ and cross Attila-٣ × Sakha ٩٣ were the earliest in days to maturity. For plant height, Sids ١ and the cross Gemmiza ٩× Sakha ٩٤ were the tallest genotypes. Sakha ٩٤ and cross Line ١ × Sakha ٦٩ had the highest number of spikes / plant. Among the parental genotypes, Sakha ٩٤ and its cross with Sids had the highest mean values for number of kernels / spike. For kernel weight / spike, Gemmiza ٩ and its cross with Sids ١٢ had the highest value. For kernel weight, Gemmiza ٩ and cross Sakha ٦٩× Sids ١٢ had the heaviest kernels. The highest grain yield was recorded for Sakha ٩٤. Meanwhile, the cross Sids ١ × Sakha ٩٤ exhibited the highest mean value. Among parents, Line ١ was the most resistant to leaf rust and among crosses Gemmiza ٩ × Sids ١٢ was the most resistant for leaf rust.

Table (٣): Mean performance of the parents and their F₁ diallel for all studied characters.

Genotype	DH	DM	PLH	NS/P	NK/S	KW/S	١٠٠KW	GY/P	LR
p١ (ATTILA-٣)	٩٩,٧	١٥٢,٠	١١٥,٨	١٧,٣	٥٠,٩	٢,٣	٤,٧	٢٧,١	٦٠,٠
p٢ (Gemmiza ٩)	٩٧,٠	١٥٥,٢	١١٥,٠	١٥,١	٥٤,٩	٣,٠	٥,٢	٢٩,٦	٤,٨
p٣ (Line ١)	٩٥,٣	١٥٢,٥	١٠٨,٣	١٥,٤	٥٥,٥	٢,٨	٥,٠	٢٤,٥	٠,٩
p٤ (Sids ١)	٩٩,٠	١٥٥,٢	١٢١,٧	١٧,٣	٦٠,١	٢,٧	٤,٥	٢٨,٦	٣٠,٠
p٥ (Sakha ٩٤)	٩٨,٣	١٥١,٧	١١٥,٠	٢٠,٣	٦٣,٠	٢,٩	٤,٦	٣٨,٩	٢,١
p٦ (Sakha ٦٩)	٩٦,٣	١٥٤,٢	١٢٠,٨	١٨,٥	٤٩,٣	٢,٣	٤,٥	٣٦,٦	٢٥,٠
P٧(Sids ١٢)	٩٦,٣	١٥٢,٧	١١٤,٢	١٦,٦	٥٥,٤	٢,٩	٤,٧	٣٨,٢	١,٥
P٨ (Sakha ٩٣)	٩٤,٣	١٥١,٨	٩٣,٣	١٨,١	٥٢,٦	٢,٦	٥,٠	٣١,٥	٣٥,٠
Mean of parents	٩٧,٠	١٥٣,١	١١٣,٠	١٧,٣	٥٥,٢	٢,٧	٤,٧	٣١,٩	١٩,٩
P١×P٢	١٠٥,٠	١٥٣,٣	١١١,٧	١٨,٦	٤١,٧	٢,٣	٥,٧	٣١,١	٥٨,٣
P١×P٣	٩٨,٨	١٥٢,٧	١١٧,٥	١٨,٦	٤٤,٩	٢,٣	٥,١	٣١,١	١٦,٧
P١×P٤	٩٥,٧	١٥٢,٨	١١٣,٣	١٧,٩	٥٨,٢	٢,٨	٤,٩	٣٦,٤	٤٨,٣
P١×P٥	١٠٤,٢	١٥٥,٠	١١٨,٣	١٨,٠	٥٩,٦	٢,٧	٤,٦	٣٣,٨	٢٦,٧
P١×P٦	٩٥,٧	١٥٣,٠	١١١,٧	١٨,٨	٥٧,٩	٣,٢	٥.٥	٤٢,٧	٥١,٧
P١×P٧	٩٥,٢	١٥٣,٥	١١٥,٠	١٦,٢	٥٩,٩	٢,٨	٤,٦	٣٣,٦	٢,٥
P١×P٨	٩٤,٨	١٥١,٠	١١٧,٥	١٧,٥	٤٦,٥	٢,٥	٥,٥	٣٠,٢	٤٦,٧
P٢×P٣	١٠٦,٨	١٥٦,٧	١١٥,٠	١٦,٠	٥٨,٢	٢,٨	٤,٩	٣٤,٦	٥١,٧
P٢×P٤	٩٨,٨	١٥٤,٥	١١٨,٣	١٥,٤	٥٨,٠	٢,٠	٣,٥	٢٨,١	٥٦,٧
P٢×P٥	١٠٤,٧	١٥٣,٢	١٢٥,٠	١٤,٢	٦١,٧	٢,٩	٤,٨	٣٦,٣	٤,٢
P٢×P٦	٩٥,٧	١٥٥,٠	١٢٠,٠	١٥,٧	٥٧,٧	٢,٦	٤,٤	٢٩,٢	٤٨,٣
P٢×P٧	٩٥,٣	١٥٣,٢	١١٠,٨	١٥,٢	٦٣,٨	٣,٦	٥,٧	٤٣,١	٠,٧
P٢×P٨	٩٦,٨	١٥١,٧	١١٥,٠	١٥,٢	٥٤,٢	٢,٤	٤,٥	٣٢,٢	٦,٨
P٣×P٤	٩٥,٣	١٥٤,٥	١٢١,٧	١٩,٦	٦١,٠	٣,٥	٥,٧	٣٧,٤	٩,٧
P٣×P٥	٩٩,٢	١٥٣,٨	١٢٠,٨	١٨,٥	٤٥,٧	٢,٣	٥,١	٣١.٤	٦,٨
P٣×P٦	٩٥,٨	١٥٢,٨	١١٦,٧	٢١,٩	٤٩,٧	٢,٥	٥,٠	٤٣,٢	٣١,٧
P٣×P٧	١٠٠,٢	١٥٤,٠	١٠٥,٠	١٥,٧	٦٣,٩	٣,٠	٤,٧	٣١,٠	٣٦,٧
P٣×P٨	٩٦,٠	١٥٢,٣	١٠٤,٢	١٨,٤	٤٨,٠	٢,٣	٥,٠	٢٥,٤	٤,٧
P٤×P٥	٩٥,٥	١٥٢,٠	١٢٠,٠	١٥,٤	٧٠,٥	٣,٥	٥,٠	٤٧,٣	٤,٧
P٤×P٦	٩٥,٣	١٥٥,٢	١١٦,٧	١٤,٥	٦٤,٥	٣,١	٤,٩	٣٣,٤	٤٠,٠
P٤×P٧	٩٥,٢	١٥٢,٨	١١٢,٥	١٨,٢	٥٢,٢	٢,٥	٤,٧	٣٢,٦	٢٦,٧
P٤×P٨	٩٦,٧	١٥٦,٧	١١٣,٣	١٧,٦	٥٠,٦	٢,٤	٤,٨	٣٧,٢	٥٥,٠
P٥×P٦	٩٦,٠	١٥٤,٧	١٢٣,٣	١٧,١	٥٤,٣	٢,٦	٤,٨	٢٧,٧	٩,٨
P٥×P٧	٩٥,٨	١٥٣,٢	١١٧,٥	١٨,٢	٦٣,٣	٣,٢	٥,٠	٣٧,٧	١,٨
P٥×P٨	٩٥,٢	١٥٥,٥	١٠٨,٣	١٨,٥	٥٥,٦	٢,٥	٤,٦	٢٩,٦	٤.٢
P٦×P٧	٩٤,٧	١٥٢,٨	١١١,٧	١٧,٩	٥٧,٧	٣,٢	٥,٧	٤٥,٢	٢,٥
P٦×P٨	٩٣,٠	١٥٣,٣	١١٥,٠	١٧,٠	٤٣,٥	٢,٢	٤,٦	٣٠,٤	٥١,٧
P٧×P٨	٩٥,٠	١٥٣,٥	١١٠,٨	١٤,٥	٦٣,١	٣,٢	٥,١	٣١,٣	١٠,٣
Mean of F١	٩٧,٤	١٥٣,٧	١١٥,٢	١٧,١	٥٥,٩	٢,٨	٤,٩	٣٤,٤	٢٥,٥
Over all mean	٩٧,٣	١٥٣,٥	١١٤,٧	١٧,٢	٥٥,٧	٢,٧	٤,٩	٣٣,٨	٢٤,٣
L.S.D ٠,٠٥	١,٣٠	١,٢١	٣,٠٠	١,٤٧	٢,٠٩	٠,١٦	٠,٣٨	٢,١٩	١٥,٠٩
L.S.D ٠,٠١	١,٧٤	١,٦١	٤,٠٠	١,٩٦	٢,٧٨	٠,٢٢	٠,٥١	٢,٩٢	٢٠,١٠

Combining Ability Analysis

Data in Table ٤ 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 ١٠٠-kernel weight . These findings indicate that GCA and SCA effects of parents and their F١s 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 ١٠٠ – 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.* (٢٠٠٣), Darwish *et al.* (٢٠٠٦), Chowdhary *et al.* (٢٠٠٧), Shehab Eldeen (٢٠٠٨) and Sharshar (٢٠١٠).

Table (٤): 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	١٠٠KW	GY/P	LR
Genotypes (G)	٣٥	٦٤,٠٨**	١١,٥٥**	٢١٩,٠٠**	١٨,٦٩**	٢٧٤,٢٠**	٠,٩٥**	١,١٨**	١٨٧,٧٩**	٢٧٠,١,١٧**
G.C.A	٧	٤٦,٨٩**	٤,٨٣**	١٩٧,٢١**	١٠,١٦**	١٨٠,٥٩**	٠,٤٠**	٠,٢٤**	٧٨,٦٨**	٢٣٣٤,٢**
S.C.A	٢٨	١٤,٩٨**	٣,٦٠**	٤١,٩٥**	٥,٢٥**	٦٩,١١**	٠,٣٠**	٠,٤٣**	٥٨,٥٨**	٥٤١,٩**
G × SD	٣٥	٩,٨٥**	٥,٥٠**	٢٩,٧٢**	١٢,١٠**	١١٥,٥٣**	٠,٣١**	١,٠٥**	٧١,٠٣**	٦٦١,٧٤**
G.C.A × SD	٧	٦,١٣**	١,٦٨**	٩,٤٣**	٤,٩٧**	٤٢,٢٥**	٠,١٣**	٠,٠٨	٢٥,٤٢**	٢٣٢,٣**
S.C.A × SD	٢٨	٢,٥٧**	١,٨٧**	١٠,٠٢**	٣,٨٠**	٣٧,٥٨**	٠,١٠**	٠,٤٢**	٢٣,٢٤**	٢١٧,٦**
ERROR	١٤٠	٠,٤٣	٠,٣٧	٢,٢٧	٠,٥٥	١,١٠	٠,٠١	٠,٠٤	١,٢١	٥٧,٥
G.C.A/S.C.A	.....	٣,١٣	١,٣٤	٤,٧٠	١,٩٤	٢,٦١	١,٣٥	٠,٥٦	١,٣٤	٤,٣١

* and ** significant at ٠,٠٥ and ٠,٠١ levels of probability, respectively.

General combining ability effects

Based on GCA estimates(Table ٥), it could be concluded that the best combiners were Sakha ٦٩ and Sakha ٩٣ for days to heading; Sakha ٩٣ and Attila-٣ for days to maturity; Sids ١ and Sakha ٩٤ for plant height; and Attila-٣ and Sakha ٩٤ for number of spike / plant ; Sids ١, and Sakha ٩٤ for number of kernels / spike; Sakha ٩٤ and Sids ١٢ for kernel weight/ spike; Attila-٣ and Line ١ for ١٠٠ kernels weight as well as Sakha ٦٩ and Sids ١٢ for grain yield / plant. In addition, for leaf rust, the best combiners were Sids ١٢ and Sakha ٩٤ .

Table (٥): Estimates of general combining ability effects of the parental genotype for all studied characters.

Parents	DH	DM	PLH	NS/P	NK/S	KW/S	١٠٠KW	GY/P	LR
P١	١,٣,٠**	-٠,٦٦**	٠,٤٠*	٠,٥٥**	-٣,١٢**	-٠,١٤**	٠,١٣**	-١,١٥**	١٥,٢٢**
P٢	٢,١٥**	٠,٠٩**	١,٣١**	-١,٤٤**	٠,٣١*	٠,٠٠	-٠,٠٣	-١,٠٨**	١,٧٧*
P٣	٠,٧٧**	-٠,٠١	-١,٥٢**	٠,٤٨**	-١,٩٥**	-٠,٠٣**	٠,١٤**	-٢,١٣**	-٥,٩٠**
P٤	-٠,٥٢**	٠,٦٩**	٢,٦٥**	-٠,١٦	٣,٣٢**	٠,٠٦**	-٠,١٧**	٠,٥٠**	٨,٢٤**
P٥	١,١٥**	-٠,١٣	٣,٠٦**	٠,٥٨**	٣,٤٨**	٠,١٠**	-٠,١١**	١,٧١**	-١٥,٦٤**
P٦	-١,٦٨**	٠,٣٢**	٢,٤٠**	٠,٥١**	-١,٨٠**	-٠,٠٦**	-٠,٠٢	٢,٠٥**	٦,٧٠**
P٧	-١,١٧**	-٠,٣٦**	-٢,١٠**	-٠,٥٧**	٣,٢٨**	٠,٢٦**	٠,٠٨**	٢,٦١**	-١٣,٤٥**
P٨	-١,٩٥**	-٠,٤٣**	-٦,١٩**	٠,٠٣	-٣,٥٢**	-٠,١٨**	-٠,٠١	-٢,٥٢**	٣,٠٧**
L.S.D.٠٥ (gi)	٠,١٥	٠,١٤	٠,٣٥	٠,١٧	٠,٢٤	٠,٠٢	٠,٠٤	٠,٢٦	١,٧٧
L.S.D.٠١ (gi)	٠,٢٠	٠,١٩	٠,٤٧	٠,٢٣	٠,٣٢	٠,٠٣	٠,٠٦	٠,٣٤	٢,٣٥
L.S.D.٠٥(gi-gj)	٠,٢٩	٠,٢٧	٠,٦٧	٠,٣٣	٠,٤٦	٠,٠٤	٠,٠٩	٠,٤٩	٣,٣٦
L.S.D.٠١(gi-gj)	٠,٣٨	٠,٣٦	٠,٨٩	٠,٤٣	٠,٦٢	٠,٠٥	٠,١١	٠,٦٥	٤,٤٦

* and ** significant at ٠,٠٥ and ٠,٠١ levels of probability, respectively.

Specific combining ability effects

Based on the estimates of SCA (Table ٦), the best crosses were Sids ١ × Sakha ٩٤ and Gemmiza ٩ × Sids ١٢ for days to heading, Gemmiza ٩ ×

Sakha ٩٣ and Sids ١ x Sakha ٩٤ were the best crosses for days to maturity. For plant height Attila-٣ x Sakha ٩٣ and Gemmiza ٩ x Sakha ٩٤ showed positive and significant SCA. For number of spike / plant crosses Attila-٣ x Gemmiza ٩ and Line ١ x Sakha ٦٩ showed positive and significant SCA. For number of kernels / spike the best crosses were Sids ١x Sakha ٦٩ and Sids ١ x Sakha ٩٤. For kernel weight / spike the best crosses were Attila-٣ x Sakha ٦٩, Gemmiza ٩ x Sids ١٢ and Line ١ x Sids ١.For kernels weight the best cross was Attila-٣x Gemmiza ٩ and Line ١ x Sids ١ . For grain yield / plant the best crosses were Line ١ x Sakha ٦٩ and Sids ١ x Sakha ٩٤. For leaf rust the hybrids Gemmiza ٩x Sakha ٩٣ and Attila-٣ x Sids ١٢ were considered to be the best among the studied crosses.

Table (٦): Estimates of specific combining ability effects for F١ crosses for all studied characters.

Crosses	DH	DM	PLH	NS/P	NK/S	KW/S	١٠٠KW	GY/P	LR
P١xP٢	٤,٢٥**	-٠,١٤	-٤,٧٩**	٢,٢٩**	-١١,٣**	-٠,٢٥**	٠,٧٣**	-٠,٥٣	١٧,٠٥**
P١xP٣	-٠,٤٨	-٠,٢١	٣,٨٨**	٠,٤٠	-٥,٧٤**	-٠,٢٥**	-٠,٠١	٠,٥٧	-١٦,٩**
P١xP٤	-٢,٤١**	-٠,٧٤	-٤,٤٥**	٠,٣١	٢,٢٦**	٠,١٧**	٠,٠٥	٣,٢٤**	٠,٥٨
P١xP٥	٤,٤٢**	٢,٢٤**	٠,١٣	-٠,٣٣	٣,٥٣**	٠,٠٤	-٠,٣٣**	-٠,٥٩	٢,٧٩
P١xP٦	-١,٢٥**	-٠,٢١	-٥,٨٧**	٠,٥٦	٧,٠٨**	٠,٦٤**	٠,٥١**	٧,٩٥**	٥,٤٥
P١xP٧	-٢,٢٦**	٠,٩٧*	١,٩٦*	-١,٠١*	٤,٠١**	-٠,١٠	-٠,٤٦**	-١,٧٥*	-٢٣,٥**
P١xP٨	-١,٨١**	-١,٤٦**	٨,٠٥**	-٠,٢٧	-٢,٠٩**	٠,١٢*	٠,٥١**	٠,٠٢	٤,٠٩
P٢xP٣	٦,٦٧**	٢,٥٤**	٠,٤٦	-٠,٢٤	٤,٠١**	٠,١٢*	-٠,١٢	٤,٠٠**	٣١,٥٠**
P٢xP٤	-٠,١٠	-٠,٣٣	-٠,٣٧	-٠,٢٠	-١,٣٩*	-٠,٨٣**	-١,٢٤*	-٥,١٧**	٢٢,٢٦**
P٢xP٥	٤,٠٧**	-٠,٨٤*	٥,٨٨**	-٢,١٧**	٢,١٣**	٠,١٢*	٠,٠٣	١,٨٣*	-٦,٢٦
P٢xP٦	-٢,١٠**	٠,٥٤	١,٠٠	-٠,٦٠	٣,٤١**	-٠,١١*	-٠,٤١**	-٥,٦٠**	١٥,٥٧**
P٢xP٧	-٢,٩٥**	-٠,٦١	-٣,١٢**	-٠,٠٤	٤,٤٥**	٠,٦٤**	٠,٧٢**	٧,٦٩**	-١١,٩٢*
P٢xP٨	-٠,٦٦	-٢,٠٤**	٥,١٣**	-٠,٥٧	١,٦٥*	-٠,١٢*	-٠,٣٧**	٢,٠٠**	-٢٢,٣**
P٣xP٤	-٢,١٦**	٠,٢٧	٥,٨٠**	٢,٠٦**	٣,٩٠**	٠,٧٠**	٠,٨٢**	٥,١٨**	-١٦,٩**
P٣xP٥	٠,٠٠	٠,٤٢	٤,٠٠**	٠,٢٩	-١١,٦**	-٠,٤٧**	٠,١٤	-٢,٠٦**	٤,٠٧
P٣xP٦	-٠,٥٠	-١,٠٣**	١,٠٥	٣,٧٤**	-٢,٣٥**	-٠,١٧**	-٠,٠٣	٩,٤٥**	٦,٥٧
P٣xP٧	٣,٣٢**	٠,٨٢*	-٦,١٢**	-١,٤٠**	٦,٧٦**	٠,٠٨	-٠,٤٣**	-٣,٣٣**	٣١,٧١**
P٣xP٨	-٠,٠٦	-٠,٧٨*	-٢,٨٧**	٠,٧٤	-٢,٢٥**	-٠,١٧**	-٠,٠٧	-٣,٧٥**	-١٦,٨**
P٤xP٥	-٢,٤٣**	-٢,١١**	-٠,٤٥	-٢,٢٤**	٧,٩٢**	٠,٦١**	٠,٣٦**	١١,٢٦**	-١٢,٢**
P٤xP٦	٠,٢٤	٠,٦١	-٣,١٢**	-٣,٠٠**	٧,٢٠**	٠,٤٢**	٠,١٧	-٣,٠١**	٠,٧٧
P٤xP٧	-٠,٤٥	-١,٠٤**	-٢,٧٩**	١,٧٣**	-١٠,٢**	-٠,٠٩**	-٠,٠٨	-٤,٤٤**	٧,٥٨
P٤xP٨	١,٨٤**	٢,٨٦**	٢,١٣*	٠,٥٤	-٤,٩٩**	-٠,١٩**	٠,٠٥	٥,٤٠**	١٩,٤٠**
P٥xP٦	-٠,٧٦	٠,٩٢*	٣,١٣**	-١,١٥*	-٣,١٠**	-٠,١٥**	٠,٠٥	-٩,٩٥**	-٥,٥٢
P٥xP٧	-١,٤٥**	٠,١١	١,٨٠	٠,٩٩*	٠,٧٥	٠,٠٦	٠,١١	-٠,٤٦	٦,٥٦
P٥xP٨	-١,٢٣**	٢,٥١**	-٣,٢٩**	٠,٦٩	-٠,١٣	-٠,١١*	-٠,١٤	-٣,٤٠**	-٧,٥٦
P٦xP٧	٠,٢٢	-٠,٦٨	-٣,٣٧**	٠,٧٣	٠,٤٢	٠,٢٦**	٠,٧١**	٦,٦٩**	-١٥,٠**
P٦xP٨	-٠,٦٦	-٠,١١	٤,٠٥**	-٠,٧٦	-٦,٩٧*	-٠,٣٢**	-٠,٢٣	-٢,٩٢**	١٧,٦٠**
P٧xP٨	٠,٨٢	٠,٧٤	٤,٣٨**	-٢,١٢**	٧,٥٨*	٠,٣٨**	٠,١٠	-٢,٦٤**	-٣,٥٨
L.S.D.٠٥(sij)	٠,٨٣	٠,٧٧	١,٩١	٠,٩٤	١,٣٣	٠,١١	٠,٢٤	١,٤٠	٩,٦٣
L.S.D.٠١(sij)	١,١٠	١,٠٢	٢,٥٤	١,٢٥	١,٧٧	٠,١٤	٠,٣٢	١,٨٦	١٢,٧٩
L.S.D.٠٥(sij-sik)	١,٢٣	١,١٤	٢,٨٣	١,٣٩	١,٩٧	٠,١٦	٠,٣٦	٢,٠٧	١٤,٢٥
L.S.D.٠١(sij-sik)	١,٦٣	١,٥٢	٣,٧٦	١,٨٥	٢,٦١	٠,٢١	٠,٤٨	٢,٧٥	١٨,٩٢
L.S.D.٠٥(sij-skl)	٠,٤١	٠,٣٨	٠,٩٤	٠,٤٦	٠,٦٦	٠,٠٥	٠,١٢	٠,٦٩	٤,٧٥
L.S.D.٠١(sij-skl)	٠,٥٤	٠,٥١	١,٢٥	٠,٦٢	٠,٨٧	٠,٠٧	٠,١٦	٠,٩٢	٦,٣١

* and ** significant at ٠,٠٥ and ٠,٠١ levels of probability, respectively.

Heterosis percentages

For mid parent (Table ٧), the result showed that ١٣ crosses had negative and significant heterosis estimates for heading date. However, the best crosses was Attila-٣ × Sids ١. For maturity date, the cross Gemmiza ٩ × Sakha ٩٣ was negative and significant. For plant height, there were ١١ positive significant crosses and the best cross was Attila-٣ × Sakha ٩٣ . For number of spike /plant, there were ١١ positive significant crosses and the best cross was Line ١ × Sakha ٦٩. For number of kernels / spike, there were ١٥ positive significant crosses and the best crosses was Sids ١ × Sakha ٦٩. For kernel weight/ spike, there were ١٥ positive significant crosses and the best crosses was Attila-٣× Sakha ٦٩ . For kernel weight, there were ١٧ positive significant crosses and the best crosses was Sakha ٦٩ × Sids ١٢ . For grain yield / plant, there were ١٥ positive significant crosses and the best crosses was Line ١× Sids ١. For leaf rust, there were ١١ negative significant crosses and the best crosses was Attila-٣ × P₇ Sids ١٢. These results are in harmony with those obtained by El-Borhamy (٢٠٠٥) and Shehab Eldeen (٢٠٠٨).

Table (٧): Estimation of heterosis over mid parent (MP) for F١ crosses For all studied characters.

crosses	DH	DM	PLH	NS/P	NK/S	KW/S	١٠٠KW	GY/P	LR
P₁×P₂	٦,٧٨**	-٠,١٦	-٣,٢٥	١٤,٧٧**	-٢١,٢١**	-١٠,٣١**	١٦,٤٩**	٩,٧٤**	٧٩,٩٥**
P₁×P₃	١,٣٧*	٠,٢٧	٤,٨٣*	١٣,٩٨**	-١٥,٠١**	-٨,٠٢**	٦,٣٣**	٢٠,٦١**	-٤٥,٣٠**
P₁×P₄	-٣,٦٩**	-٠,٤٩	-٤,٥٦*	٣,٤٢**	٤,٩٥**	١٣,٠٤**	٧,٣٩**	٣٠,٨٣**	٧,٤١
P₁×P₅	٥,٢٢**	٢,٠٩**	٢,٥٣	-٤,٣٨**	٤,٧٦**	٥,٧٦**	-٠,٦١**	٢,٤٢	-١٤,٠٧
P₁×P₆	-٢,٣٨**	-٠,٠٥	-٥,٦٣**	٥,١٤**	١٥,٦١**	٣٨,١٦**	٢٠,٨٦**	٣٤,٠١**	٢١,٥٧*
P₁×P₇	-٢,٨٩**	٠,٧٧	٠,٠٠	-٤,٧٠**	١٢,٧٤**	٦,٠١**	-٠,٩٦**	٢,٨٥*	-٩١,٨٧**
P₁×P₈	-٢,٢٣**	-٠,٦٠	١٢,٣٥**	-١,٢٧	-١٠,٠٤**	٤,٢٧**	١٤,٩٣**	٣,١٧*	-١,٧٥
P₂×P₃	١١,٠٩**	١,٨٤*	٢,٩٩	٥,٠٧**	٥,٣٢**	-١,١٧**	-٤,١٩**	٢٧,٩٩**	١٦٩٠,٨٧**
P₂×P₄	٠,٨٥	-٠,٤٣	٠,٠٠	-٤,٨٨**	٠,٩١	-٣٠,٦٠**	-٢٨,٣٧**	-٣,٤٣*	٢٢٥,٣٦**
P₂×P₅	٧,١٧**	-٠,١٦	٨,٧٠**	-١٩,٩٩**	٤,٦٦**	١,٠٤**	-١,٥٥**	٥,٩٦**	٢٠,٨٢*
P₂×P₆	-١,٠٣	٠,٢٢	١,٧٧	-٦,٥٩**	١٠,٧٧**	-٣,٠٦**	-٧,٩٢**	-١١,٧٦**	٢٢٤,٠٢**
P₂×P₇	-١,٣٨*	-٠,٤٩	-٣,٢٧	-٤,٤١**	١٥,٦٧**	٢٤,٠٧**	١٤,٧٣**	٢٧,١٤**	-٧٧,٨٦**
P₂×P₈	١,٢٢	-١,١٩*	١٠,٤٠**	-٨,٤٠**	٠,٨٨	-١٢,٢٢**	-١١,٤٣**	٥,٦٧**	-٦٥,٦٩**
P₃×P₄	-١,٨٩**	٠,٤٣	٥,٨٠**	١٩,٩٨**	٥,٦٢**	٢٦,٤٨**	١٩,٤٣**	٤٠,٦٨**	-٣٧,٥١**
P₃×P₅	٢,٤١**	١,١٥	٨,٢١**	٣,٩٥**	-٢٢,٩٥**	-١٧,٢٨**	٥,٤٩**	-١,٢٠	٣٥٥,٠٥**
P₃×P₆	٠,٠٠	-٠,٣٣	١,٨٢	٢٩,٦٨**	-٥,٢٥**	-٢,٦٢**	٥,٠٧**	٤١,٢٥**	١٤٤,١٨**
P₃×P₇	٤,٥٢**	٠,٩٣	-٥,٦٢**	-١,٧٢	١٥,١١**	٧,٦٦**	-٣,٩٤**	-١,١٦	٢٨٦٦,٩٦**
P₃×P₈	١,٢٣	٠,١١	٣,٣١	١٠,١٢**	-١١,١٠**	-١٢,٠١**	-٠,٧٣**	-٩,١٢**	-٧٤,٠٣**
P₄×P₅	-٣,٢١**	-٠,٩٢	١,٤١	-١٨,٢٠**	١٤,٥٦**	٢٤,٩١**	٩,٩٨**	٤٠,٠٦**	-٧٠,٦٨**
P₄×P₆	-٢,٣٩**	٠,٢٢	-٣,٧٨*	-١٨,٦٢**	١٧,٩١**	٢٥,٠٤**	٨,٨٥**	٢,٣٢	٤٥,٤٥**
P₄×P₇	-٢,٥٦**	-٠,٧٠	-٤,٥٩*	٧,٣٨**	-٩,٦٧**	-١٢,٣٥**	٢,٧٥**	-٢,٦٥	٦٩,١٢**
P₄×P₈	٠,٠٠	٢,٠٦**	٥,٤٣**	-٠,٥٦	-١٠,١٩**	-٨,٣٨**	١,٠٦**	٢٣,٩٤**	٦٩,٢٣**
P₅×P₆	-١,٣٧*	١,١٤	٤,٥٩*	-١١,٦٣**	-٣,٢٢*	٠,٣٨**	٦,٦٦**	-٢٦,٨١**	-٢٧,٣٤**
P₅×P₇	-١,٥٤*	٠,٦٦	٢,٥٥	-١,٤٨	٦,٨٦**	٨,٩١**	٧,١٧**	-٢,٢١	-١,٨٠
P₅×P₈	-١,٢١	٢,٤٧**	٤,٠٠*	-٣,٧٧**	-٣,٧٩**	-٧,٢٤**	-٢,٧١**	-١٥,٧٩**	-٧٧,٥٢**
P₆×P₇	-١,٧٣**	-٠,٣٨	-٤,٩٦**	١,٩١*	١٠,١٠**	٢٢,١٦**	٢٣,٥١**	٢٠,٨٢**	-٨١,١٦**
P₆×P₈	-٢,٤٥**	٠,٢٢	٧,٣٩**	-٧,٢٤**	-١٤,٦٦**	-١١,٤٧**	-١,٦٩**	-١٠,٥٥**	٧٢,٢٢**
P₇×P₈	-٠,٣٥	٠,٨٢	٦,٨٣**	-١٦,٣٠**	١٦,٨٦**	١٦,٣٩**	٤,٨٢**	-١٠,١١**	-٤٣,٤٣**

* and ** significant at ٠,٠٥ and ٠,٠١ levels of probability, respectively.

For better parent (Table ٨), the result showed that ١٣ crosses had negative and significant heterosis estimates for heading date. However, the

best crosses was Attila-٣ × Sakha ٩٣ . For maturity date, there were two crosses were negative and significant. However, the best cross was Gemmiza ٩ × Sakha ٩٣. For plant height, the cross Gemmiza ٩× P₅ Sakha ٩٤ and Line ١ × Sakha ٩٤ were positive and significant. For number of spike /plant, there were seven positive significant crosses and the best cross was Line ١ × Sakha ٦٩. For number of kernels / spike, there were ١٠ positive significant crosses and the best crosses was Gemmiza ٩ × Sids ١٢. For kernel weight/ spike, there were ١٠ positive significant crosses and the best cross was Attila-٣ × Sakha ٦٩. For kernel weight, there were ١٤ positive significant crosses and the best cross was Sakha ٦٩ × Sids ١٢. For grain yield / plant, there were ١٤ positive significant crosses and the best cross was Line ١ × Sakha ٦٩. For leaf rust, there were ١٨ negative significant crosses and the best cross was Attila-٣ × Sids ١٢. These results are in line with those obtained by Shehab Eldeen (٢٠٠٨) and Sharshar (٢٠١٠).

Table (٨): Estimation of heterosis over better parent (BP) for F₁ crosses for all studied characters.

crosses	DH	DM	PLH	NS/P	NK/S	KW/S	١٠٠KW	GY/P	LR
P₁×P₂	٥،٣٥**	-١،١٨	-٣،٦٠	٧،٣١**	-٢٤،٠٨**	-٢٠،٦٧**	١٠،٧٠**	٩،٧٤**	-٢،٧٨
P₁×P₃	-٠،٨٤	٠،١١	١،٤٤	٧،٥١**	-١٩،٠٣**	-١٦،١٤**	٢،٤١**	٢٠،٦١**	-٧٢،٢٢**
P₁×P₄	-٤،٠١**	-١،٥٠	-٦،٨٥**	٣،٢٧**	-٣،٠٦*	٣،٨٦**	٥،٣٦**	٣٠،٨٣**	-١٩،٤٤
P₁×P₅	٤،٥٢**	١،٩٧*	٢،١٦	-١١،٤٤**	-٥،٣١**	-٥،٥٠**	-١،٠٩**	٢،٤٢	-٥٥،٥٦**
P₁×P₆	-٤،٠١**	-٠،٧٦	-٧،٥٩**	١،٩١	١٣،٨٢**	٣٦،٥٢**	١٨،٤٢**	٣٤،٠١**	-١٣،٨٩
P₁×P₇	-٤،٥٢**	٠،٥٥	-٠،٧٢	-٦،٥٩**	٨،١٠**	-٥،١٠**	-١،٥٣**	٢،٨٥	-٩٥،٨٣**
P₁×P₈	-٤،٨٥**	-٠،٦٦	١،٤٤	-٣،٤٩**	-١١،٤٨**	-٢،٠١**	١١،٣٨**	٣،١٧*	-٢٢،٢٢*
P₂×P₃	١٠،١٤**	٠،٩٧	٠،٠٠	٤،١٠**	٤،٧٢**	-٤،٤٤**	-٥،٠٣**	٢٧،٩٩**	٩٦٨،٩٧**
P₂×P₄	-٠،١٧	-٠،٤٣	-٢،٧٤	-١،٩٤**	-٣٣،٤٤**	-٣٣،١٥**	-٢،٤٣*		٨٨،٨٩**
P₂×P₅	٦،٤٤**	-١،٢٩	٨،٧٠**	-٣٠،٣٣**	-٢،٠٧	-٠،١٠	-٧،٣٣**	٥،٩٦**	-١٣،٧٦
P₂×P₆	-١،٣٧	-٠،١١	-٠،٦٩	-١٥،١٥**	٥،٠٩**	-١٣،٣٥**	-١٤،١٧**	-١١،٧٦**	٩٣،٣٣**
P₂×P₇	-١،٧٢	-١،٢٩	-٣،٦٢	-٨،٩٠**	١٥،٠٩**	٢٣،٠٦**	٩،٦٣**	٢٧،١٤**	-٨٥،٤١**
P₂×P₈	-٠،١٧	-٢،٢٦**	٠،٠٠	-١٦،١٥**	-١،٢٥	-١٧،٧٤**	-١٣،٢١**	٥،٦٧**	-٨٠،٤٨**
P₃×P₄	-٣،٧٠**	-٠،٤٣	٠،٠٠	١٣،٣٢**	١،٦٣	٢٥،٤٢**	١٢،٩٥**	٤٠،٦٨**	-٦٧،٧٨**
P₃×P₅	٠،٨٥	٠،٨٧	٥،٠٧*	-٨،٧٦**	-٢٧،٥٢**	-١٩،١٢**	٠،٦٤*	-١،٢٠	٢٣٠،٦٥**
P₃×P₆	-٠،٥٢	-٠،٨٦	-٣،٤٥	١٨،٧٩**	-١٠،٥٥**	-١،٢٤**	-٠،٧٥**	٤١،٢٥**	٢٦،٦٧**
P₃×P₇	٣،٩٨**	٠،٨٧	-٨،٠٣**	-٥،٥٠**	١٥،٠٢**	٤،٩٤**	-٦،٩٦**	-١،١٦	٢٢٨٨،٧١**
P₃×P₈	٠،٧٠	-٠،١١	-٣،٨٥	١،٦٦	-١٣،٤٧**	-١٤،٨١**	-١،٣٦**	-٩،١٢**	-٨٦،٦٧**
P₄×P₅	-٣،٥٤**	-٢،٠٤*	-١،٣٧	-٢٤،٣٤**	١١،٨٩**	٢١،١٣**	٨،٩٨**	٤٠،٠٦**	-٨٤،٣٣**
P₄×P₆	-٣،٧٠**	٠،٠٠	-٤،١١	-٢١،٢٣**	٧،٣٥**	١٦،١٥**	٨،٧٠**	٢،٣٢	٣٣،٣٣**
P₄×P₇	-٣،٨٧**	-١،٥٠	-٧،٠٣**	٥،٤،٢٥	-١٣،١٤**	-١٠،٢٧**	٠،٢٥	-٢،٦٥	-١١،١١
P₄×P₈	-٢،٣٦*	٠،٩٧	-٦،٨٥**	-٢،٩٤**	-١٠،٧٩**	-١،٠٦**	-٢،٨٥**	٢٣،٩٤**	٥٧،١٤**
P₅×P₆	-٢،٣٧*	٠،٣٢	٢،٠٧	-١٥،٦٩**	-١٣،٧٤**	-٩،٣٥**	٥،٥٤**	-٢٦،٨١**	-٦٠،٦٧**
P₅×P₇	-٢،٥٤**	٠،٣٣	٢،١٧	-١٠،٤٢**	٠،٤٥	٨،٥٧**	٥،٥١**	-٢،٢١	-١٤،٤٤
P₅×P₈	-٣،٢٢**	٢،٤١**	-٥،٠٨**	-٨،٩٤**	-١١،٧٦**	-١٢،١٢**	-٦،٦٢**	-١٥،٧٩**	-٨٨،١٠**
P₆×P₇	-١،٧٣	-٠،٨٦	-٧،٥٩**	-٣،١٢**	٤،٠١**	٩،٩٩**	٢٠،٣٤**	٢٠،٨٢**	-٩٠،٠٠**
P₆×P₈	-٣،٤٦**	-٠،٥٤	-٤،٨٣*	-٨،٠٤**	-١٧،٣٠**	-١٥،٨٦**	-٦،٥٨**	-١٠،٥٥**	٤٧،٦٢**
P₇×P₈	-١،٣٨	٠،٠٠	-٢،٩٢	-١٩،٧٧**	١٣،٨٤**	٩،٩٢**	٢،١٦**	-١٠،١١**	-٧٠،٤٨**

* and ** significant at ٠،٠٥ and ٠،٠١ levels of probability, respectively.

Correlation coefficient

The correlation coefficient between the studied characters are shown in Table ٢٩. 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.* (٢٠٠٣) and Sharshar (٢٠١٠).

Table (٩): Simple correlation coefficients among all studied characters.

characters	GY/P	HD	MD	PLH	NS/P	NK/S	KW/S	١٠٠٠-KW	LR
GY/P	١	-٠,١١١	-٠,١٣٦	٠,١٣٣	٠,٢١٨	٠,٤٠٣**	٠,٥٩٦**	٠,٣٧٢*	-٠,١٤٨
HD		١	٠,٢٩٧	٠,٢٣٢	-٠,٠٨١	-٠,٠٢٤	-٠,١٧٠	-٠,٠٩٣	٠,٢٣٠
MD			١	٠,٢٤٨	-٠,١٧٢	٠,١٣٩	-٠,٠١٢	-٠,٢٢٩	٠,٢١٢
PLH				١	-٠,٠٥١	٠,١٠١	٠,٠٠٢	-٠,١٧٢	-٠,٠٤٤
NS/P					١	-٠,٤٢١*	-٠,٢٣٦	٠,٢٠٩	٠,٠٧٥
NK/S						١	٠,٧٨١**	-٠,٠٨٧	-٠,٣٢٢*
KW/S							١	٠,٥١٢*	-٠,٤٢٨**
١٠٠٠-KW								١	-٠,١٧٩
LR									١

* and ** significant at ٠,٠٥ and ٠,٠١ levels of probability, respectively.

REFERENCES

Awaad, H. A., A .H. Salem, M. M. M. Atia, and Minass, E. A. Sallam ٢٠٠٣ .the genetic system controlling leaf rust reisstance in bread wheat.Zagazig J. agric. Res. ٣٠:١١٥١ –١١٦٧.

Bai, D., D. R. Knott, and J. M. Zale. ١٩٩٧. The inheritance of leaf and stem rust resistance in Triticum monococcum L. Can. J. Plant Sci.٧٨:٢٢٣-٢٢٦.

Chowdhary, M. A., M. Sajad, and M.L. Ashraf, ٢٠٠٧ Analysis of combining ability of metric traits in Bread wheat, Triticum aestivum. J Agric. Res., ٤٥ (١). ١١-١٧.

Darwish, I.H.I.; El-Sayed, E. and Waffa, El-Awady ٢٠٠٦. Genetic studies of heading date and some agronomic characters in wheat. Annals of agric. Sc. Moshtohor. ٤٤(٢):٤٢٧-٤٥٢.

Dyck , P .L. ١٩٩١. Genetic of adult plant leaf rust resistance in "Chinese spring" and "Sturdy" wheat .Crop Sci. ٣١ : ٣٠٩ –٣١١.

El-Beially, I.E.M.A. and E.M.A. El-Sayed ٢٠٠٢. Heterosis and combining ability in some bread wheat crosses (*T. aestivum* L). j. Agric. Sci. Mansoura Univ. ٣٠(٢) : ٧٥٥-٧٦٢.

El-Borhamy, H. S. A. ٢٠٠٥. Estimation of Heterosis and combining ability in some bread wheat crosses *(Triticum aestivum L.).* J. gric. Sci. Mansoura Univ., ٣٠ (٢) : ٧٥٥-٧٦٢.

Ganeva, G., M. Todorova, and H. Kurzhin, ٢٠٠١. Inheritance of the resistance to the causative agent of the brown rust in wheat varieties and lines. Rasteniev" dni Nauki٣٨ ١٨١-١٨٥. (C.F. Review of Plant Patho.٨١: ٩٣٥٢.

Griffing, B. ١٩٥٦. Concept of general and specific combining ability inrelation to diallel crossing system. Aust. J. Biol. Sci. ٩: ٤٦٣-٤٩٣.

Menshawey A.M., and M. Najeeb. ٢٠٠٤. Genetical and pathological studies on certain Egyptian wheat genotypes as effected by both leaf and stripe rust. J. Agric. Sc. Mansoura Univ. ٢٩:٢٠٤١-٢٠٥١.

Nawar, A. A., T. M. Shehab El-Din, A. N. Khalil, H. H. Nagaty and K. E. Ragab.٢٠١٠. Inhertance nature of leaf rust resistance and some agronomic characters in bread wheat. J. of plant production, Vol. ١ (٣): ٤١٧-٤٢٩.

Patil, J. V., A. B. Deokar, and R. B. Deshmukh. ٢٠٠٠ . Genetic analysis of three wheat cultivars for reaction to stem rust of wheat. Indian J. Agric. Res. ٣٤: ٢٧٥-٢٧٧. (C.F. Review of Plant Pathology ٨١(٩) ٨١٩٢).

Salama, S.M., ٢٠٠٠. Partial diallel analysis and heterosis in bread wheat (*Triticum aestivum* L.) Zagzig J. Agric . Res. ٢٧: ١٣٧١- ٣٨٤.

Sharshar, A. M. ٢٠١٠. Combining ability and heterosis for bread wheat under stress and normal irrigation treatments. M.Sc.Thesis, Kafr El-Sheikh Univ, Egypt.

Shehab Eldeen, M. T. M. ٢٠٠٨. Genetic studies on earliness and drought tolerance in bread wheat. M.Sc. thesis, Cairo, Univ., Egypt.

Shehab El-din, T. M., M. A. Gouda, S. Abouel-Naga, and M. M. EL-Shami. ١٩٩١. Quantitative study on wheat resistance to stem rust caused by puccinia graminis tritici .J. Agric. Sci. Mansoura Univ. ١٦ : ١٢٩٨ –١٣٠٣.

Shehab El-din, T. M., and A. H. Abd El-Latif. ١٩٩٦. Quantitative determination of the gene action of stripe rust resistance in a ٦-parent diallel cross of wheat. J. Agric. Sci. Mansoura Univ. ٢١: ٣٤٦١ –٣٤٦٧.

Singh, R. P., A. Mujeeb-Kazi, and J. Huerta-Espino. ١٩٩٨. *Lr٤٦*: a gene conferring slow-rusting resistance to leaf rust in wheat. Phytopathol. ٨٨: ٨٩١- ٨٩٤.

Snedecor, G.W. and W.G.Cochran ١٩٨٠. Statistical method. ٧th Ed.Iowa State Univ.Press,Ames. Iowa. USA.

Stubbes, R. W., J.M. Prescott, E. E. Saari and H. J. Dubin. ١٩٨٦. Cereal diseas methodology manual.(CIMMYT). Mexico pp.٢٢٢.

Yadav, B., C. S. Tyagi, and D. Singh. ١٩٩٨. Genetical studies and transgressive segregation for field resistance to leaf rust of wheat. Wheat Info. Serv. ٨٧:١٥-٢١.

Zhang, Z. J., G. H. Li, S. L. Jin, and X.B. Yang. ٢٠٠١. Transgressive segregation, Heritability and number of genes controlling durable resistance to stripe rust in one Chinese and two Italian wheat cultivars. Phytopathol. ٩١: ٦٨٠ –٦٨٦.

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 ٢٠٠٨/٢٠٠٧ و٢٠٠٩/٢٠٠٨ لتقدير قوه الهجين و القدره على التآلف و نظام التحكم الـوراثى 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-٣، جميزه ٩، سلاله١، سدس١ سخا ٩٤، سخا٦٩، سدس١٢و سخا٩٣. 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 المائـة حبـة ، محصـول الحبوب للنبات و صفه المقاومه لصدأ الورقة.بينما استبعدت بيانات الصدأ الأصفر لعدم كفايتها نظرا لعدم ظهور المرض بصوره كافيه يمكن الاعتماد عليها. و أشـارت النتـائج وجـود تبـاين معنوى لكـل 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. كمـا أظهرت نتـائج التحليل ان تبـاين كل من القدره العامـه و الخاصـه على التآلف كانت معنويـه لجميع الصفات ممـا يدل على اهميه التباينات الوراثيه المضيفه و السائده و كانت نسبه القدره العامـه الـى نسبه القدره الخاصـه للتآلف اكبر من الواحد لجميع الصفات ماعدا صفه وزن الحبه مما يدل على أهميه التباينات الوراثيه المضيفه. و اعطت الهجن سلاله١ × سدس١ و سلاله١× سخا٦٩ أعلى قيمه معنويه موجبه لقوه الهجين لصفه وزن حبوب النبات نسبه الى متوسط الأبوين و أفضل الأبوين على الترتيب. بينما أعطى الهجين اتيلا-٣ × سدس١٢ 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 الحبـه كانت معنويـه موجبه بينمـا كـان معامـل الارتباط بين صفه صدأ الورقه مع صفتى عدد حبوب السنبله و وزن حبوب السنبله سالبا ومعنويا.

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