INHERITANCE OF YIELD AND ITS COMPONENTS IN SOME BREAD WHEAT (*TRITICUM AESTIVUM*) CROSSES UNDER HEAT STRESS

TAMMAM, A.M. AND A.G. ABD EL-RADY

Wheat Res. Department, Field Crops Res. Institute, ARC, Giza

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Abstract

Six bread wheat genotypes namely Giza164, Giza168, Sids1, Sids7, Sahka93 and Debeira were used to study. The inheritance of grain yield and its components i.e. number of spikes/plant, number of kernels/spike and kernels weight, using a half-diallel cross in the F_1 and F_2 generations. The parental genotypes, F_1 hybrids and F_2 populations were grown in a randomized complete block design with three replicates under normal and late sowing conditions (heat stress). Results exhibited that late sowing reduced number of spikes/plant, number of kernels/plant, kernels weight and grain yield/plant by (13.17 and 11.65 %), (11.76 and 7.50 %), (9.98 and 15.78%) and (21.82 and 27.27 %) for F_1 and F_2 generation, respectively as compared with normal planting date. The best parents under the two sowing dates were Debeira for number of spikes /plant, Sids 7 for number of kernels /spike and kernels weight, Sids 1 for grain yield and Sakha 93 under the recommended planting date. The most promising F_2 populations in grain yield were ($P_1 \times P_3$), ($P_4 \times P_6$), ($P_3 \times P_6$) and. ($P_4 \times P_5$) under normal conditions. Heat stress index values showed that the heat tolerant parents were Sids 7, Giza 164 for number of spikes/plant, Sids 1 and Debeira for number of kernels/spike, Sids 1 for kernels weight and Sids 7 for grain yield. The promising F_2 populations for heat tolerance were ($P_1 \times P_6$), ($P_1 \times P_5$), ($P_2 \times P_5$) and ($P_2 \times P_3$) and selection could be practiced in these populations for grain yield and/or its components. Both additive and non-additive gene effects were important in the genetic system for yield and its components. The additive gene effects were the most prevalent type under both sowing dates for these characters except for grain yield in F_1 under late sowing and in F_2 populations under both sowing dates. The parents showed more positive alleles for all traits in both generations under both sowing dates except for kernels weight in the F_1 and F_2 generations under recommended planting. Broad-sense heritability values varied from intermediate to high in all characters. Narrow-sense heritability values intermediate to low in all characters. These results indicate that these characters could be affected by dominance effects and environmental factors. From the previous results we can concluded that selection in segregation generation could be effective to produce lines have high grain yield under heat stress.

INTRODUCTION

Wheat is one of the major cereal crops in Egypt, which receive the attention of specialists in plant breeding. Successful breeding programs need continuous information on the genetic variation and systems governing grain yield and its components. Wheat yield was reduced 3 to 4% per 1^0C above the optimum range of 15 to 20 ^{0}C in grain filling (Chowdhury and Wardlaw, 1978).

Grain yield and its components remain major selection criteria for improved adaptation to stress environments in many breeding programs (Ortiz Ferrara *et al.* 1991). Hence, there is a strong need to elucidate molecular and genetic basis of heat tolerance in cereals to identify beneficial genes and alleles and to utilize them in the molecular breeding programs targeted to produce superior cereal cultivars in the future. Selim (2000) found a significant decrease in number of spike/m^2, number of kernels/spike, 1000 – kernel weight and grain yield /plant in late sowing. Sandeep *et al.* (2000) found that Genotypes and sowing dates had a significant influence on grain yield/plant and biological yield/plant. Kheiralla and Sherif (1992) found that late sowing decreased 1000- kernel weight and grain yield/plant by 8.7% and 22.8%, respectively. Jatasra and paroda (1980) and Tammam (2005) showed the importance of additive genetic variance in the inheritance of number of spikes/plant, number of kernels/plant, 100-kernel weight and grain yield/plant. Hamada and Tawfelis (2001) demonstrated that the additive gene effects played a major role in the inheritance of number of kernels/plant, 100-kernel weight and grain yield. Tammam (1989) found that the dominance gene effects played an important role in the inheritance of number of spikes/plant and grain yield. Hassan *et al.* (1993) and Ismail *et al.* (2001) indicated that the degree of dominance $(H_1/D)^{1/2}$ was higher than unity. Also $H_2/4H_1$ was less than 0.25 for number of spikes/plant, number of kernels/plant, 100-kernel weight and grain yield/plant. El-Sayed (2004) found that low values of heritability for number of kernels/plant, 100-kernel weight and grain yield/plant.

The objectives of this study were:

1-asses the genetic behavior of some agronomic characteristics in 15 bread wheat crosses under heat stress.

2-detrmine the type of gene action controlling agronomic traits under heat stress.

3-Identify the best parents combinations under heat stress.

MATERIALS AND METHODS

This study was conducted at Shandaweel Agricultural Research Station, ARC, Egypt, during the three growing seasons 2003/04, 2004/05 and 2005/06. The genetical materials chosen for this study included six bread wheat cultivars, which represents a wide range of diversity for several traits. The local name, pedigree and origin of these six varieties are presented in Table (1).

Table 1. Local name, pedigree and origin of the six parents.

Ent. No	Name	Pedigree	Origin
1	Giza 164	KVZ / BUHO"S" // KAI / BB=VEERY"S" #5	Egypt
2	Giza 168	MRL / BUC // SERI.	Egypt
3	Sakha 93	SAKHA 92 / TR 810328	Egypt
4	Sids 1	HD21 / PAVON "S" // 1158.57 / MAYA74"S"	Egypt
5	Sids 7	IMAYA"S"/MON"S"//CMH74.592/3/SAKHA8*2	Egypt
6	Debeira	(Shandaweel Bread wheat breeding program)	Sudan

In 2003/04 season, the parental varieties were sown at 3 various dates in order to produce F_1 seeds of all possible cross combinations (excluding reciprocals) of the 6-parent diallel. In 2004/05 season, the 15 F_1 hybrids and the parents were sown in the field to produce grains of the F_2 generation. In addition, the parents were intercrossed again to produce more hybrid grains for each cross. In 2005/06, parents, F_1 hybrids and F_2 populations were grown in two sowing dates namely, 25th November (normal sowing date) and 25th December (late sowing date).

The experiment was designed in a Randomized Complete Block Design with three replications. Each of the parents and F_1 hybrids were represented by one row, while each F_2 population was represented by six rows per block. The plants were grown in one-meter long rows, spaced 30 cm apart and plants were spaced 10 cm within each row. The borders were sown with Sohag3 durum wheat variety. The recommended agricultural practices were applied from sowing to harvest.

The following characteristics were measured on a random sample of 5 guarded plants from the parents, F_1 hybrids and mean random sample of 48 guarded plants from the F_2 populations in each replicate in the two dates. The means of the 5 or 48 plants were subjected to statistical and genetical analysis. The studied characters were number of spikes/plant, number of kernels/plant, 100-kernel weight and grain yield/plant. A diallel analysis as developed by Hayman (1954 a, b, 1957 and 1958) and Mather and Jinks (1971) was performed on the data of 2005/06 seasons. The Heat Tolerance Index (HTI) for each entry was computed according to Farshadfar, *et al.* (2001) as follow:

$HTI = Y_P \times Y_S / (Y_P)^2 \times 100$ = Heat Tolerance Index = HTI

Where,

Y_P = grain yield under normal condition.

Y_S = grain yield under heat stress condition.

RESULTS AND DISCUSSION

1- Number of spikes/plant

The average number of spikes/plant and Heat Tolerance Index "HTI" for the six parents, 15 F_1 and 15 F_2 generations are presented in Table (2). These results showed that the average number of spikes/plant for the parents ranged from 5.57 for Sids 7 (P_5) to 18.63 spikes/plant for Debeira (P_6) with an average of 13.21 spikes/plant under recommended sowing date and varied from 5.25 for Sids 7 (P_5) to 13.97 spikes/plant for Debeira (P_6) with an average of 10.85 spikes/plant under late sowing. The average of F_1's crosses ranged from 11.03 for the cross (Sakha93 x Sids7) to 16.13 for the cross (Giza 168 x Debeira) with an average of 13.82 spikes/plant under the recommended planting date and varied from 11.00 for (Sakha 93 x Sids 7) to 14.16 for (Giza 164 x sids1) with an average of 12.00 spikes/plant under late planting. The average of 15 F_2 populations ranged from 11.87 for the cross (Giza 168 x Side 7) to 16.60 for the cross (Sids 7 x Debeira) with an average of 14.41 spikes/plant under recommended planting and from 10.93 for (Giza 168 x Sids 7) to 14.83 for (Sakha 93 x Debeira) with an average of 12.73 spikes/plant under late planting. Delaying planting reduced number of spikes by 13.17 and 11.65 % for F_1 and F_2 generations, respectively, when compared with the recommended planting date. Heat Tolerance Index "HTI" values based on number of spikes/plant indicated that Sids 7(P_5) and Giza164 (P_1) were the best parents which relatively tolerated heat (HTI=94.25 and 90.34, respectively), while Sakha 93 was the most heat susceptible parent (HTI=74.51).The most tolerant F_1hybrids and their F_2 populations were (P_1x P_3), (P_1x P_4) (P_1x P_5),(P_1x P_6), (P_2x P_5),(P_3x P_5),(P_4x P_5),(P_4x P_6) and (P_5x P_6). It was shown that Giza164 (P_1) and Sids 7 (P_5) were common parents in four crosses out of nine tolerant crosses. This suggested that Sids 7 and Giza 164 possess heat tolerance genes and could be used in crossing to produce lines with high yield and tolerant to heat stress. These results are in agreement with those reported by Selim (2000).

Table 2. Mean performance and Heat Tolerance Index (HTI) of six wheat parental genotypes, F_1 hybrids and F_2 Populations for number of spikes/plant, number of kernels/spike, 100-kernel weight and grain yield (g/plant) under normal (N) and late (L) planting dates.

Entry	No. of spikes/plant		H.T.I	No. of kernels/spike		H.T.I	100-kernel weight (g)		H.T.I	Grain yield (g)		H.T.I
Parents	N	L		N	L		N	L		N	L	
P_1	12.73	11.50	90.34	48.94	43.59	89.07	4.76	4.49	94.32	29.57	23.00	77.78
P_2	13.50	10.80	80.00	43.79	38.44	87.78	4.57	3.60	78.77	26.91	14.34	53.29
P_3	14.67	10.93	74.51	44.08	36.41	82.60	4.37	4.11	94.05	27.78	17.31	62.31
P_4	14.13	12.68	89.74	45.62	43.66	95.70	4.49	4.29	95.54	31.94	23.67	74.11
P_5	5.57	5.25	94.25	65.68	60.57	92.22	5.02	4.79	95.42	18.39	16.53	89.88
P_6	18.63	13.97	74.98	32.22	30.01	93.14	4.36	3.82	87.61	26.02	17.02	65.41
Mean	13.21	10.85		46.72	42.11		4.66	4.19		26.77	18.64	
LSD (G) P≤0.05	2.37	1.55		6.27	5.38		0.44	0.31		4.76	2.32	
LSD (D) P≤0.05	1.58			1.72			0.16			3.26		
F_1 hybrids												
P_1× P_2	14.37	11.08	77.11	43.22	39.28	90.88	4.64	4.35	93.75	28.66	24.42	85.20
P_1× P_3	12.50	11.17	89.36	41.61	40.02	96.17	4.87	4.29	88.09	25.30	24.14	95.41
P_1× P_4	15.43	14.16	91.77	43.22	38.20	88.38	4.93	4.53	91.88	32.54	23.93	73.54
P_1× P_5	14.03	12.53	89.31	52.99	47.64	90.00	5.19	4.18	88.25	38.55	23.39	60.67
P_1× P_6	14.37	12.87	89.56	42.88	41.25	96.19	5.06	4.40	86.95	31.15	24.64	79.10
P_2× P_3	13.17	11.13	84.51	36.56	34.45	94.22	4.40	4.25	96.59	23.23	20.23	87.08
P_2× P_4	15.83	13.31	84.08	42.15	38.55	91.45	4.56	3.96	86.84	30.42	20.30	66.73
P_2× P_5	12.80	11.62	90.78	43.67	38.63	88.46	4.63	4.40	95.03	25.85	25.37	98.14
P_2× P_6	16.13	12.22	75.76	37.74	34.84	92.31	4.65	3.97	85.37	28.16	22.62	80.33
P_3× P_4	15.47	11.32	73.17	33.30	30.87	90.35	5.11	4.30	84.15	26.17	18.85	72.03
P_3× P_5	11.03	11.00	99.72	54.69	42.28	77.31	5.14	4.73	92.02	30.38	25.31	83.31
P_3× P_6	14.33	12.07	84.23	39.20	30.14	76.88	4.51	4.23	93.79	25.24	18.70	74.09
P_4× P_5	12.07	12.03	99.66	55.25	50.87	92.07	5.08	4.63	91.14	33.45	23.22	69.42
P_4× P_6	13.23	12.02	90.85	43.32	34.75	80.22	4.65	4.37	93.39	26.55	18.44	69.45
P_5× P_6	12.60	11.53	91.51	38.95	34.30	88.06	4.78	4.43	92.67	23.37	21.83	93.41
Mean	13.82	12.00		43.52	38.40		4.81	4.33		28.60	22.36	
LSD(G) P≤ 0.05	2.10	1.21		7.24	4.63		0.42	0.40		3.24	2.24	
LSD (D) P≤ 0.05	0.71			2.34			0.21			0.90		

Table 2. continued

Entry	No. of spikes/plant		H.T.I	No. of kernels/spike		H.T.I	100-kernel weight (g)		H.T.I	Grain yield (g)		H.T.I
F_2 populations	N	L		N	L		N	L		N	L	
$P_1 \times P_2$	14.90	12.63	84.76	46.63	43.32	92.90	4.35	3.72	85.52	30.14	20.14	66.82
$P_1 \times P_3$	16.27	14.05	86.35	45.17	40.75	90.21	4.69	4.05	86.35	34.09	21.53	63.16
$P_1 \times P_4$	12.93	12.43	96.13	47.49	45.18	95.13	4.59	3.93	85.62	28.16	21.73	77.16
$P_1 \times P_5$	12.27	11.38	92.75	47.41	45.53	96.03	4.77	3.93	82.39	27.50	22.34	81.33
$P_1 \times P_6$	15.83	14.06	88.82	38.72	35.98	92.92	4.54	3.91	86.12	27.79	22.50	80.96
$P_2 \times P_3$	13.97	12.27	87.83	42.15	36.32	86.17	4.14	3.65	88.16	24.27	21.40	88.17
$P_2 \times P_4$	14.23	13.05	91.71	48.51	41.93	86.43	4.35	3.62	83.22	30.00	19.81	40.1
$P_2 \times P_5$	11.87	10.93	92.08	48.78	46.62	95.57	4.74	4.10	86.49	27.37	23.46	85.71
$P_2 \times P_6$	15.17	12.15	80.09	46.71	44.55	95.37	4.30	3.66	85.12	30.28	19.65	65.00
$P_3 \times P_4$	14.27	11.78	82.55	40.92	40.59	99.10	4.81	4.05	84.20	27.90	19.34	69.32
$P_3 \times P_5$	13.53	12.43	91.87	44.86	40.82	90.99	5.03	4.39	87.28	30.42	22.30	73.30
$P_3 \times P_6$	16.27	14.83	91.15	46.60	39.89	85.60	4.56	3.77	82.67	34.59	22.24	64.30
$P_4 \times P_5$	12.43	11.48	92.36	51.36	45.26	88.12	5.13	4.39	85.57	32.34	23.11	71.46
$P_4 \times P_6$	15.67	13.73	87.62	45.58	44.63	97.91	4.35	3.64	83.67	31.02	22.72	73.24
$P_5 \times P_6$	16.60	13.76	82.89	33.33	32.31	96.93	5.14	3.63	70.62	27.97	20.54	73.44
Mean	14.41	12.73		44.95	41.58		4.63	3.90		29.59	21.52	
LSD (G) $P \leq 0.05$	1.73	1.76		7.88	4.25		0.41	0.27		3.06	2.74	
LSD (D) $P \leq 0.05$	1.09			1.48			0.15			1.49		

* H.T.I = Heat Tolerance Index.

LSD (G) = Genotypes.

LSD (D) = Planting date

2- Number of kernels/spike

The average number of kernels/spike and Heat Tolerance Index (HTI) for six parents, 15 F_1 crosses and 15 F_2 populations are presented in Table (2). The results revealed that the average of number of kernels/spike for the parents ranged from 32.22 for Debeira (P_6) to 65.68 kernels/spike for Sids 7 (P_5) with an average of 46.72 kernels/spike under recommended planting and varied from 30.01 for Debeira (P_6) to 60.57 kernels/spike for Sids 7 (P_5) with an average of 42.11 kernels/spike under late planting. The average of F_1 crosses ranged from 6 for (Sakha 93 x Sids 1) to 55.25 for (Sids 1 x Sids 7) with an average of 43.52 kernels/spike under recommended planting date and varied from 30.14 for (Sakha 93 x Debeira) to 50.87 for (Sids 1x Sids 7) with an average of 38.40 kernels/spike under late of planting date. The average of F_2 populations ranged from 33.33 for (Sids 7 x Debeira) to 51.36 for (Sids1 x Sids7) with an average of 44.95 kernels/spike under normal date and varied from 32.31 for (Sids 7 x Debeira) to 46.62 for (Giza 168 x Sids 7) with an average of 41.58 kernels/spike under late sowing. Delaying sowing reduced number of kernels/spike by 11.76 and 7.50 for F_1 and F_2 generations, respectively, when compared with recommended planting date. Similar results were obtained by Selim (2000).

With respect to Heat Tolerance Index "HTI" (Table 2), it was shown that Giza 164 (P_1), Sids 1 (P4), Sids 7 (P_5) and Debeira (P_6) were the best parents which were relatively stress tolerant, while Giza 168 (P_2) and Sakha 93 (P_3) were moderately stress tolerant. The most tolerant F_1 hybrids were (P_1xP_2), (P_1x P_3), (P_1x P_5), (P_1x P_6), (P_2x P_3), (P_2x P_4), (P_2x P_6) (P_3xP_4) and (P_4x P_5). These results revealed that Giza 164 (P_1) was a common parent in four crosses out of nine tolerant crosses. This indicated that Giza 164 possesses heat tolerance genes. For F_2 populations, the most tolerant populations were (P_1x P_2), (P_1x P_3), (P_1x P_4), (P_1xP_5), (P_1x P_6), (P_2x P_3), (P_2x P_5), (P_2x P_6), (P_3x P_4), (P_3x P_5), (P_4x P_6) and (P_4x P_5). These populations could serve as base populations for selection to heat tolerance.

3- 100- Kernel weight (gm)

The average of 100–kernel weight and Heat Tolerance Index "HTI" for the six parents, 15 F_1 and 15 F_2 generations are presented in Table (2). The results showed that the average of 100–kernels weight for the parents ranged from 4.36 for Debiera (P_6) to 5.02 gm for Sids 7 (P_5) with an average of 4.66 gm under recommended planting and varied from 3.60 for Giza 168 (P_2) to 4.79 gm for Sids7 (P_5) with an average of 4.19 gm under late planting. The average of 100-kernels weight for F_1 hybrids ranged from 4.40 for (Giza 168 x Sakha 93) to 5.19 gm, for (Giza 164 x Sids

7) with an average of 4.81 gm under recommended sowing date and varied from 3.96 for (Giza 168 x Sids 1) to 4.73 gm for (Sakha 93 x Sids 7) with an average of 4.33 gm under late sowing. For F_2 populations it ranged from 4.14 for (Giza 168 x Sakha 93) to 5.14 gm (Sids7 x Debeira) with an average of 4.63 gm under normal sowing and varied from 3.62 for (Giza 168 x sids 1) to 4.39 gm for (Sakha 93 x Sids 7) and (Sids1 x Sids 7) with an average of 3.90 gm under late sowing. These results indicated that delaying sowing date reduced 100-kernel weight by 9.98 and 15.78 % for F_1 and F_2 generations, respectively, when compared with the recommended planting date. These results could be due to that grain maturity may be affected by high temperature during grain filling period, similar findings were obtained by Kheiralla and Sheriff (1992) and Selim (2000).

With regard to Heat Tolerance Index "HTI" for 100-kernels weight, Sids 1 (P_4) was the best heat tolerant parent, while Giza 168 (P_2) was a susceptible parent. The most tolerant F_1 crosses were (P_1 x P_2), (P_1 x P_3) (P_1 x P_4), (P_1x P_5), (P_2 x P_3), (P_2 x P_5), (P_3 x P_5), (P_3 x P_6), (P_4 x P_5), (P_4x P_6) and (P_5 x P_6), these results showed that four out of eleven crosses, including Giza 164(P_1) and Sids 7 (P_5) as a common parents, showed heat tolerance, suggesting that the tolerant parents (P_1) and (P_5) transmitted genes controlling heat stress tolerance to their hybrids. For F_2 populations, the most heat tolerant segregates were from the crosses (P_1xP_2), (P_1 x P_3), (P_1 x P_4), (P_1 x P_6), (P_2 x P_3), (P_2 x P_5), (P_2 x P6), (P_3 x P_5) and (P_4 x P_5).

4- Grain yield /plant

The average of grain yield/plant and Heat Tolerance Index "HTI" of grain yield/plant for the six parents, 15 F_1 hybrids and 15 F_2 populations are presented in Table (2). The results showed that the average of grain yield/plant for the parents ranged from 18.39 for Sids 7 (P_5) to 31.94 g/plant for Sids1 (P_4) with an average of 26.77 g/plant under recommended planting and varied from 14.34 g/plant for Giza 168 (P_2) to 23.67 g/plant for Sids1 (P_4) with an average of 18.64 g/plant under late planting. The average of grain yield/plant in F_1 crosses ranged from 23.23 for (Giza 168 x sakha 93) to 38.55 g/plant for (Giza 164 x sids 7) with an average of 28.60 g/plant under recommended sowing and varied from 18.44 for (Sids1 x Debeira) to 25.37 gm/plant for (Giza 168 x sids 7) with an average of 22.36 g/plant under late sowing date. The average of grain yield/plant in the F_2 generation ranged from 24.27 for (Giza 168 x Sakha 93) to 34.59 g/plant for (Sakha 93 x Debeira) with an average of 29.59 g/plant under recommended planting and varied from 19.34 for (Sakha 93 x Sids 1) to 23.46 g/plant for (Giza 168 x Sids 7) with an average of 21.52 g/plant under late planting date. Delaying planting date reduced grain yield plant by 21.82 and 27.27

% in $F_1$and F_2 generations, respectively, when compared with the recommended planting date. These results were in agreement with those reported by Sandeep *et al.* (2000).

With respect to Heat Tolerance Index "HTI" (Table 2), it was shown that Giza 164 (P_1) and Sids 7 (P_5) were the best parents, which are relatively heat tolerant, while, Sakha 93 (P_3), Sids 1 (P_4) and Debeira were of moderate tolerance. Giza 168 (P_2) was the susceptible parent. The most tolerant F_1 hybrids were (P_1 x P_2), (P_1 x P_3), (P_1 x P_6) (P_2 x P_3), (P_2 x P_5), (P_3 x P_5) and (P_5 x P_6). It is of the interest to note that Giza 164 (P_1) as a common parent in three crosses out of the seven tolerant crosses had as. This indicates that Giza 164 posses heat tolerance genes and it could be considered a tolerant parent in breeding programs for heat stress. The most tolerant F_2 populations were those of the crosses (P_1 x P_5), (P_1 x P_6), (P_2 x P_3) and (P_2 x P_5).

Genetic analysis

The diallel analyses of variance for number of spikes/plant, number of kernels/plant, 100-kernel weight and grain yield/plant are presented in Table (3). The analysis of variance revealed that the additive "a" and non-additive "b" components were highly significant in both the F_1 and F_2 generations under both environments for all traits except for 100-kernel weight in both F_1 and F_2 generations under late planting date. The magnitude of additive genetic effects was very high when compared with non-additive genetic effects for all traits except for grain yield in the F_2 populations under late planting date, suggesting that the additive genetic variability was more important in the inheritance of these traits. The (b) component was further partitioned to its separate components, b_1, b_2 and b_3. The b_1 item was significant for all traits, except for number of spikes/plant in the F_1 hybrids under normal sowing, number of kernels/spike in the F_2 populations under both sowing dates, 100-kernel weight in the F_1 hybrids under both sowing dates and in the F_2 populations under normal sowing date, indicating the presence of heterosis or epistatic effects. The "b_2" item was significant for all traits except for number of kernels/spike in the F_1 hybrids under normal sowing date and100-kernel weight in the F_1 hybrids under both sowing dates and in the F_2 populations under late sowing date, suggesting asymmetrical distribution of the dominant and recessive genes between the parents. The "b_3" item was significant for all traits except for 100-kernel weight in the F_1 hybrids under normal sowing date and in the F_2 populations under the two sowing dates, indicating a further dominance effects due to specific crosses not attributable to b_1 and b_2. These results are in line with those found by Jatasra and Paroda (1980), Ismail *et al.* (2001), Hamada and Tawfelis(2001) and Tammam (2005).

Graphical analysis

The analysis of variance of (Wr+Vr) and (Wr-Vr) values for F_1 and F_2 generations are presented in Table (4). The magnitude of (Wr+Vr) values were significant for all traits except for 100-kernel weight in the F_1 hybrids under both sowing dates and in the F_2 populations under normal sowing date, grain yield/plant in the F_2 populations under late sowing date, confirmed the presence of non-additive gene effects. The magnitude of (Wr-Vr) values were insignificant for number of spikes/plant in the F_1 hybrids under both sowing dates and in the F_2 populations under normal sowing date, number of kernels/spike in the F_1 hybrids under both sowing dates and 100-kernel weight in the F_1 hybrids under both sowing dates and in the F_2 populations under normal sowing date. It was also insignificant for grain yield/plant in the F_2 populations under the two sowing dates, indicating the absence of deviation from the simple model and the part of non-allelic gene interaction or epistasis. The significance of (Wr-Vr) values for the other cases demonstrate the presence of non-additives genetic effects and it was mainly due to epistatic effects.

The Wr/Vr graphs for the studied traits of both F_1 9 F_2 generations are shown in Figures (1 - 8). The regression coefficients were significant from zero and not different from unity for all studied traits except for grain yield in F_1 hybrids and in F_2 populations under late planting, indicating that additive-dominance model was satisfactory to explain the genetic system for these traits.

Genetic components

The estimates of genetic component controlling the variation of the studied traits with their respective standard errors are given in Table (5). The magnitude of additive gene effects "D" were significant for all studies traits in both $F_1$and F_2 generations under the two planting dates except for 100-kernel weight in the F_1 hybrids under both sowing dates. The dominance (H_1 and H_2) components were significant for all studies traits in both $F_1$and F_2 generations under the two planting dates except 100-kernel weight in the F_1 hybrids under both sowing dates. The additive gene effects "D" were higher in magnitude than dominance effects for all studies traits except grain yield in the F_1 hybrids under the two sowing dates, indicating that additive gene effects played a major role in the inheritance of these traits. The average degree of dominance $(H_1/D)^{1/2}$ was less than unity for all studied traits except grain yield under the two planting dates, suggesting the presence of partial dominance, while it was more than unity for all studied traits in the F_2 populations except number of spikes/plant, indicating the presence of over dominance. The F value was positive and significant for all traits except for 100-kernel weight in both $F_1$and F_2 generations under normal planting date, indicating that the dominance is directed towards increasing yield and its attributes, while the negative F value indicated a stronger influence of genes for a lower number of kernels/spike. The estimates of $H_2/4H_1$ were less than 0.25 for all studied traits in both F_1 and F_2 generations under recommended and late planting dates except 100-kernel weight in the F_1 hybrids, indicating that unequal distribution of dominant to recessive genes between this group of parents. The ratio of $[(4DH_1)^{1/2} + F/ (4DH_1)^{1/2} - F]$ was more than one in both generations under the two planting dates except for 100-kernel weight in both $F_1$and F_2 generations under normal planting date, confirming that the dominant genes were in excess. Similar findings were obtained by Hassan *et al.* (1993) and Tammam (2005). Broad-sense heritability values varied from intermediate to high in all traits. Narrow-sense heritability values were intermediate to low in all characters. These results indicated that these characters could be affected by dominance effects and environmental factors. These results are in line with those obtained by El-Sayed (2004).

These results indicate that using selection in early segregation generations could be effective to produce lines have high grain yield under heat stress.

Table 3. The diallel analysis of variance for number of spikes/plant, number of kernels/spike, 100-kernel weight and grain yield/plant of six parents of wheat genotypes, F_1 hybrids and F_2 Populations under normal (N) and late (L) planting dates (2005-2006).

Item	d.f	No. of spikes/plant		No. of kernels/spike		100-kernel weight		Grain yield	
F_1hybrids		N	L	N	L	N	L	N	L
a	5	56.08**	18.82**	736.5**	639.97**	0.87**	0.814**	146.19**	59.76**
b	15	12.5**	8.47**	118.1**	88.30**	0.194	0.177*	84.98**	42.14**
b_1	1	5.74	20.54**	180.94*	206.15**	0.349	0.295	42.96*	207.1**
b_2	5	20.7**	14.67**	39.63	43.09*	0.178	0.073	112.97**	52.99**
b_3	9	8.72**	3.68**	154.6**	100.35**	0.186	0.221*	74.10**	17.78**
Block interaction	40	2.729	0.945	29.482	14.450	0.1014	0.0835	6.933	1.66
F_2populations									
a	5	70.89**	32.62**	271.39**	267.32**	1.29**	1.24**	45.23**	21.69**
b	15	9.76**	8.96**	146.11**	114.23**	0.193	0.239**	56.14**	25.20**
b_1	1	21.88**	52.79.**	47.24	4.28	0.0118	1.32**	119.41**	124.15**
b_2	5	13.70**	9.02**	193.00**	155.63**	0.322*	0.031	38.76**	29.94**
b_3	9	6.23**	4.01*	131.04**	103.44**	0.142	0.236	58.77**	11.25**
Block interaction	40	2.000	1.734	34.544	11.01	0.1032	0.0444	7.296	4.196

*, ** Significant at 0.05 and 0.01 levels of probability, respectively

Table 4 Analysis of variance of the (Wr+Vr) and (Wr-Vr) values for number of spikes/plant, number of kernels/spike, 100-kernel weight and grain yield/plant in both F1and F2 generations under normal (N) and late (L) planting.

Item	d.f	No. of Spikes/plant				No. of kernels/spike			
		N		L		N		L	
F_1 hybrids		Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr
Blocks	2	10.81	2.18	0.760	4.76	3478.14	412.35	46.18	253.43
Arrays	5	108.40*	10.19	81.82**	1.16	10971.6*	681.72	11506.5**	124.101
Error	10	21.666	5.321	0.602	0.498	2906.69	294.57	448.94	49.79
F_2 populations									
Blocks	2	27.21	2.70	2.117	1.05	60.38	1387.4	130.77	13.72
Arrays	5	258.0**	2.77	100.98**	3.91*	20873.1**	2238.4**	11108.6**	1417.2**
Error	10	15.794	1.50	5.46	0.744	17393.84	376.375	340.19	9.32

Item	d.f	100-kernel weight				Grain yield			
		N		L		N		L	
F_1 hybrids		Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr
Blocks	2	0.0181	0.0042	0.0340	0.0098	70.03	339.86	18.46	33.925
Arrays	5	0.0258	0.0013	0.0150	0.0024	2536.2**	512.89*	157.12**	74.11**
Error	10	0.0105	0.0024	0.0689	0.0012	225.36	120.69	25.614	12.772
F_2 populations									
Blocks	2	0.0474	0.0107	0.0217	0.0034	6.656	27.635	17.94	8.208
Arrays	5	0.0165	0.0658	0.0367**	0.0022*	624.09**	90.247	44.88	25.697
Error	10	0.0118	0.0563	0.0059	0.00062	60.157	47.654	16.15	12.123

*, ** Significant at 0.05 and 0.01 levels of probability, respectively.
N: Normal planting.
L: Late planting.

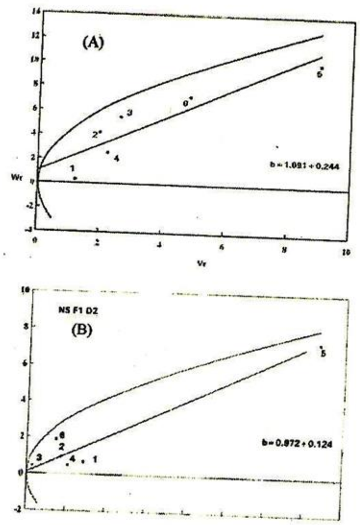

Fig.1. The Wr/Vr graphs for number of spike/plant of F_1diallel cross in the recommended (A) and late (B) sowing dates.

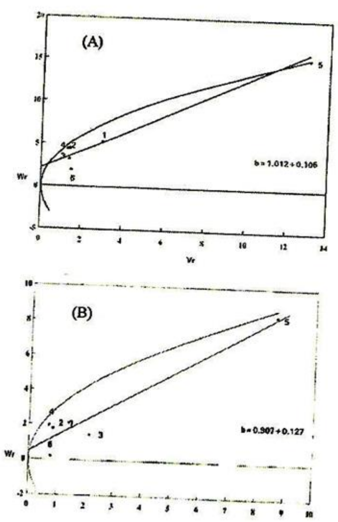

Fig. 2. The Wr/Vr graphs for number of spike/plant of F2diallel cross in the recommended (A) and late (B) sowing dates.

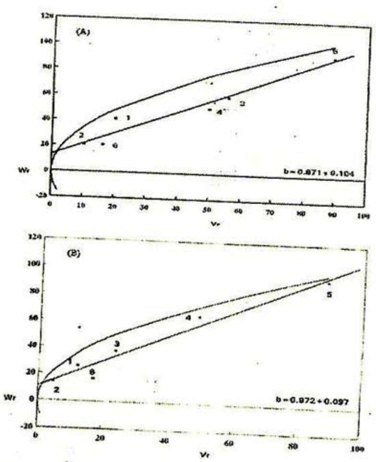

Fig.3. The Wr/Vr graphs for number of kernels/spike of F1diallel cross in the recommended (A) and late (B) sowing dates.

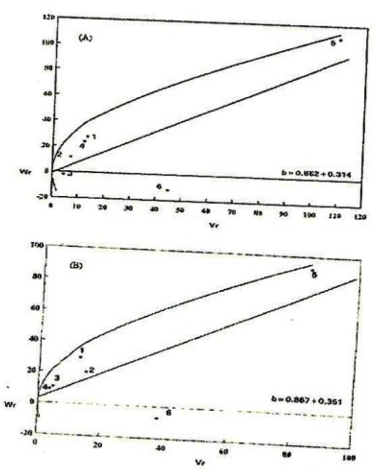

Fig.4. The Wr/Vr graphs for number of kernels/spike of F2diallel cross in the recommended (A) and late (B) sowing dates.

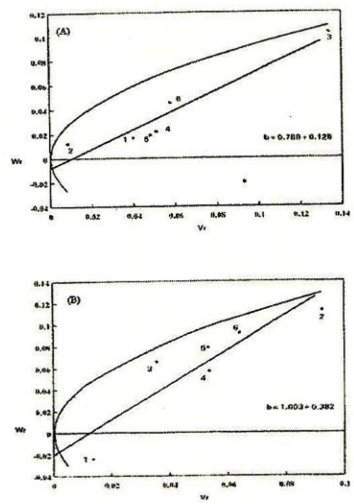

Fig.5. The Wr/Vr graphs for 100-kernel weight of F1 diallel crosses in the recommended (A) and late (B) sowing dates.

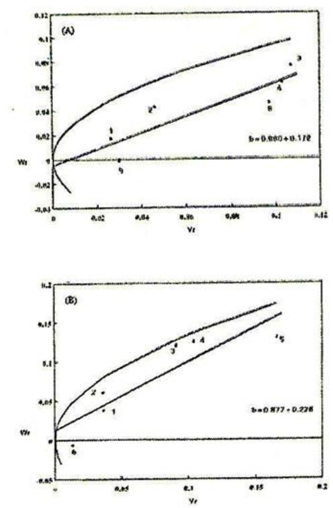

Fig.6. The Wr/Vr graphs for 100-kernel weight of F2 diallel crosses in the recommended (A) and late (B) sowing dates.

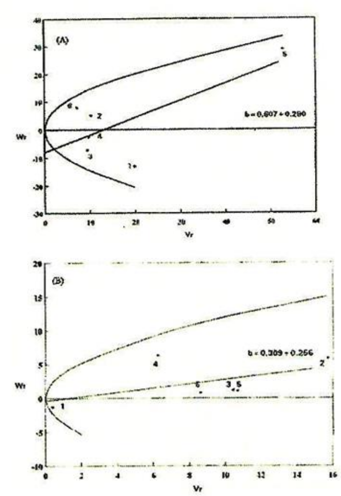

Fig.7. The Wr/Vr graphs for grain yield/plant of F1 diallel crosses in the recommended (A) and late (B) sowing dates.

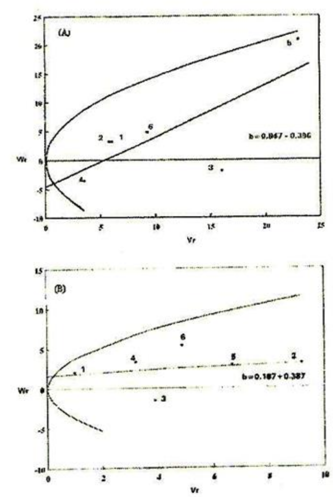

Fig.8: The Wr/Vr graphs for grain yield/plant of F2 diallel crosses in the recommended (A) and late (B) sowing dates.

Tables 5. Components of genetic variation influencing number of spikes /plant, number of kernels/spike, 100-kernel weight and grain yield in both F_1 and F_2 generations under both normal (N) and late (L) planting dates.

Components	No. of spikes/plant		No. of kernels/spike		100-kernel weight		Grain yield	
	N	L	N	L	N	L	N	L
F_1 hybrids								
D	16.66 ± 1.44	8.43 ± 0.44	101.46 ± 10.7	99.26 ± 4.40	0.030 ± 0.031	0.132 ± 2.12	17.32 ± 6.85	13.37 ±1.64
F	14.52 ± 3.51	9.42 ± 1.07	22.82 ± 26.15	34.96 ± 10.75	-0.047 ± 0.075	0.042 ± 0.052	24.86 ± 16.73	18.18 ± 3.99
H_1	8.79 ± 3.65	7.46 ± 1.11	42.58 ± 27.17	46.41 ± 11.17	0.014 ± 0.078	0.007 ± 0.054	71.19 ± 17.39	37.32 ± 4.15
H_2	5.31 ± 3.26	4.59 ± 0.99	45.94 ± 24.27	42.81 ± 9.98	0.017 ± 0.068	0.025 ± 0.048	48.95 ± 15.54	26.24 ± 3.71
h_2	.200 ± 2.19	3.51 ± 0.672	24.15 ± 16.32	33.59 ± 6.72	0.032 ±0.047	0.029 ± 0.032	5.760 ± 2.59	37.83 ± 2.49
E	1.559 ± .544	0.540 ± 0.166	16.85 ± 4.05	8.25 ± 1.66	0.032 ± 0.047	0.047 ± 0.008	3.962 ± 2.59	0.953 ± 0.618
$(H_1/D)^{½}$	0.726	0.941	0.648	0.684	0.691	· 0.227	2.027	1.67
$H_2/4H_1$ uv	0.151	0.156	0.269	0.230	0.291	0.912	0.172	0.175
$(4DH_1)^{½}+F/(4DH_1)^{½}-F$	3.99	3.92	1.42	1.69	0.982	1.573	2.096	2.37
h_2/H_2	0.038	0.76	0.531	0.785	1.918	1.148	0.118	1.44
$H_{b.s}$	72.64%	79.46 %	74.46%	84.39%	41.61%	46.91%	83.17%	91.04%
$H_{n.s}$	49.34%	35.75 %	57.05%	64.16%	37.41%	39.96%	31.22%	29.44%
F_2 populations								
D	17.08 ± .765	7.98 ± 0.538	98.57 ± 12.10	101.23 ± 7.68	0.290 ± 0.047	0.155 ± 0.016	17.12 ± 4.30	11.92 ± 2.17
F	23.73 ± 1.87	12.09 ± 1.31	209.4 ± 29.6	208.1 ± 18.78	-0.126 ± 0.114	0.030 ± 0.037	38.63 ± 10.52	30.74 ± 5.30
H_1	36.18 ± 1.94	30.23 ± 1.36	526.07 ± 30.7	431.76 ± 19.5	0.697 ± 0.119	0.622 ± 0.039	176.7 ± 10.93	89.56 ± 5.51
H_2	17.14 ± 1.73	16.19 ± 1.22	236.1 ± 27.44	255.67 ± 17.4	0.057 ± 0.106	0.442 ± 0.035	117.29 ± 9.76	48.56 ± 4.92
h_2	1.03 ± 4.67	25.93 ± 3.28	-228.1 ± 73.8	-80.68 ± 46.9	-78.65 ± 0.286	0.196 ± 0.094	33.02 ± 26.27	60.03 ± 13.25
E	1.143 ± .289	0.991 ± 0.203	19.74 ± 4.57	6.29 ± 2.91	0.059 ± 0.018	0.025 ± 0.006	4.169 ± 1.627	2.39 ± 0.820
$(H_1/D)^{½}$	0.728	0.973	1.16	1.032	2.451	1.002	1.606	1.37
$H_2/4H_1$ uv	0.118	0.134	0.112	0.148	0.0204	0.181	0.166	0.135
$(4DH_1)^{½}+F/(4DH_1)^{½}-F$	2.827	2.27	2.70	2.98	0.387	1.103	2.082	2.77
h_2/H_2	0.06	1.60	-0.96	-0.315	-0.771	0.443	0.28	1.236
$H_{b.s}$	84.17%	79.02%	70.83%	85.33%	68.72%	82.53%	76.63%	72.88%
$H_{n.s}$	69.24%	57.59%	49.02%	48.07%	66.82%	63.51%	35.52%	38.52%

$H_{b.s}$ = Broad sense heritability $H_{n.s}$ = Narrow sense heritability

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وراثة المحصول ومكوناته فى بعض هجن قمح الخبز تحت ظروف الإجهاد الحراري

احمد محمد تمام ، ايمن جمال عبد الراضى

قسم بحوث القمح – معهد المحاصيل الحقلية – مركز البحوث الزراعية – جيزة

استخدمت ستة تراكيب وراثية من قمح الخبز هى جيزة ١٦٤، جيزة ١٦٨، سدس١، سدس٧، سخا٩٣ و دبيرة لدراسة وراثة المحصول ومكوناته (عدد السنابل بالنبات، عدد الحبوب بالسنبلة، وزن المائة حبة و محصول الحبوب/النبات) باستخدام طريقة الهجن نصف الدائرية لإنتاج الجيل الأول و الثانى. زرعت الأباء، الجيل الأول و الجيل الثاني في تصميم قطاعات كاملة العشوائية باستخدام ثلاثة مكرارات تحت ظروف ميعاد الزراعة الامثل والمتأخر.اظهرت النتائج ان الزراعة المتأخرة ادت الى خفض عدد السنابل للنبات، عدد حبوب السنبلة، وزن المائة حبة و محصول الحبوب للنبات بنسبة (١٣,١٧، ١١,٦٥ %)، (١١,٧٦، ٧,٥٠ %)، (٩,٩٨، ١٥,٧٨ %) و (٢١,٨٢، ٢٧,٢٧ %) فى الجيل الأول والجيل الثانى على التوالى عند المقارنة بالزراعة المثلى. كان الصنف Debeira أحسن الآباء فى عدد السنابل للنبات فى كل من الميعاد الأمثل والمتأخر وفى عدد حبوب السنبلة ، وزن المائة حبة الصنفSids7 تحت ميعادى الزراعة، وفى محصول الحبوب/ النبات الصنف Sids 1 تحت ظروف البيئتين. كانت افضل عشائر الجيل الثانى المبشرة فى محصول الحبوب فى عشائر الهجن (Sakha 93×Giza 164)، (Sids 1 × Debeira)، (Sakha93 × Debeira)، (Sids 1 × Sids 7). أظهرت قيم معامل الإجهاد الحرارى ان الأباء المتحملة للحرارة هىSids 7 ، Giza 164 لعدد السنابل للنبات،Debeira،Sids1 لعدد حبوب السنبلة، Sids1 لوزن المائة حبة Sids 7 لمحصول الحبوب. وكانت عشائر الجيل الثانى المبشرة لتحمل الحرارة هى (Giza164 × Debeira)، (Giza164 × Sids7) ، (Giza 168 × Sids 7)، (Giza × Sakha 93 168) ومن ثم يكون الانتخاب لمحصول الحبوب ومكوناته فعالا فى تلك العشائر. أظهرت النتائج ان كلا من الفعل الجينى المضيف والفعل الجينى غير المضيف يتحكم فى النظام الوراثى للمحصول ومكوناته. وكانت الجينات المضيفة اكثر اهمية من الجينات غير المضيفة ما عدا فى صفة محصول الحبوب فى الجيل الأول تحت الزراعة المتأخرة والجيل الثانى فى كلا ميعادى الزراعة. كانت الأليلات الموجبة والسالبة موزعة بغير انتظام بين الأباء لكل الصفات تحت ميعادى الزراعة و كانت الآباء تحتوى على اليلات موجبة لكل الصفات فى كلا الجيلين تحت ميعادى الزراعة ما عدا وزن المائة حبة فى الجيل الأول والجيل الثانى تحت الميعاد الامثل. تراوحت درجة التوريث العامة من متوسطة إلى مرتفعة لكل الصفات. تراوحت درجة التوريث الخاصة من متوسطة إلى منخفضة لكل الصفات مما يوحى بان هذه الصفات تتأثر بفعل الجينات السائدة وعوامل البيئة. تشير النتائج السابقة أن استخدام الانتخاب فى الأجيال الانعزالية يمكن أن يكون فعال فى إنتاج سلالات عالية المحصول تحت الإجهاد الحراري.