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GENETIC ANALYSIS FOR HEAT TOLERANCE OF GRAIN YIELD IN THREE BREAD WHEAT CROSSES UNDER UPPER EGYPT CONDITIONS.

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ABSTRACT

The present work was carried out during 2006/2007 to 2009/2010. Three crosses among four parents, namely Giza 164 x Giza 168, Debeira x Giza 168 and Giza 164 x Hubara-5 were grown in two experiments (normal sowing date 20th November " N" and 20th December " late sowing" or heat stress " H "). Five populations (P_1, P_2, F_1, F_2 and bulk F_3) for each cross were used. Significant positive heterotic effects were found for all characters except for days to heading in the first and third crosses, spikes /plant in the second cross, kernels/ spike in all crosses and kernel weight in the first cross in the normal sowing date (N) and also grain yield /plant in all crosses, days to heading in the first cross, days to maturity in the second cross, grain filling rate/day and spikes/plant in the first and the second crosses, kernels/spike in the second and the third crosses and kernel weight in the second one in the late sowing date (heat stress "H"). Over-dominance above the higher parent, was detected for all characters, except for days to heading in the second cross, days to maturity in all crosses, kernels/spike in the first and the third crosses and kernel weight in the first one in (N) and also, except days to heading in all crosses, days to maturity and grain filling rate/day in the third cross, spikes/plant in the second and the third crosses, kernels /spike in the second cross and kernel weight in the first and the third crosses in late sowing date (H). The other types of dominance were also studied. Inbreeding depression estimates were found to be significant and positive for days to heading and kernel weight in the third cross, days to maturity in the first and the third crosses, grain filling rate/day and grain yield/ plant in all crosses, spikes/plant and kernel weight in the third cross and kernels/spike in the second cross in F_2 and F_3 under (N) and also significant and positive for grain filling rate/day and kernels /spike in the second cross and for grain yield/plant in all crosses for F_2 under (H). Additive gene effects were significant for all characters except for days to maturity in the second cross and grain filling rate/day in the third cross in (N) and days to heading and kernel weight in the second cross under in late sowing date (H). F_2 deviation (E_1) was significant for all studied characters except for grain filling rate/day in all crosses, spikes/plant and grain yield/plant in the second cross and kernels /spike in the first cross under (N), while under heat stress (H), E_1 was significant for days to heading in the third cross, days to maturity in the first and the second crosses, grain filling rate/day, spikes/plant , kernels/spike and grain yield/ plant in the second cross and kernel weight for all crosses. Moreover, F_3 deviation (E_2) was significant in all characters except for grain filling rate/day and grain yield/plant in all crosses, spikes/plant in the first and the second crosses and kernel weight in the third cross under (N), and except days to heading and spikes/plant in the first and the second crosses, days to maturity in the third cross, grain filling rate/day in all crosses, spikes/plant in the first and the second crosses, kernels /spike in the first and third crosses, kernel weight in the second cross and grain yield/plant in the first cross under (H). These results suggest the potential for obtaining further improvements in most studied characters. In addition, dominance and epistasis were found to be significant for most of the studied attributes. High to medium values of heritability estimates were found to be associated with low and

high expected and actual grain in most characters at both normal and heat stress. Selection in segregating generations could be effective to produce lines that have high yielding ability under late sowing.

Key words: ***wheat, Heat tolerance, Genetic components, five population model.***

INTRODUCTION

Global warming with the ensuing elevated heat stress is a recent phenomenon that poses a serious threat to wheat productivity all over the world (Southworth *et al* 2000). Many of the world's wheat plants are exposed to short periods of very high temperature during grain filling period. The average wheat yield loss due to moderately high temperature is estimated at 10-15 % mainly due to the reduced single kernel weight (Wardlaw and Wrigley 1994). Such loss in single kernel weight is estimated at 4% for each ˚C above the optimum degree in wheat. A heat wave of 3 or 4 days at 35–36 C can modify grain morphology and reduce grain size in wheat. Overcoming the gap of cereal production depends mainly on horizontal extension of cultivated area of cereals. This is encountered by unfavorable conditions such as drought, heat and high salinity of soil. The first step is to identify the superior tolerant genotypes to be used in this programs. Continual heat stress (main daily temperature above 17.6 ˚C in the coolest month of the year) affects approximately 7 million ha of wheat in developing countries, while terminal heat stress is a problem in 40 % of irrigated wheat growing areas of the world (Fischer and Byerlee 1991). Crops damage due to high temperature under late planting condition has become an important factor limiting wheat yields. Therefore, it is highly desirable to develop varieties having tolerance to the heat encountered due to late planting in the region. Elahmadi, (1993) found that heat stress is known to cause stunted plant growth, reduced tillering and accelerated development and lead to small heads, shriveled grains and low yields.

Since potential yield in wheat is established early in the life cycle by the terminal spikelet stage (Siddique *et al* 1989), selection for higher grain yield might be directd to pre-anthesis plant attributes that are related to yield in area experiencing late heat stress. Hybridization between the local wheat cultivars and exotic materials would be the solution to increase genetic variability. Therefore, increasing wheat production vertically and/or horizontally becomes an important goal to reduce the amount of wheat imports and provide enough food to meet the increasing domestic demands. By using some of these response; days to heading and maturity, grain filling rate/day and yield and its components; an easily identifying for heat tolerance can be found.

Genetic analysis provides a guideline to the breeder in evaluating and selecting the elite parents and desirable identifiable cross to be used in the formulation of systemic breeding program for improving quantitative traits such as yield and yield attributes. The results of Kheiralla *et al* (2001), Omara *et al* (2004) and Amin and Ali (2008) indicated that additive and non-additive variance were highly significant for days to heading, No. of kernels/spike, kernel weight and grain yield/plant under normal and late sowing date. The additive gene effect was the main type of gene action in the inheritance of all traits, except for kernel weight under late sowing date. Meanwhile, the dominance gene effect played an important role in the inheritance of grain yield/plant under both environments. El-Sayed (2006), found that both additive and non-additive gene effects controlled genetic system of morph-physiological traits (days to heading and maturity) and grain yield and its components. The additive gene effects were the most prevalent type under normal and late sowing date for these traits except for grain yield in F_1 under late sowing date and F_2 in the two sowing dates. Heritability values were high in both broad and narrow-sense for morpho-physiological traits in the two sowing dates, while broad and narrow-sense values for grain yield and its components varied from intermediate to high in broad and intermediate to low in narrow sense values for all traits under two sowing dates. In addition, concerning the heritability estimates, Abdel-Nour (2006a and b), Abd-Allah (2007), Abd-Allah and Abdel-Dayem (2008) and Abdel-Nour and Hassan (2009) reported that narrow sense heritability estimates were medium to high for yield and its components.

The objectives of this study were to identify the genetic behavior of some agronomic and yield characteristics under normal and heat environment; study the type of gene action which control the agronomic and yield traits under normal and heat stress; and to determine the most promising character(s) to be used for indirect selection for yield under heat stress in bread wheat crosses using five populations.

MATERIALS AND METHODS

Three crosses were used in the present study. They were derived from four widely diverse bread wheat genotypes. Names and pedigrees of parental genotypes are given in Table (1). These genotypes were used to obtain the following crosses: (1) Giza 164 x Giza 168, (2) Debeira x Giza 168 and (3) Giza 164 x Hubara-5

Cultivar Giza 164 (high yield, having high number of kernels/spike, high heavy kernel weight and heat tolerant), cultivar 168 (high yielder, and high number of spikes/plant), cultivar Debeira from exotic materials (high yielder, high number of spikes/plant and have heavy kernel weight under heat stress) and cultivar Hubara-5 is from exotic materials (high yielder and had high number of spikes/plant under heat stress).

Table 1. The name, pedigree and origin of the four parental bread wheat genotypes.

No.	Name	Pedigree	Origin
P_1	Giza 164	KVZ/BUHO"S"//Kal/BB=VEERY "S"#5	Egypt
P_2	Giza 168	MRL/BUC//SERI	Egypt
P_3	Debeira	Unknown	Sudan
P_4	Hubara-5	Unknown	ICARDA

The study was carried out at El-Giza Research Station during three successive seasons from 2006/2007 to 2008/2009. The final experiment (the fourth season) was conducted at Kom Ombo Research Satation, Aswan Governorate, Agriculture Research Center, ARC in 2009/2010 season. In the first season (2006/2007), the parental genotypes were crossed to obtain F_1 seeds. In the second season (2007/2008), the hybrid seed of the three crosses were sown to give the F_1 plants. These plants were selfed to produce F_2 seeds. Crossing was repeated to ensure enough and more fresh hybrid seeds. The new hybrid seed and part of the F_2 seeds were stored under refrigeration for further use. In the third season (2008/2009), F_1, F_2 and parents seeds were sown to produce more F_2 seeds and F_2 plants were selfed to produce F_3 seeds.

In the fourth season (2009/2010), the five populations P_1, P_2, F_1, F_2 and F_3 of each of the three crosses were grown in two adjacent experiments two sowing dates; 20th November (normal sowing date (N) and 20th December (late sowing date "heat stress" (H)). Each experiment was arranged in a randomized complete blocks design with four replications, Rows were 4m long spaced 20cm. apart. The plants within rows were 10cm. apart. Each plot consisted of two rows for each parent and F_1, five rows for F_2 generation and 20 rows for F_3 families selected from F_2 at season 2008/2009 from each cross. Data were recorded on individual guarded plants from each plot (50 plants from F_2, 40-plant from F_3-bulk and 10 plants for parents and/or F_1), for days to heading, days to maturity, grain filling rate/day, No. of spikes/plant, No. of kernels /spike, 100-kernel weight (g) and grain yield/plant. The proper cultural practices were applied as recommended for wheat production in both dates. The average temperature in 2009/2010 season at Kom-Ombo Agric. Res. Station is shown in Table (2).

Table 2. Average, maximum and minimum of monthly temperature at Kom-Ombo during 2009/2010 winter season.

Degree of temperature / Month	Maximum	Minimum	Average
November 2009	29.6	10.5	20.05
December 2009	25.7	6.2	15.95
January 2010	28	8.0	18.0
February 2010	30.8	10.9	20.85
March 2010	33.8	14.2	24.0
April 2010	37.7	17.6	27.65
May 2010	40.5	19.7	30.1

The amount of heterosis was expressed as the percentage increase of F_1 above better parent values. Inbreeding depression was calculated as the difference between the F_1 and F_2 means expressed as percentage of the F_1 mean, and the difference between the F_2 and F_3 means expressed as percentage of the F_2 means. The T-test was used to determine the significance of these deviations where the standard error (S.E.) was calculated as following:

S.E. for better parents heterosis:

$$\overline{F}_1 - \overline{BP} = (V\overline{F}_1 + V\overline{BP})^{1/2}$$

And S.E. for inbreeding depression

$$\overline{F}_1 - \overline{F}_2 = (V\overline{F}_1 + V\overline{F}_2)^{1/2}$$

$$\overline{F}_2 - \overline{F}_3 = (V\overline{F}_2 + V\overline{F}_3)^{1/2}$$

Where in addition F_2 deviation (E_1) and F_3 deviation (E_2) were measured as suggested by Mather and Jinks (1971). Potence ratio (P) was also calculated according to Peter and Frey (1966).

Type of gene effects was estimated according to Singh and Chaudhary (1985) for the five parameter model.

The standard error of additive (d), dominance (h), dominance x dominance (l) and additive x additive (i) is obtained by taking the squares root of respective variation. "T " test values are calculated upon dividing the effects of d, h, l and i by their respective standard error.

$m = \overline{F}_2$

$d = 1/2\,\overline{P}_1 - 1/2\,\overline{P}_2$

$h = 1/6\,(4\overline{F}_1 + 12\,\overline{F}_2 - 16\,\overline{F}_3)$

$l = 1/3\,(1/16\,\overline{F}_3 - 24\,\overline{F}_2 + 8\,\overline{F}_1)$

$i = \overline{P}_1 - \overline{F}_2 + 1/2\,(\overline{P}_1 - \overline{P}_2 + h) - 1/4\,l$

and $Vm = V\overline{F}_2$

$Vd = 1/4\,(V\overline{P}_1 + V\overline{P}_2)$

$Vh = 1/36\,(16V\overline{F}_1 + 144\,\overline{F}_2 + 256\,V\overline{F}_3)$

$Vl = 1/9(256\,V\overline{F}_3 + 576\,V\overline{F}_2 + 64\,V\overline{F}_1)$

$Vi = V\overline{P}_1 + V\overline{F}_2 + 1/4(\,V\overline{P}_1 + V\overline{P}_2 + Vh) + 1/16\,Vl$

Heritability in broad and narrow sense was calculated according to Mather (1949) and parent off-spring regression according to Sakai (1960).

Furthermore, the predicated and actual genetic advance (Δg) from selection were computed according to Johanson *et al* (1955).

The genetic gain as percentage of the F_2 and F_3 mean performance (Δg%) was computed using the method of Miller *et al* (1958).

RESULTS AND DISCUSSION

Genotypes differences were significant in most characters under investigation. The F_2 genetic variances were also significant for all studied characters in the three crosses under the two dates of sowing. Therefore, the different biometrical parameters used in this investigation were estimated. Means and variances of the five populations P_1, P_2, F_1, F_2 and F_3 for the characters studied in the three crosses under normal and late sowing dates conditions are presented in Table (3).

It could be seen that delaying planting date (H) reduced number of days to heading when compared with favorable condition. These results could be due to the fact that unit and the accumulated metabolites required for wheat flowering were reduced in (H). Similar results were reported by Abdel-Karim (1991), Abd El-Shafi and Ageeb (1993), Kheiralla *et al* (2001) and El-Sayed (2006).

Table 3. Means ($\overline{x}$) and variances (S^2) for the studied characters of the five populations (P_1, P_2, F_1, F_2 and bulk F_3 families) in three bread wheat crosses.

Characters	Parameter	Giza 164 x Giza 168									
		Normal sowing date (N)					Late sowing date (heat stress)				
		P_1	P_2	F_1	F_2	F_3 bulk	P_1	P_2	F_1	F_2	F_3 bulk
Days to heading	$\overline{X}$	105.33	101.47	99.84	99.67	99.46	94.25	91.42	92.13	92.40	92.22
	S^2	1.62	1.32	0.72	5.18	4.10	0.39	1.58	1.49	4.85	3.95
Days to maturity	$\overline{X}$	143.27	141.40	146.08	145.80	145.50	133.25	131.33	130.63	130.80	130.33
	S^2	0.32	0.47	0.68	1.25	1.00	0.68	1.63	1.75	8.70	6.69
Grain filling rate/day	$\overline{X}$	0.69	0.56	0.77	0.715	0.65	0.343	0.28	0.414	0.384	0.364
	S^2	0.01	0.01	0.01	0.135	0.09	0.01	0.003	0.007	0.042	0.03
Spikes / plant	$\overline{X}$	9.67	11.60	14.83	14.07	13.08	9.25	7.42	10.00	9.70	9.67
	S^2	5.10	4.80	4.12	23.20	18.50	1.75	1.62	2.30	13.90	9.70
Kernels /spike	$\overline{X}$	59.07	47.39	52.31	51.15	50.67	34.00	38.00	39.90	38.55	36.18
	S^2	50.70	38.60	41.60	150.90	120.95	41.50	36.20	46.70	156.90	123.60
100-kernel weight (g)	$\overline{X}$	4.58	4.04	4.58	4.58	4.59	4.27	3.959	4.00	3.98	3.97
	S^2	0.07	0.08	0.05	0.41	0.26	0.02	0.022	0.029	0.13	0.1
Grain yield/plant (g)	$\overline{X}$	26.16	22.21	35.49	32.96	30.13	13.38	11.17	15.95	14.73	13.88
	S^2	15.60	10.50	13.40	64.70	50.10	4.85	5.67	4.97	48.60	36.80
		Debeira x Giza 168									
Days to heading	$\overline{X}$	101.92	101.47	104.67	104.20	104.36	91.75	91.42	91.63	91.50	91.78
	S^2	2.75	1.32	3.25	8.70	7.20	4.60	1.58	10.50	17.90	13.50
Days to maturity	$\overline{X}$	141.38	141.40	144.08	143.67	143.71	134.25	131.33	135.88	136.10	135.67
	S^2	1.20	0.47	2.50	8.90	5.86	6.60	1.63	8.70	20.50	16.40
Grain filling rate/day	$\overline{X}$	0.75	0.56	0.84	0.77	0.75	0.34	0.28	0.55	0.50	0.474
	S^2	0.01	0.01	0.01	0.12	0.08	0.004	0.003	0.002	0.092	0.069
Spikes / plant	$\overline{X}$	16.75	11.60	15.33	15.07	14.50	10.00	7.42	12.25	11.70	11.00
	S^2	3.70	4.80	2.85	14.70	11.80	1.24	1.62	1.54	12.60	8.25
Kernels /spike	$\overline{X}$	38.38	47.39	45.28	41.83	41.54	36.06	38.00	46.59	44.30	45.33
	S^2	5.98	38.60	7.45	94.50	71.20	4.60	36.20	6.20	99.50	71.50
100-kernel weight (g)	$\overline{X}$	4.61	4.04	4.76	4.83	4.87	3.99	3.959	4.263	4.26	4.167
	S^2	0.04	0.08	0.07	0.32	0.24	0.04	0.022	0.03	0.369	0.275
Grain yield/plant (g)	$\overline{X}$	29.62	22.21	33.03	30.42	29.34	14.39	11.17	24.33	22.08	20.78
	S^2	2.58	10.50	4.55	53.90	35.90	2.50	5.67	3.80	58.60	37.90
		Giza 164 x Hubara 5									
Days to heading	$\overline{X}$	105.33	105.67	101.33	101.20	100.77	94.25	92.54	92.63	92.50	92.30
	S^2	1.62	1.53	1.24	2.57	2.20	0.39	2.65	3.40	6.70	5.60
Days to maturity	$\overline{X}$	143.27	141.80	145.33	144.33	143.38	133.25	132.62	133.13	133.08	133.00
	S^2	0.32	0.64	1.15	6.80	4.80	0.68	3.70	4.65	10.50	7.80
Grain filling rate/day	$\overline{X}$	0.69	0.68	0.9	0.82	0.762	0.34	0.393	0.411	0.37	0.359
	S^2	0.01	0.01	0.01	0.06	0.05	0.01	0.007	0.01	0.11	0.087
Spikes / plant	$\overline{X}$	9.67	12.27	18.00	16.80	15.62	9.25	11.92	11.00	10.58	10.30
	S^2	5.10	1.20	3.90	12.95	10.25	1.75	0.620	1.55	4.70	3.50
Kernels /spike	$\overline{X}$	59.07	49.00	46.00	45.45	44.86	34.00	31.95	38.64	36.95	36.51
	S^2	50.70	25.80	19.70	126.80	98.60	41.50	21.50	10.60	153.50	115.80
100-kernel weight (g)	$\overline{X}$	4.58	4.15	4.78	4.67	4.63	4.27	4.142	3.91	3.88	3.89
	S^2	0.07	0.03	0.03	0.19	0.15	0.02	0.19	0.14	0.65	0.48
Grain yield/plant (g)	$\overline{X}$	26.16	24.66	39.49	35.55	32.45	13.38	15.77	16.63	15.15	14.63
	S^2	15.60	6.40	8.50	47.75	38.60	4.85	2.75	4.10	29.80	19.80

Heterosis relative to the better parent, inbreeding depression percentage, potence ratio (P), E_1, E_2 and different gene actions for the seven studied characters under the two environments are given in Table (4).

Significant positive heterosis was found for grain yield under normal and heat stress in all crosses, days to heading in the second cross, days to maturity and grain filling rate/day in all crosses, spikes/plant in the first and second crosses and kernel weight in the second and the third crosses under (N) and was found for days to heading in the first cross, days to maturity in the second cross, grain filling rate/day and spikes/plant in the first and the second crosses, kernels/spike in the second and the third crosses and kernel weight in the second cross under (H) condition.

Significant negative heterosis was found for days to heading in the first and the third crosses, spikes/plant in the second cross and kernels/spike in the three crosses under (N); days to maturity in the first cross, spikes/plant in the third cross and kernel weight in the first and the third crosses under (H). These results indicated the presence of heterosis effects for these characters.

Similar results were reported by Gautam and Jain (1985), El-Hosary *et al* (2000), Hendawy (2003), Abdel-Nour (2006 a and b), Abdel-Nour and Moshref (2006), Abd-Allah (2007) and Abd-Allah and Abd El-Dayem (2008).

Number of spikes /plant, number of kernels/spike and kernel weight are the main components of grain yield/plant. Hence, heterotic increase if found in one or more of these attributes with other attributes being constant would lead to favorable yield increases in hybrids. The lack of significance in heterosis of kernel weight in the first cross under (N) and kernels/spike in the first cross under (H) could be due to lower magnitude of the non-additive gene action. These results are in agreement with Amaya *et al* (1972) and Katata *et al* (1976). The pronounced heterotic effect detected for No. of spikes/plant in the first and third crosses, kernels weight in the second and the third crosses under (N) and also, spikes/plant in the first and the second crosses, kernels/spike in the second and the third crosses and kernel weight in the second cross under (H) would be of interest in a breeding program for high yield.

These results indicated that duration from planting to heading and maturity was reduced with the delay in sowing, but the reduction was slow up to the end of November and became rapid after November.

Grain filling period under (H) environment was reduced as compared with the normal planting date. The decrease in grain filling period could be due to increasing temperature during this period, causing decrease in grain yield. These results are similar to those reported by Abdel-Karim (1991), El-Morshidy et al (2001), and Ficher and Maurer (1978). They reported that grain yield was reduced by 4% as a result of increasing

Table 4. Heterosis, potence ratio, inbreeding depression and gene action parameters in the three bread wheat crosses.

Character			Days to heading			Days to maturity			Grain filling rate/day			Spikes / plant		
Cross			1	2	3	1	2	3	1	2	3	1	2	3
Heterosis % over B.P.		N	-1.61	3.15**	-3.80**	3.31**	1.91**	2.49**	11.30**	11.58**	30.14**	27.84**	-8.48**	46.70**
		H	0.78**	0.23	0.097	-0.53**	3.46**	0.38	20.70**	62.24**	4.58	8.11**	22.50**	-7.72**
Potence ratio		N	1.845	-13.22	24.53	-4.005	-269	-3.8	2.164	1.892	60.43	4.347	2.744	5.41
		H	0.498	0.515	0.895	1.729	2.116	-0.62	3.254	8.153	0.022	1.82	0.449	0.311
Inbreeding depression %	Normal	F_2	0.17	0.450	0.13	0.19*	0.29	0.69**	6.90*	7.99**	8.24**	5.13	1.70	6.67**
		F_3	0.21	-0.15	0.43*	0.19*	-0.03	0.42	8.53	3.24	7.52*	7.04	3.78	7.02**
	Heat	F_2	-0.29	0.14	0.14	-0.13	-0.16	0.04	7.25	9.09*	9.24	3.00	4.49	3.82
		F_3	0.195	-0.31	0.22	0.36	0.32	0.06	5.21	5.20	3.75	0.31	5.98	2.65
Gene action parameters	Normal	m	99.67**	104.2**	101.2**	145.8**	143.67**	144.33**	0.715**	0.838**	0.824**	14.07**	15.07**	16.80**
		d	1.93**	0.225*	-0.17	0.935**	-0.01	0.735**	0.067**	0.098**	0.004	-0.965**	2.58**	-1.30**
		h	0.673	-0.113	1.23**	0.907**	0.167	3.20**	0.198**	0.111	0.215**	3.147*	1.69	3.95**
		l	-0.667	2.107	-1.95	-0.693	1.307	-2.4	-0.184	0.045	-0.133	-7.92*	-2.35	-3.09
		i	8.093**	-2.64**	5.06**	-0.968*	-2.54**	1.88**	0.187*	0.122	0.01	-1.812	5.69**	-5.68**
		E_1	-1.95**	1.02**	-2.22**	1.593**	0.935**	0.398**	0.02	0.03	0.032	1.338**	0.318	2.32**
		E_2	-4.32**	2.36	-5.29**	2.645**	1.99**	-1.11*	-0.083	0.001	-0.061	0.695	-0.505	2.27**
	Heat	m	92.40**	91.50**	92.50**	130.8**	136.1**	133.08**	0.384**	0.50**	0.373**	9.70**	11.70**	10.58**
		d	1.415	0.165	0.855**	0.96**	1.46**	0.315**	0.032**	0.03**	-0.025**	0.915**	1.29**	-1.34**
		h	0.30	-0.66	0.62	1.14	1.0	0.25	0.073	0.103	0.063	0.28	2.23*	1.03*
		l	-1.68	1.84	-0.72	-2.96	-2.88	-0.32	-0.027	-0.005	0.027	0.64	-2.27	-0.37
		i	3.835**	-0.37	3.095**	4.72**	0.83	0.69	0.034	-0.08	-0.03	0.445	1.27	-2.06**
		E_1	-0.083	-0.11	-0.51*	-0.66**	1.77**	0.05	0.021	0.07**	-0.017	0.533	1.22**	-0.21
		E_2	-0.53	0.35	-1.43**	-2.26**	2.67**	-0.07	0.003	0.089	-0.06	1.065	1.04	-0.99*

Table 4. Cont.

Character			Kernels /spike			100-kernel weight (g)			Grain yield/plan (g)		
Cross			1	2	3	1	2	3	1	2	3
Heterosis % over B.P.		N	-11.44**	-4.45*	-22.13**	-0.11	3.28**	4.26**	35.67**	11.51**	50.96**
		H	5.0	22.61**	13.64**	-6.26**	6.84**	-8.23**	19.21**	69.07**	5.45**
Potence ratio		N	-0.158	9.86	-1.60	0.981	18.61	1.90	5.724	1.92	18.77
		H	1.95	0.532	5.53	-0.734	1.533	-4.66	3.326	7.17	1.72
Inbreeding depression %	Normal	F_2	2.22	7.62**	1.12	-0.11	-1.43	2.26**	7.13**	7.90**	9.98**
		F_3	0.938	0.69	1.30	-0.13	-0.93	0.77	8.59**	3.55	8.72**
	Heat	F_2	3.38	4.92**	4.37	0.50	-0.07	0.97	7.65*	9.25**	8.89**
		F_3	6.15	-2.33	1.19	0.33	2.18	-0.39	5.77	5.89	3.43
Gene action parameters	Normal	m	51.15**	41.83**	45.45**	4.58**	4.826**	4.667**	32.96**	30.42**	35.55**
		d	5.84**	-4.51**	5.04**	0.27**	0.284**	0.217**	1.975**	3.705**	0.75**
		h	2.773	3.07	1.94	-0.019	-0.165	0.168	9.233**	4.62*	10.89**
		l	-2.35	7.65	-1.68	0.019	0.059	0.10	-8.35	1.20	-6.027
		i	15.73**	-8.33**	20.05**	0.256*	-0.033	0.19*	1.879	4.915**	-1.688
		E_1	-1.62	-2.25**	-4.57**	0.138*	0.285**	0.098**	3.12**	0.948	3.10**
		E_2	-4.20*	-5.09**	-10.32**	0.287**	0.661	0.124	0.59	-0.265	0.00
	Heat	m	38.55**	44.33**	36.95**	3.98**	4.263**	3.875**	14.73**	22.08**	15.15**
		d	-2.0**	-0.97**	1.025*	0.154**	0.016	0.063*	1.105**	1.61**	-1.195**
		h	7.22*	-1.22	2.30	0.048	0.25	-0.015	3.08	4.97**	2.373
		l	-9.04	8.24	2.16	-0.016	-0.49	0.18	-1.28	-0.93	1.173
		i	-0.68	-11.88**	-1.32	0.469**	-0.01	0.40*	1.615	-3.36*	-2.072
		E_1	0.60	2.49**	1.14	-0.077**	0.14**	-0.18**	0.618	3.53**	0.45
		E_2	-3.54	7.04**	1.41	-0.179**	0.097	-0.34*	-0.465	4.45**	-1.95*

temperature by 1℃ over the optimum temperature if such rise occurred from the end of tillering until the grain filling stage.

The potence ratio obtained indicated over-dominance towards the higher parent were obtained for all characters except for days to heading in the second cross, days to maturity in all crosses, kernels /spike in the first and the third crosses and kernel weight in the first cross under (N) and also days to heading in all crosses, days to maturity and grain filling rate/day in the third cross, spikes/plant in the second and the third crosses, kernels/spike in the second cross and kernel weight in the first and third crosses under (H). Complete dominance was found for kernel weight in the first cross under (N). Over-dominance towards the lower parent was obtained for days to heading in the second cross, days to maturity in all crosses and kernels/spike in the third cross under (N) and also found for kernel weight in the third cross under (H). There was partial dominance towards the higher parent for days to heading in all crosses, grain filling rate/day in the third cross, spikes/plant in the second and the third crosses and kernels/spike in the second cross under (H). Meanwhile, partial dominance towards the lower parent was found for kernels/spike in the first cross under (N) and also days to maturity in the third cross and kernel weight in the first cross under (H). These results are in harmony with those obtained by Ketata *et al* (1976), Jatasra and Paroda (1980), Abul-Nass *et al* (1991), Hendawy (2003), Abdel-Nour (2006b), Abdel-Nour and Moshref (2006), Abdel-Allah (2007), Abdel-Alla and Abdel-Dayem (2008) and Abdel-Nour and Hassan (2009).

Significant inbreeding depression (ID) was found for days to heading, spikes/plant and kernel weight in the third cross, days to maturity in the first and the third crosses, grain filling rate/day and grain yield/plant in all crosses and kernels/spike in the second cross under (N).However, under heat stress condition, significant (ID) was found for grain filling rate/day and kernels/spike in the second cross and grain yield/plant in all crosses. These significant values may be mainly due to high magnitudes of over-dominance and dominance for these trairs.

Significant heterosis and insignificant inbreeding depression were obtained for days to heading and days to maturity and kernel weight in the second cross and spikes/plant in the first cross under (N) and also days to heading and grain filling rate in the first cross, days to maturity and kernel weight in the second cross, spikes/plant in the first and the second crosses under (H) condition. These results indicated that selection in the segregating populations for development of grain yield under (H) condition could be effective to produce lines that have high grain yield and high tolerance to heat stress. Similar results were obtained by Kherialla, *et al* (2001), Omara *et al* (2004) and Amin and Ali (2008).

Nature of gene action was determined using the five parameter model (Table 4). The estimated mean effect of $\overline{F_2}$ (m) which reflects the contribution due to the overall mean plus the locus effect and interaction of fixed loci, was found to be highly significant for all studied characters in all crosses under both normal and heat stress. The additive gene effect (d) was found to be significant and positive for days to heading and grain filling rate/day in the first and the second crosses, days to maturity and kernels/spike in the first and the third crosses, spikes/plant in the second cross and kernel weight and grain yield/plant in all crosses under (N). However, significant negative additive values (d) was obtained for days to maturity in the third cross, spikes/plant in the first and the third crosses and kernels/spike in the second cross also under (N) condition. However, significant positive additive values (d) was obtained for all characters except for days to heading and kernel weight in the second cross, grain filling rate/day, spikes/plant and grain yield/plant in the third cross and kernels/spike in the first and the second crosses under (H) condition. By contrast, significant negative additive values (d) was obtained for grain yield, spikes/plant and grain yield/plant in the third cross, and kernels/spike in the first and the second crosses under (H) condition. These results suggest the potential for obtaining further improvement for the former characters that showed positive and significant values by using pedigree selection program.

Dominance gene effect (h) was found to be significant for days to heading in the third cross, days to maturity, grain filling rate/day and spikes/plant in the first and the third crosses, and grain yield/plant for all crosses under (N) and also spikes/plant in the second and the third crosses, and grain yield /plant in the second cross under (H) condition. When dominant genes are present, it would be tend to favor the production of hybrids, while the existence of the additive gene action in the gene pool encourage the improvement of the character by selection program.

Dominance x dominance (l) type of gene action was found to be negative and significant for spikes/plant in the first cross under (N) condition. These results confirm the important role of dominance x dominance gene interaction in the genetic system controlling these characters. A significant additive x additive type of epistasis (i) was detected for all characters in all crosses except for grain filling rate/day in the second and the third crosses, spikes/plant in the first cross, kernel weight in the second cross and grain yield/plant in the first and the third crosses under (N) condition and also significant additive x additive types was obtained for days to heading and kernel weight in the first and the third crosses, days to maturity in the first cross, spikes/plant in the third cross and grain yield in the second cross under (H) condition. The important roles of both additive and non-additive gene actions in certain studied characters indicated that selection procedures based on the accumulation of additive effects would be very successful in improving these characters. Similar trends were reported by Nayeem and Veer (1994), Abdel-Karim (1991), Kherialla *et al* (2001), Hendawy (2003), Omara *et al*(2004), Abdel-Nour (2006 b), Abdel-Dayem (2008), Amin and Ali (2008) and Abdel-Nour and Hassan (2009).

Significant and positive F_2 deviation (E_1) was found for days to heading in the second cross, days to maturity and kernel weight in all crosses, spikes/plant and grain yield/plant in the first and the third crosses and also negative significant F_2 deviation (E_1) was found for days to heading in the first and the third crosses and kernels/spike in the second and the third crosses under (N).

Significant and positive F_2 deviation (E_1) was found for all characters in the second cross except for days to heading and also negative significant for days to heading in the third cross, days to maturity in the first cross and kernel weight in the first and the third crosses under (H) condition. On the other hand, insignificant F_2 deviation was detected for grain filling rate/day in all crosses, spikes/plant and grain yield/plant in the second cross and kernels/spike in the first cross under (N) condition and also were found for days to heading in the first and the second crosses, days to maturity in the third cross, grain filling rate/day, spikes/plant, kernels/spike and grain yield/plant in the first and the third crosses under heat (H) condition. This may indicate that epistatic gene effects had major contribution in the inheritance of these traits.

F_3 deviation (E_2) was found to be significant and positive for days to heading in the second cross, days to maturity and kernel weight in the first and the second crosses and spikes/plant in the third cross and also negative significant value was found for days to heading in the first and the third crosses, days to maturity in the third cross and kernels/spike in all crosses under (N) condition. Positive significant (E_2) values were detected for days to maturity , kernels /spike and grain yield/plant in the second cross and also negative significant estimate was found for days to heading, spikes/plant and grain yield/plant in the third cross, days to maturity in the first cross, and kernel weight in the first and the third crosses under (H) condition and also for days to heading and spikes/plant in the first and the second crosses, days to maturity in the third cross, grain filling rate/day in all crosses, kernels/spike in the first and the third crosses, kernel weight in the second cross and grain yield/plant in the first cross under (H) condition. These results would ascertain the presence of epitasis in such magnitude as to warrant great deal of attention in a breeding program.

Heritability estimates in broad and narrow sense and between generations (parent-offspring regression), are presented in Table (5). High heritability values in broad sense were detected for all studied characters under both conditions ranged from 96.74 to 71.09 % (indicating that

Table 5. Heritability and expected versus actual gain for all the studied characters in three crosses of bread wheat.

Characters	Cross	Heritability %						Expected gain				Actual gain			
		Broad sense		Narrow sense		Parent offspring regression		G. S		Δ g % of F_2		G. S		Δ g % of F_3	
		N	H	N	H	N	H	N	H	N	H	N	H	N	H
Days to heading	1	76.45	76.23	41.70	37.11	59.07	56.67	1.955	1.684	1.96	1.82	2.464	2.32	2.48	2.52
	2	71.95	68.94	34.48	49.16	53.22	59.05	2.095	4.285	2.01	4.68	2.942	4.469	2.82	4.87
	3	43.07	67.97	28.79	32.84	35.93	50.40	0.951	1.751	0.94	1.89	1.098	2.457	1.09	2.66
Days to maturity	1	60.80	84.45	40.00	46.12	50.40	65.33	0.921	2.808	0.63	2.15	1.038	3.48	0.71	2.67
	2	84.38	72.47	68.31	40.00	76.35	56.24	4.198	3.730	2.92	2.74	3.807	4.692	2.65	3.46
	3	89.66	71.33	58.82	51.43	74.24	61.38	3.160	3.433	2.19	2.58	3.35	3.531	2.34	2.66
Grain filling rate	1	95.56	85.71	72.59	57.14	84.07	71.43	0.549	0.241	76.84	62.82	0.508	0.255	77.66	70.02
	2	93.33	96.74	53.33	50.00	73.33	73.37	0.356	0.312	46.17	62.48	0.419	0.397	56.19	83.76
	3	89.06	93.75	56.25	44.64	72.66	69.20	0.293	0.308	35.58	82.51	0.321	0.419	42.13	116.78
Spikes / plant	1	79.86	86.40	40.52	60.43	60.19	73.42	4.020	4.640	28.58	47.85	5.333	4.711	40.77	48.71
	2	74.27	88.36	39.46	69.05	56.86	78.70	3.117	5.049	20.68	43.15	4.024	4.657	27.75	42.33
	3	73.75	72.19	41.70	51.06	57.72	61.63	3.091	2.280	18.40	21.55	3.807	2.375	24.37	23.06
Kernels /spike	1	71.09	73.57	39.70	42.45	55.39	58.01	10.05	10.95	19.64	28.41	12.55	13.29	24.77	36.72
	2	81.65	84.25	49.31	56.28	65.48	70.27	9.87	11.57	23.61	26.11	11.38	12.24	27.40	27.00
	3	74.71	84.02	44.48	49.12	59.60	66.57	10.32	12.54	22.70	33.93	12.19	14.76	27.18	40.42
100-kernel weight (g)	1	83.66	80.24	73.17	44.80	78.41	62.52	0.965	0.326	21.07	8.20	0.824	0.401	18.12	10.11
	2	79.68	91.68	46.35	50.95	63.02	71.31	0.536	0.638	11.11	14.97	0.639	0.770	13.11	18.49
	3	77.97	79.26	48.96	52.53	63.46	67.36	0.442	0.873	9.47	22.53	0.498	0.961	10.75	24.71
Grain yield/plan (g)	1	79.65	89.38	45.13	48.56	62.39	68.97	7.478	6.974	22.69	47.34	9.097	8.619	30.19	62.09
	2	89.10	93.19	66.79	70.65	77.94	81.92	10.10	11.14	33.21	50.46	9.620	10.39	32.79	50.00
	3	78.71	86.91	38.32	67.11	58.52	77.01	5.455	7.55	15.34	49.81	7.49	7.059	23.08	48.25

superior genotypes for these characters could be identified from the phenotypic expression and illustrates the importance of straight forward phenotypic selection for improvement of these traits) except for days to heading in the third cross and days to maturity in the first cross under (N) condition (N) which revealed moderate broad sense heritability.

Narrow sense heritability estimates ranged from 28.79% for days to heading in the third cross to 73.17 % for kernel weight in the first cross under (N) condition and ranged from 32.84 % for days to heading in the third cross to 70.65 % for grain yield in the second cross under (H). The parent-offspring regression heritability was found to be high to moderate and ranged from 35.93% to 84.07% under (N) condition and from 50.4 % to 81.92 % under (H) condition. The differences in magnitude of both narrow sense and parent-offspring regression heritability estimates for all studied characters would ascertain presence of both additive and non-additive gene effects in the inheritance of these characters. This conclusion was confirmed by estimates of gene action parameter. Similar conclusions were also reported by Kherialla *et al* (2001), Abdel-Nour and Moshref (2006), Abdel-Nour (2006 a and b), Abdel-Allah and Abdel-Dayem (2008) and Abdel-Nour and Hassan (2009).

Besides, Table (5) shows the expected versus actual genetic gain for all studied characters. The expected genetic advance ($\Delta g\%$ F_2) and actual genetic advance ($\Delta g\%$ F_3) ranged from low to moderate for all studied characters in all crosses under both normal and heat stress conditions. These results indicated the possibility of practicing selection in early segregating generations to enhance these characters and hence selecting high yielding genotypes. Dixit *et al* (1970) pointed out that high heritability is not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with high genetic gain.

Generally, most of the significant biometrical parameters resulted from all crosses were higher in magnitude under heat stress but results from the second cross (Debeira x Giza 168) was higher than those obtained from the first and third ones. Consequently, it could be concluded that the crosses (Giza 164 x Giza 168), (Debeira x Giza 168) and (Giza 164 x Hubara-5) would be of interest in breeding program for genetic improvement of wheat under heat stress condition.

REFERENCES

Abd-Allah, Soheir M. H. (2007). Gene effect on yield components of five bread wheat crosses. Alx. Sci. Ex. J. 28(3): 92-101

Abd-Allah, Soheir M. H. and S. M. A. Abdel-Dayem (2008). Determination of gene effects and variances in three bread wheat crosses. Amn. Agric. Sci. Moshtohor. 46(1): Ag. 23 – 31

Abdel-Karim, A. A. (1991). Evaluation of Some Wheat Germplasm under Stress. M. Sci. Thesis, Fac. Agric., Assiut University, Egypt.

Abdel-Nour Nadya, A. R.(2006 a). Gene effect on yield and yield components for three bread wheat crosses (*Triticum aestivum* L.) Egypt J. Agric. Res. 84 (4): 1157-1171.

Abdel-Nour, Nadya A. R. (2006 b). Genetic variation in grain yield and its components in three bread wheat crosses. Egypt J. Plant Breed. 10 (1): 289 – 304.

Abdel-Nour, Nadya A. R. and Manal A. Hassan (2009). Determination of gene effects and variance in three bread wheat crosses for low water (drought). Egypt. J. Plant Breed. 13: 235 – 249.

Abdel-Nour, Nadya A.R. and M. Kh. Moshref (2006). Gene effects and variances in three wheat crosses using five parameters model. Egypt. J. Plant Breed. 10(1):305-318.

Abdel-Shafi, A. M. and O. A. A. Ageeb (1993). Breeding strategy for developing heat-tolerant wheat varieties adapted to Upper Egypt and Sudan. In Proceeding of the International Conferences. Wheat in Hot Dry, Irrigated Environment Wad Medani, Sudan. 1- 4 February.

Abul-Nass, A. A., A. A. El-Hosary and M. Asaker (1991). Genetical studies on durum wheat (*Triticum durum* L.) Egypt. J. Agron. 16 (1-2): 81-94.

Amaya, A. A., R. H. Bunch and K. L. Iebsock (1972). Estimates of genetic effects of heading date, plant height and grain yield in durum wheat. Crop Sci. 12: 478-481.

Amin, I. A. and S. A. Ali (2008). Breeding for heat tolerance in bread wheat under Upper Egypt conditions. Minia J. of Agric. Res. And Devlop. 28: 47 – 66.

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

Elahmadi, A. B. (1993). Development of wheat germplasm tolerant to heat stress in Sudan. Wheat in Hot Dry, Irrigated Environment. Wad Medani, Sudan 1- 4 February.

El-Hosary, A. A., M. E. Riad, Nagwa A. Rady and Manal A. Hassan (2000). Heterosis and combining ability in durum wheat Proc. 9th conf. Agron., Minufiya Univ., Sep: 101 – 117.

El-Morshidy, M. A.; K. A. A. Kheiralla and M. M. Zakaria (2001). Studies on grain filling under different planting dates in wheat. The second Pl. Breed. Conf. October 2, 2001 Assiut Univ. 241 - 263.

El-Sayed, A. G. A. (2006). Genetical studies on some bread wheat crosses under heat stress. M. Sc. Thesis, Fac. Agric. Minia University. Egypt.

Fischer, R. A. and D. R. Byerlee (1991). Trends of wheat production in the warmer areas: major issues and economic considerations. In: D. A. Saunders (ed). Wheat for Nontraditional warm areas. Mexico, D. F. CYMMYT, PP. 3- 27.

Fischer. R. A. and R. O. Maurer (1978). Drought resistance in spring wheat cultivars. 1-Grain yield response. Aust. J. Agric. Res. 29: 897 – 912.

Gautam, P. L. and K. B. L. Jain (1985). Heterosis for various characters in durum wheat . Indian J. Genet. 45: 159– 165.

Hendawy, H. I. (2003). Genetic architecture of yield and its components and some other agronomic traits in bread wheat. Menufyia J. Agric. Res. 28 (1): 7 – 86.

Jatasra, D. S. and R. S. Paroda (1980). Genetics of yield and yield components in bread wheat. Indian J. of Agric Sci. 50(5): 379 – 382.

Johanson, H. W., H. F. Robinson and R. E. Comstock (1955). Estimates of genetic and environmental variability in soybeans. Agron. J. 47: 314.

Ketata, H., E. L. Smith, L. H. Edwards and R. W. Mc New (1976). Detection of epistatic additive and dominance variation in winter wheat (*Triticum aestivum* L. em Thell). Crop. Sci. 16(1): 1 – 4.

Kheiralla, K. A., M. A. El-Morshidy and M. M. Zakaria (2001). Inheritance of earliness and yield in bread wheat under favourable and late sowing dates. The Second Pl. Breed. Conf. October 2, 2001. Assiut University: 219-239

Mather, K. (1949). Biometerical Genetics. Methuen Co., ltd. London.

Mather, K. and J. L. Jinks (1971). Biometrical Genetics. 2nd edition. Champman and Hill, Itd London.

Miller, P. A., J. C. Williams, H. F. Robinson and R. E. Comstock (1958). Estimates of genotypes and environmental variances in upland cotton and their implications in selection. Agron. J. 50: 126 – 131.

Nayeem, K. A. and M. V. Veer (1998). Gene effects for themtolerance parameters and some yield components in bread wheat (*Triticum aestivum* L.) under normal and late sowing. Crop. Improvement 25 (2): 229 – 231.

Omara, M. K., M. M. El-Defrawy, A. M. Tammam and A. A. F. Kassam (2004). Genetic control of pre-anthesis attributes of wheat plant and their associations with yield under heat stress. Assiut J. Agric. Sci. Vol.35 (4): 97–115.

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

Sakai, K. I. (1960). Scientific basic of plant breeding. Lectures given at the Fac. Of Cairo Agric. Univ. and Alex. University.

Siddique, K. H. M.; E. J. M. Kirby and M. W. Perry (1989). Ear stem ratio in old and modern varieties. Relationship with improvement in number of grains per ear and yield. Field Crops. Res. 21: 59 – 78.

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

Southowrth, J. J. C. Randolph, M. D. Habeck, O. C. Doering, R. A. Pfeifer, D. G. Rao and J. J. Johanston (2000). Consequences of future climate changing variability on maize yields in the Midwest United States. Agric Ecosyst. Enoir N. Y. PP. 243 – 291.

Wardlaw, I. F. and C. W. Wrigley (1994). Heat tolerance in temperature cereals; an overview. Austr. J. Plant Physiol. 21: 698 – 703.

التحليل الوراثي لتحمل محصول الحبوب للحرارة لثلاث هجن من قمح الخبز تحت ظروف مصر العليا

نادية عدلي رياض عبد النور ومحمد مختار زكريا

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

أجري هذا البحث في محطة بحوث الجيزة في ثلاث مواسم من ٢٠٠٧/٢٠٠٦ إلى ٢٠٠٩/٢٠٠٨، ثم أجريت تجربة التقييم النهائي في محطة البحوث الزراعية بكوم أمبو – محافظة أسوان في الموسم الرابع ٢٠١٠/٢٠٠٩م على ثلاث هجن من قمح الخبز في ميعادين الأول ٢٠ نوفمبر وهو الميعاد الأمثل والميعاد الثاني متأخر في ٢٠ ديسمبر ، وبتحليل العشائر الخمسة لكل من الأبوين والأجيال الأول والثاني والثالث لكل من الهجن الثلاثة (جيزة ١٦٤ × جيزة ١٦٨ ، دبيرا × جيزة ١٦٨ و جيزة ١٦٤ × هبرا–٥) كانت النتائج كما يلي :

١) كانت قوة الهجين في الجيل الأول (F_1) بالنسبة للأب الأفضل معنوية وموجبة لحبوب النبات للهجن الثلاثة تحت الميعاد المناسب ، وكذلك بالنسبة لعدد الأيام حتى الطرد في الهجين الثاني، عدد الأيام حتى النضج الفسيولوجي ومعدل امتلاء الحبوب/ يوم للثلاث هجن ، عدد السنابل/نبات في الهجين الأول ووزن مائة حبة في الهجينين الثاني والثالث وذلك تحت ظروف الزراعة في الميعاد المناسب ، أما بالنسبة للميعاد المتأخر فكانت قوة الهجين بالنسبة لحبوب النبات موجبة ومعنوية في الثلاث هجن ، عدد الأيام حتى طرد السنابل في الهجين الأول، عدد الأيام حتى النضج الفسيولوجي ووزن مائة حبة في الهجين الثاني ، معدل امتلاء الحبوب/يوم وعدد السنابل/ نبات في الهجينين الأول والثاني وعدد الحبوب/ سنبلة في الهجينين الثاني والثالث وذلك تحت ظروف الإجهاد الحراري (الزراعة المتأخرة) .

٢) أوضحت دراسة طبيعة التوارث أن درجة السيادة كانت فائقة تجاه الأب الأعلى لجميع الصفات ما عدا عدد الأيام حتى طرد السنابل في الهجين الثاني ، عدد الأيام حتى النضج الفسيولوجي للثلاث هجن ، وعدد الحبوب/ سنبلة للهجينين الأول والثاني، وذلك تحت ظروف ميعاد الزراعة المناسب، وكذلك بالنسبة لعدد الأيام حتى طرد السنابل في كل الهجن الثلاثة ، عدد الأيام حتى النضج الفسيولوجي ، ومعدل امتلاء الحبوب/يوم في الهجين الثالث ، عدد السنابل / نبات بالنسبة للهجينين الثاني والثالث، عدد الحبوب / سنبلة في الهجين الثاني ووزن مائة حبة في الهجينين الأول والثالث وذلك تحت ظروف الزراعة المتأخرة الحرارة العالية في مراحل امتلاء الحبوب (تحمل الحرارة).

كما أظهرت النتائج وجود سيادة جزئية تجاه الأب الأعلى لصفة طرد السنابل في الثلاث هجن، معدل امتلاء الحبوب/يوم للهجين الثالث ، عدد السنابل/نبات للهجينين الثاني والثالث وعدد الحبوب/سنبلة في الهجين الثاني بالنسبة لظروف الإجهاد الحراري كما أظهرت النتائج وجود سيادة كاملة لوزن المائة حبة في الهجين الأول لميعاد الزراعة الأمثل.

٣) كان تأثير التربية الداخلية موجباً ومعنوياً لصفة عدد الأيام حتى طرد السنابل ، عدد السنابل / نبات ووزن المائة حبة للهجين الثالث وعدد الأيام حتى النضج الفسيولوجي للهجينين الأول والثالث ، معدل امتلاء الحبوب / اليوم ومحصول حبوب النبات للثلاث هجن وعدد الحبوب / سنبلة في الهجين الثاني، وذلك تحت ظروف

الزراعة في الميعاد المناسب وكذلك موجبة ومعنوية لصفة معدل امتلاء الحبوب /اليوم وعدد الحبوب/سنبلة للهجين الثاني ومحصول حبوب النبات للثلاث هجن وذلك تحت ظروف الزراعة المتأخرة .

٤) كما أظهرت التأثيرات الوراثية المضيفة وكذلك الفعل الجيني غير المضيف دوراً هاماً في وراثة معظم الصفات المدروسة .

٥) كانت انحرافات الجيل الثاني (E_1) وانحرافات الجيل الثالث (E_2) معنوية لمعظم الصفات في الهجن تحت الدراسة تحت ظروف كل من الزراعة في الميعاد المناسب والمتأخر مما يوضح أهمية الفعل الجيني التفوقي في وراثة الصفات .

٦) أظهرت التأثيرات الوراثية المضيفة وكذلك الفعل الجيني غير المضيف (السيادة والتفوق) دوراً هاماً في وراثة معظم الصفات المدروسة لكل من الزراعة في الميعاد المناسب والزراعة المتأخرة.

٧) أظهرت كفاءة التوريث بمعناها الواسع قيماً عالية لكل الصفات ، كما أظهرت كفاءة التوريث بمعناها الضيق وكذلك الكفاءة الوراثية المحسوبة من الانحدار بين الأجيال قيماً عالية إلى متوسطة مرتبطة بنسبة تحسين وراثي متوسط في معظم الصفات المدروسة .

والخلاصة أنه يمكن الاستفادة من الهجن الثلاثة في برامج تربية القمح للحصول على سلالات جيدة متفوقة في المحصول تحت ظروف الزراعة في الميعاد المناسب ، أما الهجين الثاني وهو دبيبرا × جيزة ١٦٨ فيمكن الاستفادة منه أيضاً تحت ظروف الحرارة المرتفعة في مصر العليا .

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