Genotypic Differences for Heat Tolerance Traits in Bread Wheat Using Five Parameters Genetic Model

Abd-Allah, Soheir M.H and I.A. Amin
Wheat Res. Dept., Field Crops Research Institute, A.R.C., Egypt.

Received on: 29/5/2013 *Accepted:27/6/2013*

ABSTRACT

The present work was carried out during 2008/ 2009 to 2011/ 2012 to study five populations (P_1, P_2, F_1, F_2 and bulk of F_3) for the three crosses i.e., Giza 168 × Pastor, Kanchan × Pastor and Debira × Kanchan under optimum and late sowing date in two experiments. The first experiment was planted in optimum sowing date (15 November) and the second was planted in late sowing (15 December) in Shandaweel Station, Sohag Governorate, Agriculture Research Center. The three crosses were significantly differed for almost the studied traits. Under optimum sowing date, highly significant and positive heterotic effects, compared to better parent, were found for maturity date in the second cross, number of kernels/ spike in the first cross, and 100-kernel weight and grain yield/ plant in the third cross. Under late sowing date, significant and positive heterotic effects were found for maturity and grain yield/ plant in the first and second crosses, and number of spikes/ plant in the second cross.

Overdominance towards the higher parents, was detected under optimum sowing date for number of spikes/ plant in the second cross, grain yield/ plant in the first cross and 100-kernel weight and grain yield/ plant in the third cross. Under optimum and late sowing dates, inbreeding depression estimates were found to be significant and positive for heading date and 100-kernel weight.

Additive gene effects under the optimum sowing date were positive and significant for maturity date in the second and third crosses, number of kernels/ spike in the second cross, 100-kernel weight and grain yield/ plant in the first cross. However, the additive gene effects under late sowing date were found to be significant and positive for maturity date in the second cross, number of kernels/ spike in the first and third crosses and grain yield/ plant in the first cross. Dominance gene effects were significant and positive for grain yield/ plant in the first and second crosses under optimum sowing date and maturity date in the first cross and number of kernels/ plant and grain yield/ plant in the third cross under late sowing date.

Narrow sense heritability estimates ranged from 0% for number of spikes/ plant in the third cross, to 71.11% for 100-kernel weight in the first cross under optimum sowing date, and from 31.14% for number of spikes/ plant in the second cross to 78.21% for maturity date in the first cross under late sowing date. The parent off-spring regression heritability, under optimum sowing date, were found to be high to moderate and ranged from 31.99% for number of spikes/ plant in the third cross to 77.19% for grain yield/ plant in the first cross, and from 49.11% for 100-kernel weight in the second cross to 77.85% for number of kernels/ spike in the first cross under late sowing date.

The expected genetic gain, under optimum sowing date ranged from 0.16% for number of spikes/ plant in the third cross to 17.95% for grain yield/ plant in the second cross, and from 0.42% for 100-kernel weight in the third cross to 18.42% for grain yield/ plant in the first cross under late sowing date. Actual genetic gain, under optimum sowing date ranged from 0.59% for 100-kernel weight in the third cross to 18.58% for grain yield/ plant in the second cross, while, under late sowing date it ranged from 0.58% for 100-kernel weight in the third cross to 20.69% for grain yield/ plant in the first cross.

Key words: Bread wheat, Heterosis, heritability and gene actions.

INTRODUCTION

Grain yield in wheat is a complicated quantitative parameter and the product of its interaction with environment and several yield attributes affect grain yield. In Egypt, the late planting of wheat after harvesting cotton, maize and vegetables is one of the most limiting factors reducing yield.

High temperature during post-anthesis, reduces duration of maturation, grain filling, grain number, 1000-kernel weight and grain yield (Kaur and Behl, 2010). Abd-EL-Shafi and Ageeb (1994) reported that grain yield was reduced under heat stress in upper Egypt in late planting, in the range of 30-46% in comparison with optimal planting.

Wheat breeders are seeking to incorporate late heat tolerance in the wheat germplasm and to develop genotypes that are early in maturity in order to escape the terminal heat stress and, thus, suit well in the maize-wheat as well as in cotton-wheat cropping systems. The true knowledge of the gene action for various bread wheat traits is useful in making decision with regard to appropriate breeding systems. Abd-Allah and Mostafa (2011) found that additive gene effects were positive and significant for number of kernels/ spike and 100-kernel weight. Abd-Allah and Hassan (2012) reported that the additive gene effects played a major role in controlling the genetic variation for number of spikes/ plant, number of kernels/ spike and grain yield/ plant. Amein (2007) found that number of grains/ spike prevalence of dominant gene action under both normal and heat stress, whereas, the dominance gene effects played a major role in controlling the genetic variations for 1000-grain weight and grain yield/ plant. Sallam (2008) pointed out the importance of both additive and dominance gene effects in the inheritance of 1000-grain weight. Fethi and Mohamed (2010) reported that dominance and dominance × dominance epistatic effects were more important than additive effects and other epistatic components for the grain yield.

The heritability values are a measure of the genetic relationship between parents and progeny, hence considerable research work has been carried out to incorporate desirable genes in the present wheat varieties to increase the productivity of the crop (Memon *et al.*, 2007). Low, medium and high narrow sense heritability estimates have been reported for yield and yield components in wheat by many researches among whom were Abd-Allah and Abd El-Dayem (2008), Abd-Allah and Mostafa (2011) and Abd-Allah and Hassan (2012). Meanwhile, values of heritability in narrow sense were more than 50% for days to heading, grain filling period and rate grain filling (Menshawy, 2007).

Information about association between early sowing and grain yield, and its components, can help breeders for increasing the selection efficiency. Tawfelis (2006) found significant variation in yield and its components among wheat genotypes under normal and late plantings. He also, reported that delaying sowing date reduced number of kernels/ spike, kernel weight and grain yield.

The objectives of this study were to:

1-Obtain information about genetic variance, gene action, heritability, actual and expected genetic gain under optimum and late sowing dates.

2-Determine the relationships among earliness traits (heading and maturity dates) and each of grain yield and stress susceptibility index of these genotypes to produce good hybrids of early-maturity and/ or tolerant to late sowing stress.

MATERIALS AND METHODS

Four bread wheat genotypes were chosen to form three crosses, viz., Giza 168 × Pastor, Kanchan × Pastor and Debira × Kanchan. (Table 1) shows name, pedigree and origin of the parental genotypes. This study was carried out at Etay Elbaroud Agriculture Research Station, Behera Governorate, Egypt, during four successive seasons from 2008/ 2009 to 2011/ 2012. In the first season (2008/ 2009), the parental genotypes were crossed to obtain F_1 seeds for the three studied crosses. In the second season (2009/ 2010), the hybrid seeds of the three crosses were sown to give the F_1 plants. These plants were selfed to produce F_2 seeds. Moreover, the same parents were crossed again to produce F_1 seeds. The new hybrid seeds and part of the seeds obtained from F_1 selfed plants (F_2 seeds) were kept in refrigerator to the final experiment. In the third season (2010/ 2011), the F_1 seeds were sown to produce F_1 plants, which were selfed to produce F_2 seeds. In addition, the F_1 and F_2 plants were selfed to produce F_2 and F_3 seeds, respectively. The final experiment (the fourth season, 2011/ 2012) was conducted at Shandaweel Research Station, Sohag Governorate, Agriculture Research Center, A.R.C., where the five populations P_1, P_2, F_1, F_2 and F_3 of the three crosses were evaluated under optimum sowing date (OS) and late sowing date (LS). Planting of (OS) was on November, 15 and (LS) was on December, 15 using a randomized complete block design with three replications, plants within rows were spaced 10 cm apart. Two rows were devoted for each parent and F_1 progenies, five rows for F_2 generation and 20 rows for F_3 families for each cross. Data were recorded on individual guarded plants for number of days to heading, number of days to maturity, grain filling period (number of days from heading to maturity) and grain filling rate (the grain yield divided by grain filling period).

Measurements were recorded, in optimum and late sowing dates, for number of spikes/ plant, number of kernels/ spike, 100-kernel weight and grain yield/ plant. The susceptibility index (SI) was used as a measure of late planting tolerance in terms of minimization of the reduction in grain yield or yield components caused by unfavorable versus favorable environments. (SI) was calculated for each genotype according to the formula of Fisher and Maurer (1978).

$$SI = (1 - Y_{LS} / Y_{OS}) / D$$

Where;

SI = an index of late sowing susceptibility

Y_{LS} = yield or yield components from late sowing experiment of a genotype.

Y_{OS} = yield or yield components from optimum sowing experiment of a genotype.

D = late sowing intensity = 1 – (mean Y_{LS} of all genotypes/ mean Y_{OS} of all genotypes)

The studied traits were statistically analyzed using split-plot design and comparison between any two generations within the same cross, under optimum and late sowing dates, were carried out according to Gomez and Gomez (1984). Various biometrical parameters, in this study, were only calculated in the F_2 genetic variance that was found to be significant. Herterosis was expressed as the percentage deviation of F_1 mean performance from better parent values (heterobelitiosis). Inbreeding depression was calculated as the difference between the F_1 and F_2 means expressed as percentage of the F_1 mean.

Table 1: Name, Pedigree and origin of the four bread wheat genotypes

Code No.	Name	Pedigree	Origin
1	Giza 168	MRL/BUC//SERI	Egypt
2	Pastor	PFAU/SERIM82//BOBWHITE	ICARDA
3	Kanchan		ICARDA
4	Debira		India/ Syria

The t-test was used to determine the significance of these deviations where the standard error (S.E) values were calculated as follows:

$$\bar{F}_1 - \overline{BP} = \sqrt{(VF_1 + VBP)}$$

(S.E. for the better parent heterosis)

$$\bar{F}_1 - \bar{F}_2 = \sqrt{(VF_1 + VF_2)}$$

(S.E. for inbreeding depression)

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

Types of gene effects were estimated according to Hayman model (1958) as described by Singh and Chaudhary (1985) as follows:

$$m = \bar{F}_2 \qquad \text{(mean effect of } F_2\text{)}$$

$$d^* = \frac{1}{2}\bar{P}_1 - \frac{1}{2}\bar{P}_2 \qquad \text{(additive effect)}$$

$$h = \frac{1}{6}\left(4\bar{F}_1 + 12\bar{F}_2 - 16\bar{F}_3\right) \text{ (dominance effect)}$$

$$L = \frac{1}{3}\left(16\bar{F}_3 - 24\bar{F}_2 + 8\bar{F}_1\right)$$

(dominance × dominance)

$$i = \bar{P}_1 - \bar{F}_2 + \frac{1}{2}\left(\bar{P}_1 - \bar{P}_2 + h\right) - \frac{1}{4}L$$

(additive × additive)

The variance of these estimates were computed as follows:

$$V_m = VF_2$$

$$Vd^* = \frac{1}{4}(VP_1 + VP_2)$$

$$Vh = \frac{1}{36}(16\,VF_1 + 144\,VF_2 + 256\,VF_3)$$

$$VL = \frac{1}{9}(256\,VF_3 + 576\,VF_2 + 64\,VF_1)$$

$$Vi = VP_1 + VF_2 + \frac{1}{4}(VP_1 + VP_2 + Vh) + \frac{1}{16}VL$$

The standard errors of additive (d^*), dominance (h), dominance × dominance (L) and additive × additive (i) were obtained by taking the square root of respective variances. Also, "t" test values were calculated by dividing the effects of d, h, L and I by their respective standard errors.

Heritability was calculated in narrow sense according to Mather (1949) and parent off-spring regression according to Sakai (1960). Furthermore, the expected and actual genetic advance (Δ g) was computed according to Johanson *et al.* (1955). Like wise, the genetic gain, represented as percentage of the F_2 and F_3 mean performance (Δ g%), was estimated using the method of Miller *et al.* (1958).

RESULTS AND DISCUSSION

Parental differences in response to their genetic background were found to be significant for most traits under investigation. The genetic variance, within F_2 population, was also found to be significant for all studied traits, in the three crosses, 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 bulk F_3) for the studied characters, in the crosses, are presented in (Table 2).

Analysis of variance for the studied yield and yield characters in optimum and late sowing date experiments, as well as, grain filling period, grain filling rate and the susceptibility index is presented in (Table 3). Data further showed significant differences between crosses under late sowing date, for grain filling period and the susceptibility index of number of spikes/ plant, number of kernels/ spike, 100-kernel weight, grain yield/ plant and grain filling rate. Also, there were significant variations between generations in all studied characters. Meanwhile, the interactions between generations and the crosses were highly significant for all studied characters except grain filling rate under late sowing date. This may be due to the differences in the response of the studied wheat genotypes to the climatic factors in both sowing dates. Average of grain filling period and grain filling rate under the two sowing dates, and the susceptibility index of the studied traits of the three crosses, five populations in each cross are presented in (Table 4). Data in the first cross and the F_1 generation showed that P_2 (Giza 168) gave the longest grain filling period under the two sowing dates. Also, in the second cross, the three generations (F_1, F_2 and F_3) recorded the longest grain filling period under the two sowing dates. Conversely, in the third cross, the three generations (F_1, F_2 and F_3) had the shortest grain filling period under the two sowing dates. However, the P_2 (Giza 168) of the first cross, Pastor parent in the second cross and F_1 in the third cross, recorded the highest grain filling rate.

Susceptibility index (SI) was used as a parameter to provide a measure of stress tolerance based on minimization of yield, and its components, losses under late sowing compared to optimum sowing date. Low susceptibility (SI < 1) is synonymous with higher stress tolerance. The susceptibility index for number of spikes/ plant recorded highly significant tolerance values (S.I < 1) for P_2 and F_1 populations, in the first cross, F_1, F_2 and F_3 populations in the second cross and F_1, F_2 and F_3 populations in the third cross. Meanwhile, the susceptibility index for number of kernels/ spike showed highly significant tolerance values for F_1 in the first cross only, but F_3 showed no change under late sowing date. Only F_3 generation in the first cross had highly significant tolerance for 100-kernel weight susceptibility index value. The populations P_2, F_1 and F_3 in the first cross, F_1 in the second cross and P_2 in the third cross had highly significant tolerance values for grain yield/ plant. The susceptibility index of grain filling period showed highly significant tolerance values for P_1, F_2 and F_3 populations in the first cross, P_2, F_2 and F_3 populations in the second cross and P_1, F_1, F_2 and F_3 populations in the third cross. In this connection, several investigators reported that there was a wide range of response to late sowing tolerance in wheat genotypes. Among those are Menshawy (2007), Abdel-Nour and Zakaria (2010), and Abdel-Nour (2011).

Heterosis, Potance Ratio and Inbreeding depression:

Heterosis, Potance ratio (P), inbreeding depression percentage and different gene action parameters, in the three crosses for the studied traits under optimum and late sowing dates, are given in (Table 5). Under optimum sowing date, highly significant and positive heterotic effects, compared to better parent, were found for maturity in the second cross, number of kernels/ spike in the first cross, and 100-kernel weight and grain yield/ plant in the third cross. Moreover, significant or highly significant and negative heterotic effects were found for number of spikes/ plant in the three crosses, number of kernels/ spike and 100-kernel weight in the second cross and 100-kernel weight in the first cross. However, insignificant heterotic effects were found for heading date in the three crosses, maturity date and grain yield/ plant in the first cross, maturity date and number of kernels/ spike in the third cross, and grain yield/ plant in the second cross. Similar findings were reported by Abd-Allah and Abd El-Dayem (2008), Abdel Nour and Zakaria (2010), Abd-Allah and Mostafa (2011), Abd-Allah and Hassan (2012). Under late sowing date, the results generally paralled with those the optimum sowing date except for significant and positive heterotic effects for maturity date in the first cross, number of spikes/ plant in the second cross, and grain yield/ plant in the first and second crosses. Also, significant and negative heterotic effects were found for number of kernels/ spike in the first cross, and 100-kernel weight in the third cross. These results are in agreement with those of Joshi *et al.* (2003) and Abd El-Haleem *et al.* (2009) who reported that heterosis above the better parent was significant and negative for heading and maturity indicating that dominance direction was toward the earlier parent.

Potance ratio (P) under optimum sowing date indicated over dominance (P > 1) towards the higher parent for maturity date and number of spikes/ plant in the second cross, number of kernels/ spike and grain yield/ plant in the first cross and 100-kernel weight and grain yield/ plant in the third cross. Conversely, over dominance towards the lowest parent was found for heading date and number of spikes/ plant in the second cross, and 100-kernel weight in the second cross. Nearly complete dominance (P = 1) was found for maturity date and number of kernels/ spike in the third cross. Partial dominance towards the higher parent was recorded for heading date in the third cross and 100-kernel weight in the first cross. On the other hand, the potance ratio (P) under late sowing date indicated over dominance (P > 1) towards the higher parent for 100-kernel weight and grain yield/ plant in the second cross, and grain yield/ plant in the first cross. Partial dominance towards, the higher parent was recorded for number of spikes/ plant in the first and second crosses, and number of kernels/ spike in the third cross. Over dominance for number of spikes/ plant, 100-kernel weight and grain yield were reported by Abd-Allah and Mostafa (2011) and Abd-Allah and Hassan (2012). Partial dominance towards the higher parent for number of kernels/ spike was reported by Abd-Allah and Mostafa (2011) and Abd-Allah and Hassan (2012).

Inbreeding depression measured the reduction in performance of F_2 generation compared to their F_1's due to inbreeding. Under optimum sowing date, positive and highly significant values were found for heading date and 100-kernel weight in the first and second crosses. Meanwhile, under late sowing date, positive and highly significant values were found for heading date, maturity date, number of kernels/ spike and 100-kernel weight in the first cross, heading date and 100-kernel weight in the third cross and for number of kernels/ spike in the second cross. The obtained results, for most of studied traits, were in harmony with Abd-Allah and Abd El-Dayem (2008), Abd-Allah and Mostafa (2011) and Abd-Allah and Hassan (2012). However, inbreeding depression was significant and negative, under the two sowing dates, for number of spikes/ plant and grain yield/ plant in the three crosses, and under late sowing date for number of kernels/ spike in the second cross and 100-kernel weight in the third cross. Sharma *et al.* (2002) reported that significant and negative inbreeding depression was recorded frequently for yield and yield contributing traits indicating that the F_2 was superior to the F_1. The coincidence of sign and magnitude of heterosis and inbreeding depression was detected for most traits, this is logic and expected since the expression of heterosis in F_1 will be followed by a considerable reduction in F_2 due to homozygosis.

Gene actions:

Nature of gene action was determined using the five parameters model (Table 3). The estimated mean effects of F_2 (m), which reflects the contribution due to the over-all mean plus the locus effect and interactions of fixed loci, were found to be highly significant for all the studied characters in all crosses under the two sowing dates. The additive gene effects (d^*), under the optimum sowing date were found to be significant and positive for maturity date in the second and third crosses, number of kernels/ spike in the second cross, 100-kernel weight and grain yield/ plant in the first cross. The additive gene effects (d^*), under the late sowing date, were found to be significant and positive for maturity date in the second and third crosses, number of kernels/ spike in the first and third crosses and grain yield/ plant in the first cross. However, significant and negative additive effects (d^*), under the two sowing dates, were detected for maturity date and number of spikes/ plant in the first cross, number of kernels/ spike in the first and third crosses, and grain yield/ plant in the second cross under the optimum sowing date. Also, significant negative additive effects (d^*), under late sowing date, were detected for number of spikes/ plant in the third cross, and number of kernels/ spike in the second cross. The magnitude of additive gene effects were small relative to the corresponding dominance effects in the former characters, suggesting that bulk selection is a useful breeding method for improving these populations.

Dominance gene effects (h) were found to be significant and positive for grain yield/ plant in the first and second crosses only under optimum sowing date, while in the late sowing date, the dominance gene effects (h) were found to be significant and positive for maturity date in the first cross and number of kernels/ plant and grain yield/ plant in the third cross. When dominance genes are present, it would tend to be in favor of production of hybrid wheat, while the existence the additive gene action in the gene pool encourages the improvement of characters by selection program. The traits with no genetic effects indicated that all the variability was attributed to environment. Dominance × dominance (L) types of gene action were found to be positive and significant for 100-kernel weight under optimum sowing date and for grain yield/ plant under late sowing date in the first cross only. However, dominance × dominance (L) type of gene action were found to be negative and significant for heading date and number of kernels/ spike in the first cross under optimum sowing date, and for number of kernels/ spike and grain yield/ plant in the second cross under late sowing date. Significant and positive additive × additive type of epistasis (i) under optimum sowing date were detected for heading and maturity dates in the third cross, and for grain yield/ plant in the first and second crosses. Also, significant and positive additive × additive type of epistasis (i), under late sowing date, were recorded for number of spikes/ plant, 100-kernerl weight and grain yield/ plant in the first cross; maturity date, number of spikes/ plant and number of kernels/ spike in the third cross and 100-kernel weight in the second cross. The important roles of both additive and non-additive gene actions, in certain studied characters, indicate that selection procedures based on the accumulation of additive effects would be successful in improving these characters. Farag (2009), reported that, among the epistatic components, the dominance × dominance was greater in magnitude than additive × additive in most studied traits. When additive effects are larger than non-additive ones, it is suggested that selection in early segregation generations would be effective, while, if non-additive portion is larger than additive, the improvement of the characters needs intensive selection through later generations.

F_2 and F_3 deviations (E_1 & E_2):

Significant and positive F_2 deviation (E_1) was found for heading and maturity date in the second cross only under optimum sowing date, while, negative values were obtained for maturity date, number of spikes/ plant and grain yield/ plant in the third cross, and number of spikes/ plant in the second cross. On the other hand, insignificant F_2 deviations were detected for heading date in the first and third crosses, maturity date in the first cross, number of spikes/ plant in the second cross, number of kernels/ spike and 100-kernel weight in the three studied crosses, and grain yield/ plant in the first and second crosses. However, under late sowing date, significant and positive F_2 deviation was found for heading date in the third cross, and maturity date in the first and second crosses. Meanwhile, significant negative F_2 deviations were found for number of spikes/ plant in the first and third crosses, number of kernels/ spike in the three studied crosses, 100-kernel weight in the first and second crosses and grain yield/ plant in the second and third crosses. Also, insignificant F_2 deviations were detected for heading date in the first and second crosses, maturity date in the third cross, number of spikes/ plant in the second cross, 100-kernel weight in the third cross and grain yield/ plant in the first cross. These results may indicate that epistatic gene effects had major contribution in the inheritance of these traits under the two sowing dates.

F_3 deviation (E_2), under optimum sowing date, was found to be positive and significant for heading date in the three crosses, maturity date in the second cross and number of kernels/ spike in the first cross. However, negative and significant F_3 deviation values were detected for maturity date in the third cross, number of spikes/ plant in the three studied crosses and grain yield/ plant in the first and third crosses. Also, insignificant F_3 deviations were detected for maturity date in the first cross, number of kernels/ spike in the second and third crosses, 100-kernel weight in the three crosses and grain yield/ plant in the second cross.

Moreover, F_3 deviations, under late sowing date, recorded significant and positive values for heading date in the third cross, maturity date in the three studied crosses and number of kernels/ spike in the first and second crosses, while, F_3 deviation was found to be significant and negative for number of spikes/ plant in the three crosses, number of kernels/ spike in the third cross, 100-kernel weight in the second cross, and grain yield/ plant in the three studied crosses. On the other hand, insignificant F_3 deviation was detected for heading date in the first and second crosses and 100-kernel weight in the first and third crosses. The F_2 deviations were accompanied by F_3 deviations in most cases, indicating the presence of epistasis and should require more attention in wheat breeding programs.

Heritability:

Heritability estimates in narrow senses, and between generations (parent off-spring regression), under the two sowing dates, are presented in (Table 4). Narrow sense heritability values, under optimum sowing date, were detected for all studied characters and ranged from zero% for number of spikes/ plant in the third cross, to 71.11% for 100-kernel weight in the first cross. Moreover, narrow sense heritability values, under late sowing date, were recorded for all studied traits and ranged from 31.14 % for number of spikes/ plant in the second cross to 78.21% for maturity date in the first cross. The parent off-spring regression heritability, under optimum sowing date, were found to be high to moderate and ranged from 31.99% for number of spikes/ plant in the third cross to 77.19% for grain yield plant in the first cross. Moreover, parent off spring regression heritability, under late sowing date, were found to be high to moderate and ranged from 49.11% for 100-kernel weight in the second cross to 77.85% for number of kernels/ spike in the first cross. The differences in magnitude of both narrow sense and parent off-spring regression heritability estimates, for all the studied characters, would ascertain the presence of non-additive genes and environmental effects in the inheritance of these characters. The heritability estimates from the two sowing dates showed that the first cross had the better chance for genetic improvement in yield and yield components. This conclusion was reported by several researchers, i.e., Abd-Allah and Abd El-Dayem (2008), Abd-Allah and Mostafa (2011) and Farooq *et al.* (2011).

The expected genetic gain versus actual gain, under the two sowing dates, are presented in (Table 6). The results revealed that the expected genetic advance, as a percentage of F_2 (Δ g%), under optimum sowing date, ranged from 0.16% for number of spikes/ plant in the third cross to 17.95% for grain yield/ plant in the second cross. However, the expected genetic advance, as a percentage of F_2 (Δ g%) under late sowing date, ranged from 0.42% for 100-kernel weight in the third cross to 18.42% for grain yield/ plant in the first cross. The actual gain, as a percentage of F_3, under optimum sowing date ranged from 0.59% for 100-kernel weight in the third cross to 18.58% for grain yield/ plant in the second cross. Also, the actual gain, as a percentage of F_3, under late sowing date ranged from 0.58% for 100-kernel weight in the third cross to 20.69% for grain yield/ plant in the second cross. The highest estimates of narrow sense heritability, which was associated with the highest genetic advance, were detected for number of kernels/ spike in the first and second crosses, and grain yield/ plant in all crosses, indicating the presence of sufficient variability for the improvement of those two characters. These results indicate the possibility of practicing selection in the early generations to obtain high yielding genotypes. Therefore, selection in those particular populations should be effective and satisfactory for successful breeding purposes. This information would help breeders in selecting of parental combination which when crossed result in the highest proportion of desirable segregates, and identifying early cultivars under optimum and late sowing date.

Generally, most of the significance in biometrical parameters resulted from the first and third crosses and were higher in their values than those obtained from the second cross under the two sowing dates. Consequently, it could be concluded that the crosses (Pastor × Giza 168) and (Debira × Kanchan) would be of interest in breeding programs for genetic improvement of wheat for late planting tolerance that could be used in double cropping systems mainly, i.e., cotton-wheat and late maize-wheat sequences.

Table 2: Means ($\bar{X}$) 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 under optimum and late sowing dates.

Cross	genotype		Heading		Maturity		No. of spikes/ plant		No. of kernels/ Spike		100-kernel weight (g)		Grain yield/ plant (g)	
			OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS
Pastor × Giza 168	P_1	$\bar{x}$	104	97.6	147.5	140.1	16.1	13.2	53.8	68	5.2	5.04	57.1	48.9
		S^2	2.3	3.4	2.9	3.4	8.7	9.7	9.7	9.92	0.13	0.12	15.1	14.7
	P_2	$\bar{x}$	103.7	97.7	153.1	144	17.3	15.9	54.8	51.9	4.81	5.05	48.7	42.8
		S^2	2.1	2.9	2.8	2.5	6.4	2.9	13.4	8.2	0.115	0.034	12.7	9.52
	F_1	$\bar{x}$	103	97	150.6	142	16.4	13.6	61.8	56.7	5.02	4.8	58.1	51.1
		S^2	1.9	1.8	4.5	3.6	8.95	4.8	12.9	8.6	0.1	0.051	14.6	14.9
	F_2	$\bar{x}$	104	97.4	150.8	144	14.91	12.1	60.9	64	5.03	4.95	54.5	45.9
		S^2	5.6	6.4	11.8	10.85	66.8	39.1	96.82	92.8	0.45	0.48	125.9	245.2
	F_3	$\bar{x}$	104.1	97.5	151.1	144.6	14.75	11.95	60.2	66.2	5.05	5.01	52.14	45.1
		S^2	4.2	4.5	8.41	7.52	45.9	29.1	66.95	62.5	0.29	0.32	84.6	175.21
Kanchan × Pastor	P_1	$\bar{x}$	103	97.5	151	141.9	16.78	15.1	57.9	54.2	4.95	5.04	45.7	46.4
		S^2	1.6	2.5	2.4	2.99	6.45	5.81	25.92	24.9	0.19	0.17	24.5	20.19
	P_2	$\bar{x}$	104	97.8	147.2	140.7	16.1	13.6	53.5	68.1	5.12	5.24	58	49.2
		S^2	1.6	3.6	2.45	3.45	7.89	6.57	21.4	20.8	0.14	0.18	28.36	25.2
	F_1	$\bar{x}$	102.7	97.3	151.9	144.1	15.2	14.8	55.8	50.8	4.85	4.7	59.9	52.6
		S^2	1.89	1.75	3.9	2.78	8.59	7.82	25.18	21.9	0.114	0.152	31.9	27.4
	F_2	$\bar{x}$	103.6	97.8	152.7	145	14.4	13.41	56.8	61.9	4.83	4.63	57.3	46.5
		S^2	4.9	8.9	9.75	8.85	54.2	60.7	96.71	82.9	0.397	0.41	202.9	182.1
	F_3	$\bar{x}$	103.8	98.1	153.2	145.6	14.1	13.2	57.2	62.4	4.81	4.57	55.1	46.1
		S^2	3.82	5.73	7.35	6.41	48.1	51.25	62.9	55.18	0.32	0.33	140.85	127.9
Debira × Kanchan	P_1	$\bar{x}$	106	98	156	146	17.1	13.2	54.6	65.9	4.81	5.01	49.1	44.1
		S^2	1.5	2.4	2.6	2.8	3.6	4.5	19.7	20.5	0.04	0.036	17.25	15.15
	P_2	$\bar{x}$	103	97.5	151	141.9	16.78	15.1	57.9	54.2	4.95	5.04	45.7	46.4
		S^2	1.6	2.5	2.4	2.99	6.45	5.81	25.92	24.9	0.19	0.17	24.5	20.19
	F_1	$\bar{x}$	103.5	97.1	151.2	142.9	15.1	14.3	58.8	64.2	5.19	4.98	52.9	47.5
		S^2	1.95	1.8	3.5	2.7	4.35	4.75	21.8	22.63	0.06	0.085	18.95	19.3
	F_2	$\bar{x}$	104.1	98	151.3	143.6	12.6	11.8	58.5	58.7	5.12	5.04	48.0	43.9
		S^2	5.8	6.9	8.9	7.95	56.7	47.15	120.1	115.9	0.35	0.351	139.4	185.7
	F_3	$\bar{x}$	104.7	98.2	151.4	143.8	12.5	11.7	57.8	57.8	5.1	5.05	47.6	42.1
		S^2	4.1	4.95	6.4	5.6	38.96	33.79	90.15	86.7	0.29	0.29	100.5	126.4

O.S.= Optimum sowing date L.S.= Late sowing date

Alex. J. Agric. Res. Vol. 58, No. 2, pp.83-96, 2013

Table 3: Mean squares for the studied traits, under the optimum and late sowing dates, of the five populations in the three crosses.

S.O.V.	d.f.	Grain filling period (days)		Grain filling rate (g/ days)		S.I. (No. of spikes/ plant)	S.I. (No. of kernels/ spike)	SI (100-kernel of weight)	SI (grain yield/ plant)	SI (grain filling period)	SI (grain filling rate)
		O.S	L.S.	O.S.	L.S.						
Rep.	2	40.288^{**}	38.400	0.030	0.013	0.001	0.025	0.035	0.0008	0.023	0.0003
Crosses	2	$10.682^{n.s}$	0.566^{**}	$0.102^{n.s}$	$0.064^{n.s}$	0.020^{**}	5.978^{**}	0.925^{**}	0.045^{**}	$0.155^{n.s}$	11.775^{**}
Ea	4	1.789	0.000001	0.021	0.011	0.0001	0.016	0.019	0.0006	0.053	0.0002
Generations	4	5.703^{*}	8.05^{**}	0.016^{**}	0.065^{**}	0.963^{**}	21.729^{**}	370.614^{**}	0.547^{**}	1.656^{**}	2.684^{**}
Gen* Crosses	8	13.877^{**}	9.741^{**}	0.050^{**}	$0.024^{n.s}$	0.820^{**}	8.539^{**}	218.886^{**}	0.720^{**}	0.966^{**}	2.845^{**}
Eb	24	1.372	0.3	0.0001	0.010	0.0001	0.006	0.024	0.0001	0.043	0.0001

O.S.= Optimum sowing date L.S.= Late sowing date

Table 4: Means of grain filling period, grain filling rate and the susceptibility Index of studied traits under optimum and late sowing dates, of the populations of three crosses.

Cross	Genotype	Grain filling period (days)		Grain filling rate (g/ days)		S.I. (No. of spikes/ plant)	S.I. (No. of kernels/ spike)	SI (100-kernel weight)	SI (grain yield/ plant)	SI (grain filling period)	SI (grain filling rate)
		O.S	L.S.	O.S.	L.S.						
Pastor × Giza 168	P_1	43.5 ^{c}	42.5 ^{c}	1.313 ^{a}	1.151 ^{a}	1.122 ^{b}	-5.027 ^{d}	2.959 ^{b}	1.057 ^{b}	0.793 ^{b}	3.205 ^{a}
	P_2	49.4 ^{a}	46.3 ^{a}	0.986 ^{e}	0.924 ^{a}	0.52 ^{d}	-1.008 ^{a}	-4.798 ^{e}	0.892 ^{d}	2.172 ^{a}	1.310 ^{d}
	F_1	47.6 ^{ab}	45 ^{b}	1.221 ^{b}	1.136 ^{a}	0.999 ^{c}	-1.572 ^{b}	4.214 ^{a}	0.887 ^{d}	1.884 ^{a}	1.450 ^{c}
	F_2	46.8 ^{b}	46.6 ^{a}	1.165 ^{c}	0.985 ^{a}	1.212 ^{a}	-0.97 ^{a}	1.529 ^{c}	1.162 ^{a}	0.147 ^{c}	3.219 ^{a}
	F_3	47 ^{b}	47.1 ^{a}	1.109 ^{d}	0.958 ^{a}	1.221 ^{a}	-1.898 ^{c}	0.762 ^{d}	0.994 ^{c}	0.073 ^{c}	2.837 ^{b}
Kanchan × Pastor	P_1	48 ^{a}	44.4 ^{b}	0.952 ^{e}	1.045 ^{a}	1.19 ^{b}	-1.102 ^{b}	-1.212 ^{d}	-0.12 ^{e}	1.786 ^{a}	-1.085 ^{e}
	P_2	43.2 ^{b}	42.9 ^{c}	1.343 ^{a}	1.147 ^{a}	1.85 ^{a}	-4.705 ^{d}	-1.563 ^{e}	1.185 ^{c}	0.166 ^{c}	1.622 ^{b}
	F_1	49.2 ^{a}	46.8 ^{a}	1.217 ^{b}	1.124 ^{a}	0.313 ^{e}	-1.514 ^{c}	2.062 ^{c}	0.952 ^{d}	1.161 ^{b}	-0.21 ^{d}
	F_2	49.1 ^{a}	47.2 ^{a}	1.167 ^{c}	0.985 ^{a}	0.818 ^{c}	1.548 ^{a}	2.761 ^{b}	1.473 ^{a}	0.921 ^{b}	1.733 ^{a}
	F_3	49.4 ^{a}	47.5 ^{a}	1.115 ^{d}	0.971 ^{a}	0.760 ^{d}	1.567 ^{a}	3.326 ^{a}	1.276 ^{b}	0.916 ^{b}	1.435 ^{c}
Debira × Kanchan	P_1	50 ^{a}	48 ^{a}	0.982 ^{c}	0.919 ^{a}	2.11 ^{a}	-4.5 ^{d}	-20.79 ^{e}	1.29 ^{b}	0.930 ^{b}	1.688 ^{d}
	P_2	48 ^{b}	44.4 ^{c}	0.952 ^{d}	1.045 ^{a}	0.927 ^{b}	-1.39 ^{b}	-9.09 ^{d}	0.194 ^{d}	1.74 ^{a}	2.571 ^{a}
	F_1	47.7 ^{b}	45.8 ^{b}	1.109 ^{a}	1.037 ^{a}	0.491 ^{d}	-2.00 ^{c}	20.23 ^{a}	1.29 ^{b}	0.926 ^{b}	1.710 ^{c}
	F_2	47.2 ^{b}	45.6 ^{b}	1.017 ^{b}	0.963 ^{a}	0.588 ^{c}	-0.070 ^{a}	7.81 ^{b}	1.08 ^{c}	0.788 ^{bc}	1.397 ^{e}
	F_3	46.7 ^{b}	45.6 ^{b}	1.019 ^{b}	0.923 ^{a}	0.583 ^{c}	0	4.9 ^{c}	1.46 ^{a}	0.548 ^{c}	2.479 ^{b}
L.S.D.		1.95	0.91	0.016	–	0.016	0.129	0.259	0.016	0.346	0.016

O.S.= Optimum sowing date L.S.= Late sowing date

L.S.D. values at 0.05 probability level.

Table 5: Heterosis, Potance ratio, inbreeding depression and gene action parameters for the studied characters in three bread wheat crosses under optimum and late sowing dates.

cross	Character	Heterosis % over B.P		Potance ratio (P)		Inbreeding depression (%)		Gene action parameters m		d*		h		L		i		E_1		E_1	
		OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS
1	Heading	-0.0675	-0.615	-5.667	-0.75	0.971**	0.412**	104**	97.4**	0.15	-0.05	-5.6**	0.533	-6.4**	0.533	-2.7**	0.95	0.575	0.075	1.35**	0.35
2	Heading	-0.291	-0.206	-1.6	-2.33	0.975**	0.514	103.6**	97.8**	-0.05	0.15	-1.133*	1.133	-1.133	0.267	1.866**	0.783	0.5*	-0.175	1.4**	1.25
3	Heading	-0.485	-0.563	0.667	-4.143	0.58	0.927**	104.1**	98**	1.5**	0.175	-2**	-1.133	1.6	1.333	2.1**	-0.725	0.1	0.538*	1.4**	1.475**
1	Maturity	0.014	1.356*	-0.107	-2.45	0.133	1.41**	150.8**	144**	-5.6**	-2**	-5.6**	2.933**	1.067	-2.133	-8.167**	-6.783**	0.35	1.975**	0.7	5.15**
2	Maturity	3.193**	2.416**	1.474	0.333	0.527	0.625	152.7**	145**	1.9**	0.6**	-1.867**	-2.2**	0.533	0.8	0.067	-2.8**	2.2**	2.3**	5.4**	4.6**
3	Maturity	0.132	0.705	-0.92	-0.512	0.066	0.49	151.3**	143.6**	2.5**	2.05**	-0.333	-0.933	0.8	-0.8	9.217**	4.184**	-1.05**	0.175	-1.9**	1.45**
1	No. of spikes/ plant	-6.936**	-14.463**	-0.522	0.762	-7.39**	-11.029**	14.91**	12.1**	-1.2**	-1.305**	1.22	-20.38**	6.96	3.2	0.54	10.385**	-1.49*	-1.998**	-3.3*	-4.295**
2	No. of spikes/ plant	-9.416**	1.987**	-3.647	0.6	-5.263**	-9.392**	14.4*	13.41**	0.34	0.75	1.333	1.487	0.533	2.587	3.52	2.537	-1.42	-1.165	-3.44*	-2.75*
3	No. of spikes/ plant	-11.696**	-5.298**	-1.291	-0.158	-16.556**	-17.483**	12.6**	11.8**	0.16	-0.95**	1.933	1.933	6.133	6.133	1.593	2.95*	-3.42**	-2.425**	-7.04**	-4.85**
1	No. of kernels/ spike	12.77**	-16.62**	15	-0.404	1.616	12.875**	60.9**	64**	-2**	8.05**	2.467	-64.4**	-16.3*	-7.33	-2.292	-18.318**	3.75	-5.675**	4.3**	16.15**
2	No. of kernels/ spike	-3.63*	-25.257**	0.045	-1.475	1.792	21.61**	56.8**	61.9**	2.2**	-6.95**	-1.733	-8.667**	-0.533	-26.667**	2.567	-30.178**	1.05	-5.125**	0.975	12.75**
3	No. of kernels/ spike	1.554	-2.58	-0.82	0.709	-0.51	-8.567**	58.5**	58.7**	-1.65*	5.85**	2.067	6.067*	-2.933	9.867	-4.083	13.617**	0.975	3.425**	0.55	-8.65**
1	100-kernel weight(g)	-3.46**	-4.95**	0.769	-49	0.199*	3.125**	5.03**	4.95**	0.195**	-0.005	-0.06	-0.26	26.96**	-0.08	-6.23*	2.737**	0.018	-0.123*	-0.015	0.175
2	100-kernel weight(g)	-5.273**	-10.31**	-2.176	4.4	0.49**	-1.49**	4.83**	4.63**	-0.085	-0.1	0.107	0.217	-0.16	-0.133	0.148	0.452*	-0.113	-0.29**	-0.265	-0.7**
3	100-kernel weight(g)	4.848**	-1.19**	4.429	-3	-1.349**	1.205**	5.12**	5.04**	-0.07	-0.015	0.1	-0.4**	0.08	-0.107	-0.35*	-0.058	0.085	-0.038	-0.13	0.095
1	Grain yield/ plant (g)	1.75	4.5**	1.238	1.869	-6.196**	-10.176**	54.5**	45.9**	4.2**	3.05**	8.693**	5.6	-8.96	28.8**	13.387**	76**	-1	-2.35	-6.72**	-6.3**
2	Grain yield/ plant (g)	3.276	6.91**	-0.309	3.429	-4.341**	-11.597**	57.3**	46.5**	-6.15**	-1.4	7.6*	5.133	-4.8	-53.067**	13.15**	-5.345	1.425	-3.7**	-1.55	-8.2**
3	Grain yield/ plant (g)	7.739**	2.371	3.235	-1.956	-9.263**	-7.579**	48**	43.9**	1.7*	-1.15	4.333	7.217*	10.933	0	2.133	1.061	-2.15*	-2.475*	-4.11*	-8.55**

O.S.= Optimum sowing date L.S.= Late sowing date

Table 6: Heritability and expected genetic gain versus actual gain for all studied characters in three bread wheat crosses under optimum and late sowing dates.

Crosses	Characters	Heritability %				Expected gain				Actual gain			
		Narrow sense		Parent of spring regression		Δ g		% of F_2		Δ g		% of F_3	
		OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS
1	Heading date	50.00	59.38	61.76	57.81	2.34	3.18	2.437	3.10	2.51	2.59	2.61	2.53
2		44.08	71.24	54.72	70.92	1.94	4.48	2.01	4.38	2.12	3.56	2.20	3.50
3		58.62	56.52	64.80	62.08	2.79	3.12	2.91	3.06	2.58	2.90	2.70	2.85
1	Maturity date	57.63	78.21	64.41	64.41	2.72	3.69	4.08	5.31	2.56	2.52	3.85	3.64
2		49.23	55.15	59.66	60.19	2.07	2.33	3.17	3.38	2.17	2.16	3.33	3.14
3		56.18	58.87	62.71	61.64	2.28	2.38	3.45	3.42	2.14	2.09	3.24	3.00
1	No. of spikes/ plant	62.68	51.53	75.35	68.37	70.78	9.29	10.55	1.12	71.30	63.58	10.52	7.60
2		22.51	31.14	54.20	60.02	23.70	37.27	3.41	5.00	54.92	67.06	7.74	8.85
3		0.00	56.67	31.99	73.01	1.23	67.93	0.16	8.02	32.91	74.72	4.11	8.74
1	No. of kernels/ spike	61.70	65.30	56.75	77.85	20.54	20.25	12.51	12.96	6.38	20.29	9.57	12.68
2		69.92	66.88	72.47	69.80	24.94	20.27	14.16	12.54	20.70	17.12	11.84	10.68
3		49.88	50.39	65.58	65.41	19.25	19.04	11.26	11.18	22.19	21.71	12.83	12.55
1	100-kernel weight (g)	71.11	66.67	72.78	76.25	19.54	19.22	0.98	0.95	15.99	17.76	0.81	0.89
2		38.79	39.02	50.76	49.11	10.42	11.12	0.50	0.51	12.30	12.72	0.59	0.58
3		34.29	34.76	53.29	53.56	8.16	8.42	0.42	0.42	11.59	11.77	0.59	0.59
1	Grain yield/ plant (g)	65.61	57.09	77.19	75.88	27.83	40.12	15.17	18.42	28.05	45.88	14.63	20.69
2		61.16	59.53	75.99	73.10	31.32	35.59	17.95	16.55	33.72	36.94	18.58	17.03
3		55.81	63.87	70.65	77.03	28.28	40.84	13.57	17.93	30.65	42.38	14.59	17.84

* selection intensity 10%. O.S.= Optimum sowing date L.S.= Late sowing date

REFERENCES

Abd EL-Shafi, A.M. and O.A.A. Ageb (**1994**). Breeding strategy for developing heat tolerant varieties adapted to upper Egypt and Sudan. P. 33-39. In: D.A. Saunders and G.P. Hetted (eds). Wheat in Heat Stressed Environment, Irrigated, Dry Areas, and Rice-Wheat Farming Systems. Proc. Int. Conf. on Wheat in Hot, Dry, Irrigated Environments. CIMMYT. Mexico.

Abd-Allah, Soheir M.H, and Manal A. Hassan (**2012**). Quantitative traits inheritance in three bread wheat crosses. Alex. J. Agric. Res. **57 (3)**: 263- 271.

Abd-Allah, Soheir M.H. and A.K. Mostafa (**2011**). Genetical analysis for yield and its attributes in bread wheat using the five parameters model. Egypt. J. Plant Production, Mansoura Univ., **2(9): 1171- 1181.**

Abd-Allah, Soheir M.H. and S.M.A. El-Dayem (**2008**). Determination of gene effects and variances in three bread wheat crosses. Annals of Agric. Sci., Moshthor, **46 (1): 23-31.**

Abd-El-Haleem, S.H.M., M.A. Reham and S.M.S. Mohamed (**2009**). Genetic analysis and RAPD polymorphism in some durum wheat genotypes. Global J. Biotech. & Biochem. **4(1): 1-9.**

Abdel-Nour, Nadya A.R. (**2011**). Genetic studies on grain yield and earliness components in bread wheat of different photothermal response. Egypt, J. Agric. Res., **89 (4): 1435- 1461.**

Abdel-Nour, Nadya A.R. and M.M. Zakaria (**2010**). Genetic analysis for heat tolerance of grain yield in three bread wheat crosses under Upper Egypt conditions. Egypt. J. Plant Breed., **14(3): 189-207.**

Amein, K.A. (**2007**). Genetic improvement of grain quality in some cereal crops, protein quality and quality in wheat (*Triticum aestivum*, L.). Ph.D. Thesis, fac. of Agric., Assiut Univ., Egypt.

Farag, H.I.A. (**2009**). Inheritance of yield and its components in bread wheat (*Triticum aestivum*, L.) using six parameters model under Ras surd conditions. Proc. 6th International Plant Breeding Conf., Ismalia, Egypt, 90-112.

Farooq, J., I. Khalid, M.A. Ali, M. Kashif, A. Ur-Rehman, M. Naveed, Q. Ali, W. Nazeer and A. Fqrooq (**2011**). Inheritance pattern of yield attributes in spring wheat at grain filling stage under temperature regimes. Aust. J. of Crops, **5(13)**: 1745- 1753.

Fethi, B. and E.G. Mohamed (**2010**). Epistatis and genotype by environment interaction of grain yield related traits in durum wheat. Crop Sci. **2(2)**: 24-29.

Fischer, R.A. and R. Maurer (**1978**). Drought resistance in spring wheat cultivars. I. Grain yield responses. Aust. J. Agric. Res. **29**: 897-912.

Gomez, K.A. and A.A. Gomez (**1984**). Statistical Procedures for Agriculture Research. 2nd Ed. John Wiley and Sons. New York, USA.

Johanson, H.W., H.F. Robinson and R.E. Comstock (**1955**). Estimates of genetic and Envirnomental variability of Soybeans. Agron. J. **47**: 314.

Joshi, S.K., S.N. Sharma, D.L. Singhania and R.S. Sain (**2003**). Hybrid vigor over environments in a ten-parent diallel cross in common wheat. Sabrao J. of Breeding and Genetics, **35 (2)**: 81-91.

Kaur, V. and R.K. Behl (**2010**). Grain yield in wheat as affected by short periods of high temperature, drought and their interactions during pre- and post anthesis stages. Cereal Res. Commun. **38**: 514- 520.

Mather, K. (**1949**). Biometrical Genetics. Dover Publications Inc. London.

Mather, K. and J.L. Jinks (**1971**). Biometrical Genetics. 3rd Ed. Chapman and Hall. London.

Memon, S.M. M.U. Qureshi, B.A. Ansari and M.A. Sial (2007). Genetic heritability for grain yield and its related characters in spring wheat. Pak. J. Bot. **39 (5)**: 1503- 1509.

Menshawy, A.M.M. (**2007**). Evaluation of some early bread wheat genotypes under different sowing dates: 1- Earliness Characters, 2- Agronomic characters. Fifth Plant Breading Conference (May 27), Giza. Egypt. J. Plant Breed. **11(1)**: 25-55.

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

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 Basis of Breeding. Lectures given at the Fac. of Agric., Cairo Univ., and Alex Univ.

Sallam, A.M.A. (**2008**). Genetic variations in stem diameter in wheat (*Triticum aestivum*, L.) in relation to drought and heat stress tolerance. M.Sc. Thesis, Fac. of Agric., Assiut Univ., Egypt.

Sharma, S.N., R.S. Sain and R.K. Sharma (**2002**). Genetic control of quantitative traits in durum wheat under normal and late-sowing environments. Sabrao J. Breeding and Genetics, **34(1)**: 35-43.

Singh, R.K. and B.D. Chaudhary (**1985**). Biochemical Methods in Quantitative Genetic Analysis. Kalyani Puplisher, New Delhi, Ludhiana, India.

Tawfelis, M.B. (**2006**). Stability parameters of some bread wheat genotypes (*Triticum aestivum*, L.) in new and old lands under Egypt conditions. Egypt. J. Plant Breed. **10(1)**: 223-246.

الملخص العربى

الاختلافات الوراثية لتحمل درجة الحرارة فى قمح الخبز باستخدام نموذج الخمس عشائر

سهير محمود حسن عبد الله وإبراهيم عبد الهادى أمين

قسم بحوث القمح- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية- الجيزة- مصر

نظراً لأهمية استنباط سلالات مبكرة النضج وكذلك سلالات تتحمل التأخير فى الزراعة فى انتشار قمح الخبز وعدم التأخير فى زراعة المحاصيل الصيفية التى تعقب القمح فقد أجريت ٤ تجارب حقلية فى ٤ مواسم شتوية متتابعة من ٢٠٠٨/ ٢٠٠٩ وحتى ٢٠١١/ ٢٠١٢ حيث تم عمل التهجينات فى الموسم الأول والحصول على حبوب الجيل الأول F_1 والتى تم زراعتها فى الموسم الثانى للحصول على الجيل الثانى وتم تجديد F_1 وفى الموسم الثالث تمت زراعة الجيلين الأول والثانى للحصول على الجيل الثانى والثالث وكذلك تجديد F_1 فى محطة بحوث- إيتاى البارود- بمحافظة البحيرة ثم أجرى تقييم العشائر الخمسة فى الموسم الرابع فى محطة البحوث الزراعية بشندويل وذلك بزراعتها فى ميعادين الأول الأمثل (١٥ نوفمبر) والثانى المتأخر(١٥ ديسمبر) لدراسة تحمل درجة الحرارة- ثم حساب عدد الأيام حتى طرد السنابل وعدد الأيام حتى النضج الفسيولوجى وطول فترة امتلاء الحبوب وكذلك معدل امتلاء الحبوب، عدد السنابل/ نبات، عدد الحبوب/ السنبلة، وزن الحبوب ووزن محصول النبات كما تم تقدير معامل الحساسية لتحمل الزراعة المتأخرة وفيما يلى أهم النتائج:

١- كانت هناك اختلافات معنوية بين الهجن فى الزراعة المتأخرة لطول فترة امتلاء الحبوب ومعامل الحساسية لتحمل الزراعة المتأخرة لصفة عدد السنابل/ النبات، عدد الحبوب/ السنبلة، وزن ١٠٠ حبة، محصول الحبوب/ النبات ومعدل امتلاء الحبوب.

٢- كانت قوة الهجين بالنسبة للأب الأعلى فى ميعاد الزراعة الأمثل معنوية وموجبة لتاريخ النضج الفسيولوجى فى الهجين الثانى، عدد الحبوب/ السنبلة فى الهجين الأول ووزن المائة حبة ومحصول الحبوب/ النبات للهجين الثالث بينما فى الزراعة المتأخرة كانت معنوية وموجبة لصفة النضج الفسيولوجى لكل من الهجين الأول والثانى، عدد السنابل/ النبات للهجين الثانى ومحصول الحبوب/ النبات للهجن الأول والثانى.

٣- أظهرت دراسة طبيعة التوارث وجود سيادة فائقة تجاه الأب الأعلى فى ميعاد الزراعة الأمثل لصفة تاريخ النضج الفسيولوجى وعدد السنابل/ النبات للهجين الثانى- محصول الحبوب/ النبات فى الهجين الأول ووزن المائة حبة ومحصول الحبوب/ النبات فى الهجين الثالث، بينما كانت هناك سيادة فائقة تجاه الأب الأقل لصفة تاريخ الطرد وعدد الحبوب/ السنبلة فى الهجين الأول، وصفة وزن المائة حبة فى الهجين الثانى. كما كانت هناك سيادة تامة لصفة تاريخ النضج الفسيولوجى وعدد الحبوب/ السنبلة فى الهجين الثالث وسيادة جزئية تجاه الأب الأعلى لصفة تاريخ الطرد فى الهجين الثالث وصفة وزن المائة حبة للهجين الأول- بينما أظهرت نتائج الزراعة المتأخرة وجود سيادة تامة تجاه الأب الأعلى لكل من صفة وزن المائة حبة فى الهجين الثانى وصفة محصول الحبوب/ النبات لكل من الهجين الأول والثانى- كذلك وجود سيادة جزئية تجاه الأب الأعلى لصفة عدد السنابل/ النبات فى كل من الهجين الأول والثانى والحبوب/ السنبلة فى الهجين الثالث.

٤- كان تأثير التربية الداخلية فى ميعاد الزراعة الأمثل موجباً ومعنوياً لكل من تاريخ النضج ووزن المائة حبة فى الهجين الأول والثانى، وكذلك لصفات تاريخ الطرد وتاريخ النضج الفسيولوجى وعدد الحبوب/ السنبلة ووزن المائة حبة فى الهجين الأول وصفة تاريخ الطرد ووزن المائة حبة فى الهجين الثالث وعدد الحبوب/ السنبلة للهجين الثانى فى الزراعة المتأخرة.

٥- كان التأثير المضيف معنوياً وموجباً فى ميعاد الزراعة الأمثل لصف تاريخ النضج الفسيولوجى لكل من الهجين الثانى والثالث وصفة عدد الحبوب/ السنبلة للهجين الثانى ووزن المائة حبة ومحصول الحبوب/ النبات للهجين الأول. بينما فى الزراعة المتأخرة كان التأثير المضيف معنوياً وموجباً لصفة تاريخ النضج الفسيولوجى فى الهجين الثانى والثالث عدد الحبوب/ السنبلة لكل من الهجين الأول والثالث ومحصول الحبوب/ النبات للهجين الأول وأظهرت التأثيرات الوراثية غير المضيفة دوراً هاماً فى بعض الصفات المدروسة لكل من ميعادى الزراعة الأمثل والمتأخر.

٦- أظهرت كفاءة التوريث بمعناها الضيق قيما تتراوح من صفر % لصفة عدد السنابل/ النبات فى الهجين الثالث إلى ٧١,١١% لصفة وزن المائة حبة فى الهجين الأول وذلك فى ميعاد الزراعة الأمثل بينما فى الزراعة المتأخرة تراوحت هذه القيم من ٣١,١٤% لصفة عدد السنابل/ النبات فى الهجين الثانى إلى ٧٨,٢١% لصفة تاريخ النضج الفسيولوجى للهجين الأول، أما قيم الكفاءة الوراثية المحسوبة من الانحدار بين الأجيال فقد تراوحت من المتوسطة إلى المرتفعة فى معظم الصفات المدروسة وقد أرتبطت قيم التحسين الوراثى المنخفضة والمرتفعة بمثيلتها لمعامل التوريث بمعناه الضيق فى جميع الهجن المدروسة وذلك لكل من الزراعة فى الميعاد الأمثل والمتأخر.