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GENETIC STUDIES ON HEADING, MATURITY AND YIELD AND ITS COMPONENTS FOR LATE SOWING CONDITIONS IN WHEAT (*T. AESTIVUM* L.)

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Abstract

An understanding of genetic analysis of earliness components is needed to develop early lines. Six bread wheat (*Triticum aestivum* L.) genotypes differing in earliness were crossed in all possible combinations excluding reciprocals in 2003/2004 season. In 2004/2005 growing season, parents and F_1'S were planted on Jan 5th and grown in a field experiment in El-Giza Experimental Farm Agricultural Reasearch Center. The Randomized Complete Blocks Design with three replications was used. Days to heading, days to anthesis, days to maturity, grain filling period and grain filling rate (earliness components), plant height, number of spikes per plant, number of kernels per spike, 100-Kernel weight, total plant weight, grain yield per plant, straw yield per plant and harvest index were recorded. The F_1'S and 15 wheat crosses and their respective parents were statistically analyzed to detect some information on the genetic effects governing the studied characters. The obtained results showed that positive heterosis values were detected for different studied characters. The mean squares of genotypes, parents and crosses were highly significant for all studied traits.

The variances associated with general and specific combining ability reached the level of significant for all studied characters. GCA variance values were two times higher than the SCA variance ones for days to heading, days to anthesis, days to maturity, plant height and 1000-kernel weight, suggesting the predominant role for additive type of gene action. Moreover, the parents P2 (Gemmiza 10) and P4 (Line 4) were the best combiners for grain filling rate and grain yield. Meanwhile, significant SCA effects for grain filing rate, grain yield, straw yield and total plant weight were found in the crosses between P1 X P3, P1 X P6, P2 X P3, P2 X P4 and P4 X P5. On the other hand, P2 X P6 showed significant SCA effect for grain filling rate and grain yield. The additive variance (D) effects were significant for all studied characters except for grain filling rate, 100-kernel weight, grain yield and total plant weight. The relative proportions of variance due to non-additive effects were significant for all characters except for 100-kernel weight and were greater of most characters in magnitude than the additive component (D). Overall dominance effect of heterozygous loci (h2) was significant in most traits, which indicating that the effect of dominance was due to heterozygosity. Over dominance effect was observed for all studied characters except for days to heading and days to anthesis. Values of H2/4H1 analysis being less than 0.25 indicated asymmetric distribution of positive and negative allels among parents for all characters except for plant height, 100-kernel weight, grain yield and total plant weight. On the other hand, low values for narrow sense heritability for most studied characters were observed, reflecting that most of the genetic variance were due to non-obtained genetic effects.

INTRODUCTION

Wheat, (*Triticum aestivum* L.), the major cereal crops in Egypt receives the most attention of the breeders. To increase grain yield per unit area is the main solution for overcoming the increased demand of food from a limited cultivated area. Plant breeders would develop high yielding wheat cultivars tolerant to biotic and abiotic stresses. Breeding early maturing cultivars is an important objective in most wheat breeding programs. Information about the inheritance of early maturing and its attributes, as well as yield and its components are very scancy in spite of its importance to wheat breeders in developing short duration cultivars. In Egypt, late planting starting from January after harvesting vegetables grown for exporting has increased.

Successful breeding programs need continuos information about the genetic variation and systems governing earliness attributes, as well as grain yield and its components. Contradictory results were obtained by several authors with respect to genetic systems governing these characters. For instance heading time in wheat is governed by three major factors: vernalization requirement, photoperiod sensitivity and narrow sense earliness (Shindo *et al.*, 2003). The first two factors are environment dependent, while the latter is environment independent.

The wheat crop planting at different dates witnesses vast differences with respect to abiotic factors like temperature, light and humidity. The wheat genotypes react differently to abiotic factors especially temperature and light in accordance with their photothermal responses and several morphological and productivity characters, (Kumar *et al.*, 1995). Therefore, there is a need to develop varities capable of facing effectively the harsh environment. The progress of breeding efforts in this direction will depend on the amount of variability present in the germplasma.

Several genes have been reported to be involved in the control of heading time, including late heading (Islam-Faridi *et al.*, 1996, Law et al 1998).

Additive and dominance effects with greater importance for additive type were found to control days to heading (Shehab el-Din, 1997, and Menshawy, 2005), grain filling period and rate of filling (Mou and Kronstad, 1994 and Menshawy, 2005).

In addition, (May and Van Sanford, 1992) detected significant additive effects for effective grain filling period and other trait related to maturity.

Wong and Baker (1986) reported that the heritability values of developmental trait and the estimates of grain filling period in spring wheat were low to intermediate. Meanwhile, values of heritability in narrow sense were more than 50 % for days to heading, grain filling period and rate of grain fill (Mou and Kronstad, 1994 and Menshawy, 2005).

El-Sayed (2000) and Hamada and Tawfeles (2001) indicated that additive and non-additive gene effects played equal roles in the inheritance of grain yield, number of spikes/plant, number of kernels/spike, kernel weight and plant height.

On the other hand, Salm and Hassan (1991) found that non-additive gene effects were more important in the inheritance of grain yield/plant and number of spikes/plant. Similarly, Darwish (1992) found that dominance gene effects were significant for grain yield/plant, number of kernels/spike and kernel weight. Reversely to that, Mekhamer (1995) reported that additive gene effects were significant for number of kernels/spike and kernel weight.

On the other side, El-Sayed *et al.* (2000), and Ashoush *et al.* (2001), found that GCA and SCA were significant for days to heading, maturity and plant height.

Concerning the heritability values, Tamam and Abd El-Gawad (1999) found that heritability in broad and narrow sense values for days to heading, number of spikes/plant, kernel weight and grain yield/plant were high, while the narrow sense heritability for number of kernels/spike was low. On the other hand, El-Sayed *et al.* (2000) found that these values were medium or low for number of spikes/plant, number of kernels/spike and grain yield/plant. They also, reported that estimates for number of days to heading and 1000-kernel weight fluctuated, varied from medium to high.

The main objective of this study was to determine which of the six studied cultivars has (have) the general and/or specific combining abilities to produce good hybrid(s) that tolerate late sowing stress. This informations would help breeders to manipulate earliness components to develop high yielding and early heading cultivars via selection for these characters in early generations. And also help breeders in chossing these parental combinations which when crossed would result in the highest proportion desirable segregates, and identifying early cultivars. Therefore, the present investigation utilized early heading sources as well as high yielding ones, crossed and tested under late sowing conditions.

MATERIALS AND METHODS

This study was conducted at El-Giza Agricultural Research Station, Agricultural Research Center (ARC),Egypt, during the two wheat growing seasons 2003/2004 and 2004/2005. Four different bread wheat cultivars and two promising lines differing in earliness were selected for this study. Name and pedigree of the six parental materials are presented in Table 1 .

Table 1. Name and pedigree of the six Bread wheat cultivars.

No.	Name	Pedigree	Relative earliness
P_1	Gemmeiza 9	Aqld "S"/Huac "S"//CmH74A.630/5x CGM483 - 5GM - 1GM - 0GM	late
P_2	Gemmeiza 10	MAYA74"S"10N//1160-147/3/BB/G/LL /4/CHAT "S"/5/CROW "S"	late
P_3	Early line 1	BCH"S"//HORK"S"/4/7C/PATO(B)/3/ LR64/INIA//INIA/BB/5/CNO/GLL//BB/ INIA/3/NAPO//TOB66/SPROW "S" CR.GZ.9269.7GZ-5GZ-3GZ-1GZ-0GZ	early
P_4	Line 2	MAYA"S"/MON"S"/4/CMH72428/MRC//J UP/3/582/5/SAKHA8/6/SAKHA69 SD10157-18SD - 1SD - 2SD - 1SD - 0SD	Intermediate
P_5	Sids 4	MAYA "S"/MON "S"//CMH74A.592/3/ Giza 157*2	early
P_6	Sakha 61	INIA/RL4220//7C//Yr "S" CM15430 – 25 – 55 – 0S	early

In 2003/2004 season, all possible crosses without reciprocals among the six parents were made. In the second season (2004/2005), the 21 entries ($15F_1$'S and 6 parents) were planted in the filed using the randomized complete block design (RCBD) with three replications. Each entry was planted in a plot of two rows. Each row was 3.0 m long and 30 cm apart, and contained 15 seeds spaced 20 cm apart. Data were recorded on a random sample of 10 guarded plants from each row. The studied characters were earliness components (days to heading, days to anthesis, days to maturity, grain filling period and grain filling rate), plant height, number of spikes/plant, number of kernels/ spike, 100-kernel weight, total plant weight, grain yield/plant, straw yield/plant, and harvest index.

The analysis of variance for combining ability effects was calculated following the technique of Griffing (1956), Griffing's diallel crosses analysis designated as method 2, model 1 and further. The genetic analysis was carried out by the procedures described by Hayman (1954).

RESULTS AND DISCUSSION

Analysis of variance for all studied characters namely number of days to each of heading, anthesis and maturity, grain filling period, grain filling rate, plant height, number of spikes/plant, number of kernels/spike, 100-kernel weight, total plant weight, grain yield/plant, straw yield/plant and harvest index % are presented in Table 2. Test of significance indicated the presence of true differences among genotypes except for number of kernels/spike, mean squares due to parents VS. crosses were significant for all studied characters indicating heterosis.

Table 2 shows the results of the analysis for GCA, SCA and the GCA/SCA ratio. The variances associated with both GCA and SCA were significant reflecting the presence of both additive and dominance types of gene effects for all characters.

Significantly large GCA effects were recorded for number of days to each heading, anthises and maturity, plant height and 100-kernel weight. The general combining ability variances were about two times higher than the specific combining ability variances, indicating a predominant role of additive type of gene action for these traits and selection could be successful.

Parents VS. cross mean squares (Table 2), as an indication to average heterosis over all crosses were found to be significant for all studied characters except for number of kernels/spike. Hence effective breeding program aiming to the improvement of such characters responsible for earliness and yielding could be useful by selecting the appropriate parents for each characters.

The mean performance of the parents and their crosses are presented in Table 3. The cultivar Gemmieza 9 (P_1) ranked the first in total plant weight and straw yield/plant and the second in grain yield/plant. Meanwhile, gemmeiza 10 (P_2) ranked the first in plant height and the second in the total plant weight. Moreover, line 1 (P_3) ranked the first in less days to heading, early anthesis, early maturity and 100-kernel weight and the second in grain yield/plant. The cultivar line 2 (P_4) ranked the first in grain filling period, grain-filling rate, number of kernels/spike, grain yield/plant and harvest index %. Likewise, Sids 4 (P_5) ranked the second in grain filling rate, 100-kernel weight and grain yield and the second of grain filling rate. Finally, Sakha 61 (P_6) ranked the second in less days to maturity and grain filling period. Moreover, the mean performance of the tested fifteen crosses are presented in Table 3. For days to heading the best five crosses were P_1 X P_3 , P_2 X P_3 , P_3 X P_4, P_3 X P_6 and P_4 X P_6. The three crosses P_3 X P_4, P_3 X P_6 and P_4 X P_6, processed of days to anthesis. The best seven P_1 X P_3, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_5, P_2 X P_6, and P_3 X P_6, processed of little days of maturity. The best seven crosses P_1 X P_3, P_1 X P_4, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_5 and P_2 X P_6 possessed of the short of grain filling period. The best four crosses of P_1 X P_6, P_2 X P_3, P_2 X P_4 and P_4 X P_5 possessed the highest grain-filling rate. The best four crosses P_1 X P_2, P_1 X P_3, P_2 X P_5 and P_3 X P_4 possessed of plant height. The best five crosses P_1 X P_3, P_2 X P_3, P_2 X P_4, P_4 X P_5 and P_4 X P_6 showed the highest number of spike/plant. The two crosses P_1 X P_5 and P_1 X P_6 were the highest number of kernel/spike for the 100-kernel weight. The best five crosses P_1XP_4 , P_3 X P_5 , P_3 X P_6 , P_4 X P_6 and P_5 X P_6. The best four crosses P_1 X P_6, P_2 X P_3, P_2 X P_4 and P_4 X P_5 possessed the heights grain yield/plant P_4 X P_5, and P_4 X P_6 possessed the highest straw yield/plant. The best six crosses P_1XP_3, P_1 X P_4, P_1 X P_6, P_2 X P_3, P_4 X P_5 and P_4 X P_6 possessed the highest straw yield/plant. The best seven crosses are P1 X P2, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_6, P_3 X P_5 and P_4 X P_5. While the best five crosses P_1 X P_3, P_1 X P_6, P_2 X P_3, P_2 X P_4 and P_4 X P_5 possessed the highest total weight.

Finally it is clear from the tabulated data that six out of 15 crosses, seem to be promising genotypes for grain filling rate and grain yield/plant (P_1 X P_2, P_1 X P_6 , P_2 X P_3 , P_2 X P_4, P_2 X P_6 and P_4 X P_5). The importance of these results are that they realized under late sowing conditions. Walton (1971) emphasized that a parent superior for one yield components character should be crossed with a parent superior for the other components to obtain heterosis in a complex trait such as grain yield. The particular components contributing to high yielding crosses were not constant from cross to another. Our results are in agreement with those reported by Hassan and Saad (1996).

Estimates of GCA effects for parents are presented in Table 4, under late sowing condition. Significant negative values would be of interest except days to heading, days to anthesis, days to maturity and grain filling period. P_3 (early line) and P_6 (Sakha 61) were the best combiners while P_5 (Sids 4) was a good combiner for days to maturity and grain filling period. Moreover, P_2 (Gemmeiza 10) was the best combiner for increasing grain yield/plant, plant height and grain filling rate whereas, p_1 (Gemmeiza 9) was the best combiner for increasing total plant weight, straw yield/plant, number ok kernel/spike, number of spike/plant and plant height. On the other hand, P_4(Line 2) was the best combiner for increasing grain-filling rate, number of kernel/spike and grain yield/plant.

Specific combining ability effects of the parental combinations for the studied characters are presneted in Table 5. Results showed that, the crosses P_1 X P_3, P_1 X P_4, P_1 X P_5, P_2 X P_6, P_3 X P_4 and P_4 X P_6 for significantly negative effects for early heading, for days to anthesis crosses P_2 X P_5, P_2 X P_6, P_3 X P_4 and P_4 X P_5; for days to maturity P_1 X P_3, P_1 X P_4, P_1 X P_5, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_5 and P_2 X P_6 for early maturing and for grain filling period P_1 X P_3, P_1 X P_4, P_1 X P_6, P_2 X P_3, P_2 X P_4 and P_2 X P_5 gave significant negative effect. Beside grain filling rate P_1 X P_3, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_6 and P_4 X P_5. Thus, the following five crosses P_1 X P_3, P_1 X P_6, P_2 X P_3 , P_2 X P_4 and P_2 X P_6 may have good potential for earliness with high filling rate for successful selection under proper methods utilizing dominant genes. For plant height P_1 X P_3, P_2 X P_5 and P_3 X P_4 gave significant positive SCA effects, also crosses P_1 X P_3, P_2 X P_3, P_2 X P_4, P_3 X P_5, P_4 X P_5 and P_4 X P_6 were desirable for number of spikes/plant, where, crosses P_1 X P_6, P_2 X P_3, P_2 X P_6, P_4 X P_5 and P_5 X P_6 gave significant positive SCA effects for number of kernels/spike , also crosses P_1 X P_4, P_4 X P_6 and P_5 X P_6 gave the significant positive SCA effects for 100-kernel weight. The combination, P_1 X P_3, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_6 and P_4 X P_5 gave the significant positive SCA effect for grain yield/plant. For straw yield/plant crosses P_1 X P_3, P_1 X P_4, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_5, P_3 X P_4, P_3 X P_6, P_4 X P_5 and P_4 X P_6 gave the significant positive SCA effects.The crosses P_1 X P_3, P_1 X P_6, P_2 X P_3, P_2 X P_4, P_2 X P_6 and P_4 X P_5 are considered to be promising hybrids for earliness, grain filling rate and grain yield and yield components improvement purpose, as they showed high specific combining ability effects and involved one good combiner for earliness and another good combiner for yield. It is worthy to note, that these hybrids were a result of crossing poor X good and good X good general combiners. In such hybrids, desirable transgressive segregates would be excepted in the subsequent generations, if the additive genetic system present in the good combiner and the complementary epistatic in the F_1 acted in the same direction to maximize the yielding ability.

Table 2. Pertinent portion of the analysis of variance for the studied characters and combining ability

	d. f.	days to heading	days to anthesis	days to maturity	grain filling period (day)	grain filling rate (g/day)	Plant Height (cm)	No. of spikes/ plant	No. of kernels/ spike	100-kernels weight (g)	grain yield/ plant (g)	Straw yield/ plant (g)	Total plant weight (g)	Harvest index %
Replication	2	0.587	0.245	3.571	3.00	0.001	4.202	4.57	0.385	0.285	2.663	87.175	114.242	0.647
Genotypes	20	9.844**	15.149**	32.205**	20.267**	0.026**	92.549**	28.503**	406.929**	0.355**	47.698**	51.601**	664.099**	77.113**
Parents (P)	5	23.200**	30.322**	55.422**	36.322**	0.014**	92.053**	24.482**	637.559**	0.253*	17.704**	371.298**	353.032**	105.574**
Crosses (C)	14	4.536**	10.105	21.308**	14.375**	0.029**	75.662**	27.987**	353.093**	0.348**	57.503**	215.347**	355.703**	39.088**
P vs C	1	19.910**	9.906**	68.673**	22.478**	0.037**	331.448**	55.833**	7.489	0.966**	60.401**	534.66**	6536.987**	467.153**
GCA	5	8.854**	15.199**	17.997**	4.405**	0.006**	59.013**	5.059**	111.364**	0.221**	12.598**	136.137**	866.112	19.812**
SCA	15	1.422**	1.693**	8.313**	7.539**	0.009**	21.462**	10.982**	143.736**	0.084**	16.999**	181.555**	3561.29	27.668**
Error	40	0.821	0.904	1.955	2.467	0.002	8.404	2.123	9.046	0.103	4.057	46.117	49.845	10.608
GCA/SCA		6.226	8.93	2.165	0.584	0.667	2.750	0.461	0.775	2.631	0.764	0.750	0.075	0.716

Table 3. Mean performance (X), and heterosis over parent (H) for the earliness attributes, yield and yield components, under late sowing condition.

Genotypes		days to heading		days to anthesis		days to maturity		grain filling period /day		grain filling rate g / day		Plant height (cm)	
		X	H	X	H	X	H	X	H	X	H	X	H
P_1		68.00		75.00		130.00		55.000		0.364		81.00	
P_2		66.00		74.00		128.00		54.000		0.356		88.00	
P_3		60.00		67.00		120.00		53.00		0.396		80.00	
P_4		67.00		75.00		121.00		45.00		0.519		72.00	
P_5		64.00		71.00		121.00		51.00		0.398		75.00	
P_6		63.00		70.00		120.00		50.000		0.322		80.00	
P_1XP_2		66.00	-0.507	75.00	-1.809	129.00	-1.044	54.000	0.000	0.439	20.604*	80.00	0.954
P_1XP_3		62.00	-2.763*	70.00	-4.975**	120.00	0.000	49.00	6.33**	0.485	22.474*	93.00	13.73**
P_1XP_4		64.00	-4.45**	73.00	1.787	122.00	-0.829	48.00	-6.618*	0.356	-31.407**	80.00	-0.614
P_1XP_5		63.00	1.048	72.00	-1.415	121.00	0.000	50.00	1.974	0.427	7.286	84.00	3.484
P_1XP_6		64.00	-1.053	71.000	-0.948	120.00	0.553	49.00	2.666	0.533	46.429**	86.00	5.533
P_2XP_3		63.00	-3.869**	71.00	-6.468**	119.00	0.279	48.000	8.861**	0.599	51.262**	82.00	-6.095*
P_2XP_4		65.00	1.016	73.000	0.905	120.00	0.829	48.00	-5.149	0.602	15.992*	80.00	-8.57**
P_2XP_5		64.00	-0.523	71.000	-0.471	118.000	2.747**	47.000	7.237**	0.425	6.784	91.00	4.762
P_2XP_6		63.00	0.526	70.000	0.473	118.00	1.662	48.00	3.334	0.471	29.396**	87.000	-0.571
P_3XP_4		62.00	-2.211	68.00	-0.996	121.00	-1.392	53.000	-16.912**	0.358	-31.021**	88.00	11.111**
P_3XP_5		64.00	-5.526**	71.00	-5.473	121.00	-0.836	51.00	-1.314	0.386	-3.015	80.00	1.677
P_3XP_6		62.00	-2.765*	69.000	-2.985*	119.000	0.557	50.000	0.000	0.338	-14.646	85.000	6.25*
P_4XP_5		64.00	-1.046	72.00	-2.358*	122.000	-1.105	50.00	-9.560**	0.600	15.607*	73.00	-1.496
P_4XP_6		63.00	1.052	70.00	0.009	123.00	-2.493*	54.00	-18.384**	0.326	-37.187**	80.00	0.209
P_5XP_6		63.00	0.526	70.000	0.473	121.00	-0.278	51.00	-1.334	0.351	-11.809	82.00	2.638
L. S.D	5%	1.494	1.495	1.568		2.306		2.590		0.072		4.781	
	1%	1.997	2.000	2.096		3.082		3.462		0.096		6.391	

Table 3. Cont.

Genotypes		No. of spikes/ plant		No. of kernels / spike		100- kernel weight (g)		grain yield/plant (g)		straw yield/plant (g)		Total plant weight (g)		Harvest index %	
		X	H	X	H	X	H	X	H	X	H	X	H	X	H
P_1		16.333		59.333		2.637		20.003		66.497		86.500		23.100	
P_2		17.000		39.000		2.940		19.267		50.230		69.500		27.63	
P_3		12.917		56.333		3.360		20.920		38.747		59.667		35.223	
P_4		13.000		73.667		3.070		23.520		36.147		59.667		39.470	
P_5		10.447		54.443		3.350		20.060		41.827		61.887		32.950	
P_6		17.667		33.333		3.327		16.033		42.300		58.333		28.037	
$P_1 X P_2$		13.667	-19.606**	55.000	-7.303	3.083	4.864	23.763	18.797*	63.737	-4.151	87.5	1.156	27.160	-1.701
$P_1 X P_3$		20.500	12.551	55.667	-6.179	2.973	-11.518	23.883	14.163	72.783	9.453	96.667	11.754	24.720	-29.819**
$P_1 X P_4$		16.000	-2.039	49.000	-33.484**	3.777	23.029**	17.150	-27.083**	75.350	13.313	92.500	6.936	18.753	-52.488**
$P_1 X P_5$		16.000	-2.039	54.467	-8.707	3.350	0.000	21.207	5.718	66.293	-0.307	87.500	1.156	23.890	-27.496**
$P_1 X P_6$		18.000	1.885	67.333	13.483**	3.063	-7.935	25.920	29.581**	74.747	12.407	100.667	16.378*	25.807	-7.954
$P_2 X P_3$		18.833	7.841	73.667	30.771**	3.157	-6.042	28.743	37.395**	70.423	4.201**	99.167	42.686**	28.987	-17.704*
$P_2 X P_4$		19.333	13.724	52.667	-28.507**	3.020	1.629	28.033	19.188	66.967	33.321**	95.000	36.691**	29.573	-25.075**
$P_2 X P_5$		12.000	-29.412**	57.333	5.308	3.327	-0.687	19.970	-0.449	63.363	26.146	83.333	19.904	24.293	-26.273**
$P_2 X P_6$		11.333	-35.852**	61.333	57.264**	3.060	-8.025	22.773	18.179*	51.393	2.315	74.167	6.715	30.840	10.354
$P_3 X P_4$		13.833	6.41	49.500	-32.806**	3.347	-0.387	18.973	19.332**	66.027	70.405**	85.000	42.457**	22.357	-43.357**
$P_3 X P_5$		16.500	27.739**	47.167	-16.271**	3.480	3.571	19.830	-5.21	51.003	21.938	70.833	14.455	27.833	-2.981*
$P_3 X P_6$		18.333	3.77	37.000	-34.319**	3.760	11.905	16.887	-19.278*	61.780	46.052**	78.667	31.843**	21.457	-39.082**
$P_4 X P_5$		20.833	60.254**	59.833	-18.779**	3.523	5.164	29.603	25.863**	80.397	92.213**	110.00	77.743**	27.113	-31.307**
$P_4 X P_6$		19.833	12.26	29.500	-59.954**	3.903	17.313*	17.513	25.54**	72.487	71.364**	90.000	5.837**	19.460	50.697**
$P_5 X P_6$		14.667	-16.981**	52.557	-3.464	3.997	19.313*	17.770	-11.416	58.34	37.92**	76.110	22.982**	23.373	-14.155
L. S. D.	5%	2.403		4.961		0.529		3.322		11.200		11.644		5.372	
	1%	3.212		6.631		0.706		4.441		14.971		15.564		7.18	

The results are similar to those obtained by El-Sayed *et al.* (2000), Ashoush *et al.* (2001) and el-Sayed (2004).

The estimated values of the genetic variation components D, F, H_1, H_2 and h^2 are presented in Table 6. Additive genetic effects D were significant for all characters except for grain filling rate, kernel weight, grain yield/plant and total plant weight. The estimates of H_1, which reflect the non-additive effect, were significant for all studied characters except for kernel weight trait. Values of H_1 for days to heading and days to anthesis, only, were smaller than the respective D, indicating the importance of additive gene action in the inheritance of these characters. Meanwhile, the values of H_1 were larger in magnitude than the respective D for other studied characters. The dominance effects associated with gene distribution (H_2) were highly significant and greater than D for all studied characters, except for days to heading and anthesis. Moreover, all H_2 values were smaller than H_1 ones for all characters indicating unequal allels frequency. Over all dominance effects of heterozygous loci (h^2) were significant for all studied characters except for days to anthesis, grain filling period, grain filling rate, number of kernels/spike and grain yield/plant, indicating that the effect of dominance is due to heterozygosity. These results agreed with those of El-Menshawy (2005). The covariance of additive and dominance effect (F) was not significant for all characters except for days to heading, anthesis and maturity as well as grain filling period, revealing an excess of recessive over-dominance allels. Therefo, it could be concluded that additive genetic components D were the most important for all studied characters except for grain filling rate, kernel weight, grain yield/plant and for total plant weight. Earliness attributes rather than yield and yield components and grain filling period which were mainly controlled by additive genes.

The mean degree of dominance $(H_1/D)^{½}$ was greater than one for all studied characters except for days to heading and anthesis, which proving over-dominance. The proportion of genes with positive and negative allels in parents ($H_2/4H_1$) were slightly below the maximum value 0.25 over all loci, indicating that the positive and negative allels were not equally distributed among the parents for all studied characters except for plant height, kernel weight, grain yield/plant and total plant weight. These results confirmed those of H_2 estimate and showed unequal frequencies of positive and negative genes among parents for all studied characters. The ratio $[4D\ H_1)^{1/2} + F/(4D\ H_1)^{1/2} - F]$ was greater than one for all studied characters except for kernel weight reflecting greater frequency of dominant genes. These results are confirmed from the positive value of the F component. On the other side, low to medium values for broad and narrow sense heritabillty were detected for all studied characters, indicating that most of genetic variances were due to non-additive genetic effects. These results supported the previous results concerning the genetic components, where the H_1 estimates played greater role (Table 6). In this respect, it could be suggested that bulk method program for most characters might be quite promising.

In conclusion, wheat breeders could manipulate earliness components to a cultivar, via selection for these traits in early generations due to the additive gene action in their genetic control. These information also help breeders in selecting parental combination that would result in the highest proportion of desirable segregates and identify early genotypes. These genotypes should be late planting tolerant and could be used in double cropping systems mainly, i.e. cotton-wheat system.

Table 4. Estimate of general combining ability effects for earliness attributes yield and yield components, under late sowing condition.

Genotypes		days to heading	days to anthesis	days to maturity	grain filling period (day)	grain filling rate (g/ day)	Plant height (cm)	No. of spikes/ plant	No. of kernels / spike	100-kernel weight (g)	Grain yield/plant (g)	straw yield/plant (g)	Total plant weight (g)	Harvest index %
P_1		1.028**	1.431**	2.458**	.958	-0.006	1.928**	0.561*	3.402**	-0.206**	0.165	7.786**	7.951**	-2.62**
P_2		0.694**	1.055**	1.083**	0.083	0.029**	3.157**	-0.397	0.674	-0.205**	1.401**	-0.908	0.493	1.096
P_3		-1.722**	-2.028**	-1.458**	0.583	-0.008	1.116*	0.186	0.382	0.033	-0.056	-3.013*	-3.09*	1.057
P_4		0.778**	0.931	-0.208	-1.166**	0.033**	-4.113**	0.436	1.903**	0.068	0.963*	1.238	2.202	1.108
P_5		-0.139	-0.278	-0.708**	-0.333	-0.004	-2.238**	-1.431**	0.917	0.151*	-0.264	-2.570*	-2.834*	0.633
P_6		-0.639**	-1.111**	-1.167**	-0.125	-0.044**	0.150	0.645*	-7.278**	0.159*	-2.209	-2.533*	-4.743**	-1.292*
L.S. D. g_i	5%	0.341	0.358	0.526	.591	0.017	1.091	0.548	1.132	0.121	0.758	2.556	2.658	1.226
	1%	0.457	0.478	0.703	0.790	0.022	1.458	0.733	1.513	0.161	1.013	3.417	3.552	1.639
L.S. D. g_i-g_j	5%	0.528	0.554	0.815	0.916	0.026	1.690	0.850	1.754	0.187	1.175	3.96	4.117	1.899
	1%	0.706	0.741	1.090	1.224	0.034	1.732	1.136	2.344	0.250	1.570	5.293	5.503	2.539

Table 5. Estimate of specific combining ability effects for earliness attribute, yield and yield components, under late sowing condition.

Genotypes		days to heading	days to anthesis	days to maturity	grain filling period (day)	grain filling rate (g/day)	Plant height (cm)	No. of spikes/ plant	No. of kernels / spike	100-kernels weight (g)	grain yield/ plant (g)	straw yield/ plant (g)	Harvest index %	Total plant weight (g)
$P_1 X P_2$		0.500	1.196**	3.887**	2.625**	-0.015	0.547	-2.547**	-2.307	0.185	0.682	-3.658	-2.976	1.902
$P_1 X P_3$		-1.083**	-0.387	-2.905**	-2.542**	0.068**	6.755**	3.704**	-1.348	-0.164	2.259*	7.494*	9.753**	-0.499
$P_1 X P_4$		-1.25**	-0.345	-2.155**	-1.792**	-0.102**	0.318	-1.047	-9.536**	0.605**	-5.494**	5.809*	0.315	-6.516**
$P_1 X P_5$		-1.667**	-0.804	-1.988**	-1.292	0.006	1.775	0.821	-3.383*	0.095	-0.211	0.561	0.351	-0.904
$P_1 X P_6$		-0.167	-0.637	-3.196**	-2.500**	0.152**	1.054	0.745	17.978**	-0.199	6.449**	8.978**	15.427**	2.937*
$P_2 X P_3$		-0.083	0.988**	-1.863*	-3.00**	0.147**	-4.808**	2.995**	19.381**	0.019	5.883**	13.828**	19.711**	0.07
$P_2 X P_4$		-0.25	-0.34	-2.780**	-1.583*	0.109**	-1.745	3.245**	-3.14*	-0.152	4.154**	6.12*	10.274**	0.606
$P_2 X P_5$		-0.333	-1.095**	-3.946**	-3.083**	-0.031	8.046	-2.221**	2.513	0.071	-2.683**	3.326*	3.642	-4.199**
$P_2 X P_6$		-0.833*	-1.262**	-3.155**	-1.958**	0.055**	0.991	-4.963**	14.707**	-0.203	2.067*	-5.682	-3.615	4.272**
$P_3 X P_4$		-1.167**	-2.554**	1.429*	3.250**	-0.099**	8.63**	-2.838**	-6.015**	-0.064	-3.449**	7.285*	3.836	-6.571**
$P_3 X P_5$		1.75**	1.655**	1.262*	0.750	-0.034	-0.745	1.696*	-7.362**	-0.014	-1.366	-3.93	-5.295	-0.62
$P_3 X P_6$		0.583	0.821*	0.054	-0.792	-0.042*	1.033	1.454	-9.335**	0.258	-2.363**	6.81*	4.447	-5.072**
$P_4 X P_5$		0.083	0.363	1.345*	0.833	0.141**	-3.016*	5.779**	3.784*	-0.005	7.388**	21.213**	28.601**	-1.390
$P_4 X P_6$		-1.25**	-1.47**	3.137**	4.625**	-0.093**	1.429	2.704**	-18.355**	0.367*	-2.756**	13.266**	10.51**	-7.119**
$P_5 X P_6$		0.00	0.071	0.97	0.792	-0.032	1.497	-0.596	5.688**	0.377*	-1.272	2.928	1.655	-2.731
L.S.D. Sij	5%	0.733	0.812	1.193	1.341	0.037	2.997	1.506	3.109	0.331	1.719	6.026	5.797	2.780
	1%	1.033	1.085	1.595	1.792	0.050	4.006	2.013	4.156	0.443	2.298	8.055	7.748	3.716
L.S.D. Sij	5%	1.397	1.467	2.157	2.423	0.068	4.472	2.248	4.640	0.494	3.108	10.892	10.477	5.025
	1%	1.868	1.961	2.883	3.239	0.090	5.978	3.005	6.202	0.661	4.154	14.559	14.004	6.717
L.S.D. Sij	5%	1.294	1.351	1.997	2.243	0.063	4.141	2.081	4.296	0.458	2.877	10.084	9.700	4.652
	1%	1.729	1.815	2.669	2.999	0.084	5.534	2.782	5.742	0.612	3.846	13.479	12.965	6.218

Table 6. Estimate of genetic components and ratios from Hayman's analysis for earliness attributes yield and yield components, under late sowing condition.

Genotypes	days to heading	days to anthesis	days to maturity	grain filling period (day)	grain filling rate (g/ day)	Plant height (cm)	No. of spikes/ plant	No. of kernels / spike	100-kernel weight (g)	grain yield/ plant (g)	straw yield/ plant (g)	Tota plant weight (g)	Harvest index %
D	7.464**	9.816**	17.797**	11.277**	0.004	27.95**	7.414*	29.642**	0.047	4.571	107.742**	100.04	31.813**
F	5.003**	4.126*	15.206**	18.783*	0.005	0.951	13.375	352.57	-0.047	2.164	110.89	57.491	51.186
H_1	4.871**	6.373**	31.221**	31.364**	0.037**	68.296**	44.443**	665.185**	0.227	65.193**	524.293**	686.904**	99.014**
H_2	3.773**	5.078**	27.037**	23.406**	0.032**	66.083**	35.791**	470.716**	0.202*	60.122**	457.76**	645.879**	71.963**
h^2	4.152**	-1.979	14.461**	4.395	0.008	70.09**	11.648*	0.019	0.188	12.31	1144.95**	1402.514**	99.051**
$(H_1/D)^{½}$	0.808	0.806	1.324	1.668	3.041	1.563	2.448	1.781	2.198	3.777	2.206	2.62	1.764
$H_2/4H_1$	0.194	0.199	0.216	0.187	0.216	0.242	0.201	0.177	0.222	0.231	0.218	0.235	0.182
$[(4DH_1)^{½} + F]/[(4DH_1)^{½} - F]$	2.418	1.706	1.952	2.932	1.526	1.022	2.166	2.788	0.628	1.134	1.608	1.246	2.676
h^2/H_2	1.100	0.390	0.535	0.188	0.250	1.061	0.325	0.403^{-5}	0.931	0.205	2.501	2.171	1.376
Heritability n. s	0.595	0.691	0.313	0.053	0.176	0.431	0.122	0.176	0.405	0.186	0.196	0.189	0.152
b . s	0.910	0.942	0.937	0.882	0.941	0.919	0.932	0.980	0.748	0.934	0.901	0.92	0.866
r	0.839	0.737	0.969	0.212	0.719	-0.705	-0.742	0.218	0.084	0.496	-0.933	-0.968	0.895

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دراسات وراثية عن التبكير في طرد السنابل والنضج والمحصول ومكوناته لظروف الزراعة المتأخرة في القمح

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يعتبر فهم التحليل الوراثي لمكونات التبكير (تحمل ظروف الزراعة المتأخرة) ضرورة لاستنباط سلالات قمح مبكرة النضج لكي تزرع متأخرة في أول يناير وتحصد في نفس الميعاد في شهر مايو . ولذلك أجري تقييم الهجن الدائرية لستة تراكيب وراثية من قمح الخبز بمحطة البحوث الزراعية بالجيزة ٢٠٠٣/٢٠٠٤ و٢٠٠٤/٢٠٠٥ لتقدير القدرة العامة والخاصة على الائتلاف في الجيل الأول والتعرف على العوامل الوراثية التي تتحكم في مكونات التبكير في النضج والتي تتحكم أيضاً في صفة المحصول ومكوناته، ويمكن تلخيص النتائج فيما يلي :

كان التباين الراجع إلى القدرة العامة والخاصة على الائتلاف معنوياً في كل الصفات تحت الدراسة ، مما يدل على أن الفعل الجيني المضيف له أهمية في وراثة هذه الصفات المدروسة .

كما أظهرت النتائج أن هناك قوة هجين بالنسبة لأفضل الأبوين في أربعة هجن بالنسبة لعدد الأيام حتى طرد السنابل وعدد الأيام حتى التزهير و هجين واحد بالنسبة لعدد الأيام حتى النضج الفسيولوجي ، وأربعة هجن بالنسبة لصفة فترة امتلاء الحبوب، سبعة هجن بالنسبة لصفة معدل امتلاء الحبوب ، ثلاثة هجن بالنسبة لصفة طول النبات، ثلاثة هجن بالنسبة لكل من عدد السنابل/نبات؛ وزن المائة حبة وعدد الحبوب /سنبلة على التوالي ، وسبعة هجن بالنسبة لصفة المحصول /للنبات ، ثمانية هجن بالنسبة لصفة القش/نبات ، أما بالنسبة لمعامل الحصاد فلا توجد قوة هجين وكذلك بالنسبة لصفة وزن النبات فقد أظهرت النتائج قوة هجينية في تسعة هجن . وكان تأثير الفعل الجيني المضيف (D) معنوياً لكل الصفات المدروسة ما عدا معدل امتلاء الحبوب ، وزن الحبوب ، محصول الحبوب / نبات و كذلك وزن النبات . كان توزيع الجينات الموجبة والسالبة غير منتظم في معظم الصفات ولوحظ وجود سيادة فائقة أوسيادة جزئية في بعض الصفات.

بالنسبة لصفة التوريث بمعناها الواسع فأظهرت قيماً مرتفعة تتراوح ما بين ٠,٧٠ إلى ٠,٩٨ .

وكذلك أظهرت النتائج قيمة التوريث بمعناها الضيق من قيمة منخفضة إلى متوسطة في كل الصفات المدروسة .