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NATURE OF GENE ACTION IN THE INHERITANCE OF EARLINESS, GRAIN YIELD AND GRAIN QUALITY TRAITS IN DIALLEL CROSSES OF BREAD WHEAT UNDER DIFFERENT ENVIRONMENTS

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ABSTRACT

Seven parents of bread wheat namely; Line-3 (P_1), Sakha 93 (P_2), Line-37 (P_3), Giza 168 (P_4), Sids 1 (P_5), Line-47 (P_6) and Gemmeiza 9 (P_7) were crossed in 2002/2003 in a half-diallel pattern. In 2003/2004 season, the 7 parents and their 21 F_1 crosses were evaluated under two sowing dates, i.e., 8th of November (early sowing date) and 8th of December (late sowing date) and two nitrogen fertilization levels, i.e., 40 (low level) and 80 (high level) kg N/fed.

The results revealed that wheat genotypes greatly differed in their responses under different environments for the studied traits. Delaying sowing date and decreasing N-level caused great reduction for grain yield/plant and two quality traits, while days to heading was increased for most genotypes by delaying sowing date, but were not affected by decreasing N-level. Line-3 was the earliest in heading date among all genotypes while the cv. Gemmeiza 9 was the latest. The crosses; P_4 x P_5, P_4 x P_7, P_5 x P_6, P_5 x P_7 and P_6 x P_7 had the highest mean values for grain yield/plant, however, the cross P_1 x P_7 and cv. Giza 168 gave the highest mean grain protein content and fermentation test, respectively under all environments.

The dominance gene effects played the major role in the inheritance of grain yield/plant and two quality traits. Moreover, variance magnitude of gene actions and other genetic parameters were fluctuated under the two sowing dates and N-fertilization levels. The two cvs. Giza 168, Sids 1 and the Line-47 proved to be good combiners for grain yield/plant, while the two parental lines -3 and -37 and the cv. Sakha 93 proved to be good combiners for days to heading and two quality traits. The crosses exhibited desirable significant SCA effects included good x good or good x poor general combiners for grain yield/plant, days to heading and two quality traits. They can be used in improving grain yield / plant and other studied traits. Heritability estimates ranged from 44.75 % for grain yield/plant under low N-level in early sowing date to 92.54% for days to heading under low N-level at late sowing date, revealing that these traits could be improved through adequate selection.

Key words: ***Wheat, Triticum aestivum, Sowing date, N-fertilization, Performance, General and specific combining ability, Types of gene action, Heritability.***

INTRODUCTION

Wheat is one of the most important cereal crops in terms of area and production. Egypt's total wheat production of grains in 2003/2004 season reached about 7.1 million tons (Statistical year's book, 2004) resulted from about 3 million faddan, while the consumption of wheat grains is about 12 million tons. Therefore, increasing production per unit area together with the horizontal increase in cultivated area, especially in new reclaimed land, appears to be a possible solution for reducing the gap between wheat production and consumption. Also improving the cultural practices and treatments of the available varieties or lines to step up their yield to its maximum. Planting promising varieties in a proper date with applying the optimum nitrogen level are among the most important factors affecting the productivity of wheat. EL-Marakby *et al* (2002) and Tammam and Tawfils (2004) reported that maximum grain yield was obtained when wheat plants were sown in the optimum sowing date (first half of November) while, reduction in grain yield have been observed owing to delaying sowing date to December. On the other hand, EL-Marakby *et al* (2002), EL-Nagar (2003), Tammam and Tawfils (2004) and Allam (2005) found that the wheat grain yield was increased with the increasing of N-level application.

For starting a breeding program to improve any crop, the breeder need to know the type of gene action and genetic system controlling the inheritance of the characters of interest and the best breeding strategy to be used to improve them. Therefore, many genetic models were introduced to estimate the different genetic parameters as approaches of Hayman (1954 a and b) and Griffing (1956).

Combining ability analysis of Griffing (1956) is most widely used as a biometrical tool for identifying parental lines in terms of their ability to combine in hybrid combinations. With this method, the resulting total genetic variation is partitioned into the variance effects of general combining ability as a measure of additive gene action and specific combining ability as a measure of non-additive gene action. Ahmed (1999), Salem *et al* (2000), Hamada (2003), Abd EL-Majeed *et al* (2004), EL-Borhamy (2005) and Koumber and Esmail (2005) found that both general and specific combining ability variances were significant for some traits in wheat. On the other hand, Yadav and Singh (1988) indicated the preponderance of additive gene action in the inheritance of days to heading and grain yield/plant. This work aimed to evaluate mean performance of seven bread wheat parents and their F_1 hybrids and estimating genetic parameters under four target environments as a combination between two sowing dates x two N-levels.

MATERIALS AND METHODS

Four local wheat cultivars namely; Sakha 93 (P_2), Giza 168 (P_4), Sids 1 (P_5), and Gemmeiza 9 (P_7) and three advanced lines, i.e., Line-3 (P_1), Line-37 (P_3) and Line-47 (P_6) of bread wheat (*Triticum aestivum*, L.) were chosen to establish the field experimental work of this investigation. The lines were developed and evaluated in F_6 and F_7 in the Agronomy Dep., Fac. of Agric., Ain Shams Univ. by EL-Marakby *et al* (2002), while the four cultivars were obtained from Wheat Dep., Agric. Res. Cent., Giza, Egypt. A half diallel set of crosses was achieved among the seven parents in 2002/2003 growing season at the Experimental Farm of the Faculty of Agriculture, Ain Shams University, at Shoubra El-Kheima, Kalubia Governorate and 21 F_1 seeds were obtained.

The seeds of the 21 hybrids and their respective parents were sown in 2003/2004 season at the Experimental Farm of the Faculty of Agriculture, Ain Shams University, at Shalakan, Kalubia Governorate on two sowing dates, i.e., 8th of November (early sowing date) and 8th of December (late sowing date) under two nitrogen fertilization levels, i.e., 40 (low level) and 80 (high level) kg N/fed. An experiment was devoted for each sowing date and laid out in a split plot design with three replicates. The two N-levels and 28 wheat genotypes were distributed at random within the main and sub-plots, respectively. The experimental plot consisted of 3 rows. Each of row was 2.5 m in length and 20 cm apart. Seeds were spaced at 15 cm within rows and one plant was left per hill. Nitrogen was added in the form of ammonium nitrate (33.5% N). The amount of each rate was splited into two parts; the first part (2/3) was immediately applied before the first irrigation, while the second part (1/3) was applied before the second irrigation.The other cultural practices were followed as recommended for wheat production in the region.

The physical and chemical properties of soil of the experimental site showed that the soil is clay in texture with pH (7.98 and 7.98), EC (2.39 and 2.88 dsm^{-1}) and total N (0.50 and 0.15 %) at the two depths of 0-15 and 15-30 cm of soil surface, respectively.

Days to heading was measured as number of days from sowing till complete emergence of the main stem spike from the sheath of flag leaf of 50% of plants per plot.

At harvest (10th and 19th of May for early and late sowing date, respectively), ten guarded plants were randomly taken from each plot for recording data of grain yield per plant, grain protein content and fermentation test. The crude protein content was calculated by multiplying the total nitrogen content by 5.75 which was determined by using micro Kjeldahal apparatus as described in the A.O.A.C. (1995). However, fermentation test was estimated according to the method outlined by A.A.C.C. (1970).

Statistical analysis for split plot design was made for each N-level under each sowing date as well as combined analysis over treatments on entry mean basis according to Gomez and Gomez (1984). L.S.D. was computed to compare differences among means at 5% level. All factors used in this study were assumed as fixed factors. The variation among parents and F_1 crosses was partitioned into general and specific combining ability as illustrated by Griffing (1956), method (2), model I. The relative importance of GCA to SCA was expressed as explained by Singh and Chaudhary

(1995). Also type of gene action, genetic ratios and heritability were calculated as developed by Hayman's approach (1954 a and b).

RESULTS AND DISCUSSION

Results the analysis of variance presented in Tables (1, 2, 3 and 4) show that the 28 wheat genotypes (7 parents and 21 F_1 crosses) significantly varied in their performance under the various environments and the combined overall environments for the studied traits.

Performance of wheat genotypes under different environments

Days to heading

Number of days from sowing to heading recorded for wheat genotypes as affected by two sowing dates and two N-fertilization levels and their combined analysis are presented in Table (1). Results show that delaying sowing date significantly prolonged time to heading of most wheat genotypes and the early genotypes appeared to be later in heading at late sowing date than the late genotypes. Lateness in heading dates in late sowing might be due to low temperature degrees in Dec. (21.38°C) comparing with 26.08°C in Nov. causing slow in early vegetative growth which resulted in delaying heading dates of most genotypes in late sowing. In this concern, Sivori (1975) and EL-Marakby *et al* (2002) observed delay in flowering of wheat by delaying sowing date, while Abd EL-Shafi *et al* (1999) found that days to heading was slightly affected by planting date from 15 Nov. to 15 Dec.

As shown in Table (1) nitrogen fertilization levels had insignificant effects effects on number of days from sowing to heading at both sowing dates and combined data between them indicating the little effects of this factor on the earliness. Similar results were obtained by EL-Marakby *et al* (2002) who did not find significant effects for increasing N- level from 50 to 100 kg N/fed on heading date in wheat. On the contrary, Ibrahim *et al* (2004) and Tammam and Tawfelis (2004) found that days to heading was delayed by increasing nitrogen rates and delaying was increased as N-rates increased.

Genotypes showed days to heading mean values of 89.29 and 92.04 days over the two N-levels at early and late sowing dates, respectively with an average of 90.66 days over all environments. Generally, crosses were earlier in heading than parents which averaged 90.04 days compared to 92.51 days for parents overall environments. Although, the parents were later in heading than crosses by 2.47 days overall environments, the Line-3 was the earliest in days to heading among all genotypes under all treatments which gave mean values of 67.00, 79.67 and 73.33 days over the two N-levels at early and late sowing date and overall environments, respectively.

Table 1. Performance of days to heading of 28 wheat genotypes (G) as affected by two sowing dates (D) and two N-fertilization levels (N).

Genotypes	*D1			D2			Combined		
	**N1	N2	Mean	N1	N2	Mean	N1	N2	General mean
P_1(Line 3)	67.00	67.00	67.00	78.67	80.67	79.67	72.84	73.84	73.33
P_2(Sakha93)	89.33	88.67	89.00	88.00	92.67	90.33	88.67	90.67	89.67
P_3(Line 37)	91.67	89.67	90.67	89.33	92.67	91.00	90.50	91.17	90.83
P_4(Giza 168)	97.00	95.33	96.17	95.00	97.33	96.17	96.00	96.33	96.17
P_5(Sids 1)	99.33	100.00	99.67	97.33	99.67	98.50	98.33	99.84	99.08
P_6(Line 47)	94.67	94.00	94.33	92.67	94.67	93.67	93.67	94.34	94.00
P_7(Gemmeiza 9)	107.67	108.67	108.17	100.67	101.00	100.83	104.17	104.84	104.50
Parents mean	92.38	91.91	92.14	91.67	94.10	92.88	92.03	93.01	92.51
$P_1 \times P_2$	74.00	73.67	73.83	83.67	84.33	84.00	78.84	79.00	78.92
$P_1 \times P_3$	74.67	74.00	74.33	84.00	85.33	84.67	79.34	79.67	79.50
$P_1 \times P_4$	78.00	74.67	76.33	84.67	86.00	85.33	81.34	80.34	80.83
$P_1 \times P_5$	79.33	79.33	79.33	86.00	87.00	86.50	82.67	83.17	82.92
$P_1 \times P_6$	80.33	77.67	79.00	85.00	86.33	85.67	82.67	82.00	82.33
$P_1 \times P_7$	82.00	80.33	81.17	88.00	88.00	88.00	85.00	84.17	84.58
$P_2 \times P_3$	83.00	83.33	83.17	88.00	87.67	87.83	85.50	85.50	85.50
$P_2 \times P_4$	91.33	87.33	89.33	93.67	93.67	93.67	92.50	90.50	91.50
$P_2 \times P_5$	89.00	87.33	88.17	91.33	92.33	91.83	90.17	89.83	90.00
$P_2 \times P_6$	92.00	90.00	91.00	89.67	91.33	90.50	90.84	90.67	90.75
$P_2 \times P_7$	93.33	91.67	92.50	92.33	95.00	93.67	92.83	93.34	93.08
$P_3 \times P_4$	88.00	87.00	87.50	90.67	92.67	91.67	89.34	89.84	89.58
$P_3 \times P_5$	88.33	87.67	88.00	91.00	92.67	91.83	89.67	90.17	89.92
$P_3 \times P_6$	92.33	91.00	91.67	92.00	96.00	94.00	92.17	93.50	92.83
$P_3 \times P_7$	95.33	94.00	94.67	95.00	97.67	96.33	95.17	95.84	95.50
$P_4 \times P_5$	96.33	95.00	95.67	93.33	97.00	95.17	94.83	96.00	95.42
$P_4 \times P_6$	91.00	91.33	91.17	92.67	94.67	93.67	91.84	93.00	92.42
$P_4 \times P_7$	101.67	102.00	101.83	96.00	97.67	96.83	98.84	99.84	99.33
$P_5 \times P_6$	103.00	100.67	101.83	98.00	100.67	99.33	100.50	100.67	100.58
$P_5 \times P_7$	102.33	99.00	100.67	98.33	100.67	99.50	100.33	99.84	100.08
$P_6 \times P_7$	94.00	93.67	93.83	95.67	98.00	96.83	94.84	95.84	95.33
Crosses mean	89.01	87.65	88.33	90.91	92.60	91.75	89.96	90.13	90.04
General mean	89.86	88.71	89.29	91.10	92.98	92.04	90.48	90.85	90.66
L.S.D 5%									
D									0.15
N			ns			ns			ns
DN									ns
G	3.04	2.63	1.99	1.64	1.82	1.21	-	-	1.16
DG									1.64
NG			ns			1.17			ns
DNG									ns

*D1 and D2 = 8 Nov. and 8 Dec., respectively.
** N1and N2 = 40 and 80 kg N/ fed., respectively.

However, the cultivar Gemmeiza 9 was the latest in days to heading which gave mean values of 108.17 and 100.83 days over the two N-levels at early and late sowing dates, respectively with an average of 104.50 days overall environments. Also, the two crosses; P_5 x P_6 and P_5 x P_7 were later in days to heading under high N-level at late sowing date which gave equal mean values of 100.67 days for this trait.

Grain yield/plant

Results in Table (2) show that genotypes significantly differed in their responses under each environment and combined analysis for this trait. However, grain yield/plant was significantly reduced by delaying sowing date and by decreasing N-level fertilizer and reduction caused by delaying sowing date was much greater (30.03%) than that caused by N fertilization (19.55%) illustrating the importance of climatic factors associated with sowing dates as temperature, rainfall, humidity...etc. on grain yield/plant than those associated with soil fertility. The increase obtained in grain yield/plant at early sowing date might be due to the suitable environmental factors in the most periods of growth compared with late sowing date and consequently plants became more efficient in utilizing growth factors, i.e., nutrients, water and light which resulted in better growth with high yielding potential. EL-Marakby *et al* (2002) and Tammam and Tawfelis (2004) also obtained variant reduction in grain yield/plant when sowing date was delayed to the first-half of Dec. in wheat. However, Said *et al* (1999), EL-Nagar (2003) and Allam (2005) reported that grain yield was significantly increased with increasing N fertilization rates. Further, Sabry *et al* (1999) suggested that the increase in grain yield with increasing N-level might be due to the fact that nitrogen is an essential element which plays prominent role in building new meristemic cells, cell elongation and increasing photosynthesis activity which in turn enhances grain yield.

Mean of grain yield/plant for all genotypes were 17.83 g under low N-level and 22.33g under high N-level with an average of 20.08 g/plant at early sowing date compared with 12.60, 15.50 and 14.05 g/plant with the same respective environments at late sowing date. The cross P_4 x P_5 which included the two high yielding cultivars; Giza 168 and Sids 1 had the highest means in grain yield/ plant under different environments and their combined analysis and exhibited the least reduction percentages under stress conditions (data of reduction percentages are not shown) showing its low sensitivity to less favorable conditions than other genotypes. This cross averaged 24.33, 19.48 and 21.90 g/plant over the two N-levels at early and late sowing date and overall treatments, respectively and significantly exceeded by 3.93 and 1.99 g than their respective parents; Giza 168 and Sids 1 across all environments, respectively. Meantime, the two crosses; P_5 x P_6 and P_5 x P_7 gave higher mean values than the cross P_4 x P_5 under high

Table 2. Performance of grain yield, g./plant of 28 wheat genotypes (G) as affected by two sowing dates (D) and two N-fertilization levels (N).

	*D1			D2			Combined		
Genotypes	**N1	N2	Mean	N1	N2	Mean	N1	N2	General mean
P_1(Line 3)	14.63	16.97	15.80	8.74	11.61	10.18	11.69	14.29	12.99
P_2(Sakha93)	17.17	19.13	18.15	8.50	12.41	10.46	12.84	15.77	14.31
P_3(Line 37)	19.55	23.79	21.67	13.14	17.07	15.10	16.35	20.43	18.39
P_4(Giza 168)	18.43	21.62	20.02	14.36	17.46	15.91	16.40	19.54	17.97
P_5(Sids 1)	19.14	25.78	22.46	16.12	18.60	17.36	17.63	22.19	19.91
P_6(Line 47)	19.96	25.74	22.85	14.92	18.61	16.76	17.44	22.18	19.81
P_7(Gemmeiza 9)	17.74	22.08	19.91	13.10	15.60	14.35	15.42	18.84	17.13
Parents mean	18.09	22.16	20.12	12.70	15.91	14.30	15.40	19.04	17.22
P_1 x P_2	15.28	20.25	17.76	7.63	9.82	8.72	11.46	15.04	13.24
P_1 x P_3	17.28	20.44	18.86	9.43	12.08	10.75	13.36	16.26	14.81
P_1 x P_4	16.23	21.99	19.11	11.32	14.40	12.86	13.78	18.20	15.98
P_1 x P_5	17.28	21.74	19.51	13.54	15.49	14.52	15.41	18.62	17.01
P_1 x P_6	17.70	20.18	18.94	11.00	13.86	12.43	14.35	17.02	15.68
P_1 x P_7	11.68	17.60	14.64	9.13	11.00	10.07	10.41	14.30	12.35
P_2 x P_3	16.56	21.34	18.95	8.75	12.36	10.55	12.66	16.85	14.75
P_2 x P_4	18.48	21.67	20.07	12.18	15.28	13.73	15.33	18.48	16.90
P_2 x P_5	13.84	19.56	16.70	9.28	12.51	10.89	11.56	16.04	13.80
P_2x P_6	18.44	21.57	20.01	13.47	15.79	14.63	15.96	18.68	17.32
P_2 x P_7	17.66	21.50	19.58	11.55	14.71	13.13	14.61	18.11	16.36
P_3 x P_4	17.15	22.17	19.66	11.78	15.31	13.55	14.47	18.74	16.60
P_3 x P_5	18.83	22.36	20.59	14.57	18.25	16.41	16.70	20.31	18.50
P_3 x P_6	18.93	22.24	20.58	14.49	17.66	16.07	16.71	19.95	18.33
P_3 x P_7	13.77	19.40	16.58	11.06	14.60	12.83	12.42	17.00	14.71
P_4 x P_5	22.73	25.93	24.33	18.36	20.60	19.48	20.55	23.27	21.90
P_4 x P_6	18.90	23.64	21.27	14.29	17.49	15.89	16.60	20.57	18.58
P_4 x P_7	20.10	25.54	22.82	13.33	17.30	15.31	16.72	21.42	19.07
P_5 x P_6	19.95	27.73	23.84	15.59	17.10	16.34	17.77	22.42	20.09
P_5 x P_7	19.73	28.15	23.94	16.64	18.48	17.56	18.19	23.32	20.75
P_6 x P_7	22.04	25.23	23.64	16.59	18.66	17.63	19.32	21.95	20.63
Crosses mean	17.74	22.39	20.07	12.57	15.37	13.97	15.16	18.88	17.02
General mean	17.83	22.33	20.08	12.60	15.50	14.05	15.22	18.92	17.07
L.S.D 5%									
D									0.80
N			1.17			1.39			0.59
DN									0.83
G	2.22	2.31	1.58	1.95	1.79	1.31	-	-	1.02
DG									1.44
NG			2.24			ns			ns
DNG									2.04

*D1 and D2 = 8 Nov. and 8 Dec., respectively.
** N1and N2 = 40 and 80 kg N/ fed., respectively.

N-level at early sowing date but the differences were not significant between them. Also, the cross P_6 x P_7 and the two crosses; P_5 x P_7 and P_6 x P_7 were superior in grain yield under low N-level at early and late sowing dates, respectively.

Quality traits

The results in Tables (3 and 4) illustrate that the two quality traits, i.e., grain protein content and fermentation test are greatly reduced by delaying sowing date and decreasing N-level application. Delaying in sowing date caused greater reduction for the two traits and the fermentation test was adversely affected than grain protein content, where reduction amounted 15.27% and 13.93% for grain protein content and 18.67% and 17.54% for fermentation test relative to early sowing date and high N-level, respectively. In this respect Parihar and Tripathi (1989) and Said *et al* (1999) reported that early sowing date showed tendency to increasing grain protein content in wheat. Also EL-Marakby *et al* (2002), EL-Nagar (2003) and Allam (2005) found that increasing N-levels significantly increased grain protein content and fermentation test.

The means of grain protein content of genotypes were 9.80% under low N-level and 11.16% under high N-level with an average of 10.48% at early sowing date compared with 8.11, 9.65 and 8.88% with the same respective order at late sowing date (Table 3). The cross P_1 x P_7 had the highest grain protein content values under all treatments and combined data as well as the cross P_1 x P_3 under all environments except under low N-level and combined data at late sowing date; the parental Line-37 and the cross P_1 x P_5 under the two N-levels and their combined data at late sowing date; the two crosses; P_1 x P_2 and P_2 x P_3 under low N-level at late sowing date and the cross P_4 x P_7 under high N-level at late sowing date. These genotypes recorded mean values ranging from 9.48% for the cross P_1 x P_5 under low N-level at late sowing date to 13.28% for the cross P_1 x P_7 under high N-level at early sowing date.

As shown in Table (4), fermentation test means of genotypes were 82.52 minutes under low N-level and 95.39 minutes under high N-level with an average of 88.98 minutes at early sowing date compared with 63.27, 81.46 and 72.37 minutes with the same respective order at late sowing date. The cv. Giza 168 exhibited the highest mean values under different treatments and combined data as well as the cross P_1 x P_4 under low N-level at early sowing date and the parental Line-37 under high N-level at early sowing date. These genotypes recorded mean values ranging from 96.00 minutes for the cv. Giza 168 under low N-level at late sowing to 114.53 minutes for the same cultivar under high N-level at early sowing date.

Table 3. Performance of grain protein content (%) of 28 wheat genotypes (G) as affected by two sowing dates (D) and two N-fertilization levels (N).

Genotypes	*D1			D2			Combined		
	**N1	N2	Mean	N1	N2	Mean	N1	N2	General mean
P_1(Line 3)	9.44	10.99	10.22	9.16	10.17	9.66	9.30	10.58	9.94
P_2(Sakha93)	10.95	12.55	11.68	7.49	9.50	8.49	9.22	11.03	10.12
P_3(Line 37)	10.79	12.66	11.72	9.61	10.72	10.16	10.20	11.69	10.94
P_4(Giza 168)	9.71	11.52	10.61	9.05	10.05	9.55	9.38	10.79	10.08
P_5(Sids 1)	8.27	9.05	8.66	7.06	8.67	7.86	7.67	8.86	8.26
P_6(Line 47)	8.29	9.03	8.66	7.62	8.67	8.14	7.96	8.85	8.40
P_7(Gemmeiza 9)	8.82	9.87	9.35	8.49	9.61	9.05	8.66	9.74	9.20
Parents mean	9.47	10.81	10.13	8.35	9.63	8.99	8.91	10.22	9.56
$P_1 \times P_2$	10.69	11.83	11.26	9.61	10.17	9.89	10.15	11.00	10.57
$P_1 \times P_3$	12.04	13.08	12.56	9.27	10.73	10.00	10.66	11.91	11.28
$P_1 \times P_4$	10.64	11.27	10.95	8.49	10.28	9.38	9.57	10.78	10.17
$P_1 \times P_5$	9.79	11.62	10.70	9.48	10.95	10.21	9.64	11.29	10.46
$P_1 \times P_6$	10.59	11.36	10.97	8.49	10.17	9.33	9.54	10.77	10.15
$P_1 \times P_7$	12.24	13.28	12.76	9.95	11.17	10.56	11.10	12.23	11.66
$P_2 \times P_3$	10.69	12.19	11.44	9.50	10.39	9.94	10.10	11.29	10.69
$P_2 \times P_4$	8.72	10.17	9.44	7.71	9.05	8.38	8.22	9.61	8.91
$P_2 \times P_5$	8.41	10.59	9.50	7.15	7.93	7.54	7.78	9.26	8.52
$P_2 \times P_6$	8.52	10.48	9.50	8.38	9.39	8.88	8.45	9.94	9.19
$P_2 \times P_7$	7.89	9.82	8.85	7.04	9.15	8.09	7.47	9.49	8.47
$P_3 \times P_4$	9.13	10.69	9.91	7.71	9.00	8.35	8.42	9.85	9.13
$P_3 \times P_5$	10.54	12.04	11.29	6.48	9.05	7.76	8.51	10.55	9.53
$P_3 \times P_6$	10.58	11.31	10.94	7.94	10.17	9.05	9.26	10.74	10.00
$P_3 \times P_7$	11.11	12.56	11.83	7.15	10.05	8.60	9.13	11.31	10.22
$P_4 \times P_5$	9.13	10.74	9.94	6.82	9.05	7.93	7.98	9.90	8.93
$P_4 \times P_6$	9.03	11.11	10.07	8.49	9.50	8.99	8.76	10.31	9.53
$P_4 \times P_7$	10.69	11.52	11.10	7.99	11.17	9.58	9.34	11.35	10.34
$P_5 \times P_6$	9.55	10.28	9.91	7.04	7.82	7.43	8.30	9.05	8.67
$P_5 \times P_7$	8.98	10.48	9.73	6.93	7.94	7.43	7.96	9.21	8.58
$P_6 \times P_7$	9.24	10.48	9.86	6.93	9.72	8.32	8.09	10.10	9.09
Crosses mean	9.91	11.28	10.60	8.03	9.66	8.84	8.97	10.47	9.72
General mean	9.80	11.16	10.48	8.11	9.65	8.88	8.96	10.41	9.68
L.S.D 5%									
D									0.24
N			0.01			0.25			0.08
DN									0.11
G	0.67	0.55	0.43	0.59	0.57	0.41	-	-	0.30
DG									0.42
NG			0.61			0.58			0.42
DNG									0.59

*D1 and D2 = 8 Nov. and 8 Dec., respectively.
** N1and N2 = 40 and 80 kg N/ fed., respectively.

Table 4. Performance of fermentation test (minutes) of 28 wheat genotypes (G) as affected by two sowing dates (D) and two N-fertilization levels (N).

Genotypes	*D1			D2			Combined		
	**N1	N2	Mean	N1	N2	Mean	N1	N2	General mean
P_1(Line 3)	76.00	99.00	87.50	57.00	87.50	72.25	66.50	93.25	79.88
P_2(Sakha93)	74.00	92.00	83.00	46.00	70.50	58.25	60.00	81.25	70.63
P_3(Line 37)	99.50	114.50	107.00	83.50	98.00	90.75	91.50	106.25	98.88
P_4(Giza 168)	107.00	114.53	110.77	96.00	109.50	102.75	101.50	112.02	106.76
P_5(Sids 1)	66.50	104.00	85.25	51.00	78.50	64.75	58.75	91.25	75.00
P_6(Line 47)	69.50	86.50	78.00	58.50	76.00	67.25	64.00	81.25	72.63
P_7(Gemmeiza 9)	77.50	110.50	94.00	69.00	92.50	80.75	73.25	101.50	87.38
Parents mean	70.36	87.22	78.79	56.00	74.29	65.14	63.18	80.75	71.97
P_1 x P_2	73.50	74.50	74.00	46.50	54.50	50.50	60.00	64.50	62.25
P_1 x P_3	99.00	101.00	100.00	75.00	92.50	83.75	87.00	96.75	91.88
P_1 x P_4	105.50	110.00	107.75	79.00	89.00	84.00	92.25	99.50	95.88
P_1 x P_5	71.00	73.50	72.25	60.00	71.50	65.75	65.50	72.50	69.00
P_1 x P_6	93.00	95.50	94.25	72.50	86.00	79.25	82.75	90.75	86.75
P_1 x P_7	86.00	97.00	91.50	75.50	85.50	80.50	80.75	91.25	86.00
P_2 x P_3	101.50	105.50	103.50	54.00	99.50	76.75	77.75	102.50	90.13
P_2 x P_4	86.00	99.50	92.75	84.00	88.00	86.00	85.00	93.75	89.38
P_2 x P_5	64.50	75.50	70.00	44.50	64.00	54.25	54.50	69.75	62.13
P_2x P_6	57.00	65.50	61.25	43.50	64.00	53.75	50.25	64.75	57.50
P_2 x P_7	71.00	84.50	77.75	62.00	73.50	67.75	66.50	79.00	72.75
P_3 x P_4	82.50	101.00	91.75	58.50	92.50	75.50	70.50	96.75	83.63
P_3 x P_5	85.50	89.50	87.50	69.00	73.00	71.00	77.25	81.25	79.25
P_3 x P_6	84.50	91.50	88.00	42.50	69.00	55.75	63.50	80.25	71.88
P_3 x P_7	94.00	108.50	101.25	66.50	92.50	79.50	80.25	100.50	90.38
P_4 x P_5	84.00	100.50	92.25	72.50	89.00	80.75	78.25	94.75	86.50
P_4 x P_6	92.00	99.50	95.75	65.50	76.50	71.00	78.75	88.00	83.38
P_4 x P_7	88.50	101.00	94.75	73.50	93.50	83.50	81.00	97.25	89.13
P_5 x P_6	74.00	86.00	80.00	42.50	64.00	53.25	58.25	75.00	66.63
P_5 x P_7	74.50	91.00	82.75	59.50	62.00	60.75	67.00	76.50	71.75
P_6 x P_7	74.50	99.50	87.00	64.00	88.50	76.25	69.25	94.00	81.63
Crosses mean	82.95	92.86	87.90	62.40	79.45	70.93	72.68	86.15	79.42
General mean	82.57	95.39	88.98	63.27	81.46	72.37	72.92	88.43	80.67
L.S.D 5%									
D									0.66
N			0.09			0.94			0.31
DN									0.43
G	1.87	2.37	1.49	2.63	2.24	1.71	-	-	1.13
DG									1.59
NG			2.11			2.42			1.59
DNG									2.26

*D1 and D2 = 8 Nov. and 8 Dec., respectively.
** N1and N2 = 40 and 80 kg N/ fed., respectively.

Estimates of general (GCA) and specific (SCA) combining abilities

Analysis of GCA and SCA combining ability variances for different traits

Partitioning of the genetic variance to GCA and SCA variances for each trait is given in Table (5). General and specific combining ability mean squares were found to be highly significant for all traits studied at each environment and combined analysis indicating the importance of both additive and non-additive gene effects in the expression of the traits.

The ratios of GCA/SCA variances were greater than unity under all environments and combined data for days to heading indicating that the inheritance of this trait was mainly controlled by additive gene effects while, ratios were less than unity under all environments and combined data for grain protein content and fermentation test, illustrating that these two traits were mainly controlled by the non-additive gene effects. Moreover, the ratios of GCA/SCA for grain yield/plant were inconsistent under different environments and combined analysis. In this connection Yadav and Singh (1988) and Ahmed (1999), Hamada (2003) and Koumber and Esmail (2005) indicated the preponderance of additive gene action in the inheritance of days to heading and grain yield/plant while, EL-Shami *et al* (1996) revealed that non-additive effects (dominance and epistasis) were more important in the inheritance of the same two traits.

The interaction of GCA and SCA with the environments were also highly significant for the traits studied except the interaction of GCA for days to heading at early sowing date that was insignificant, revealing that the variance magnitude of different types of gene action were fluctuated from one environment to another. Therefore sowing dates and N-levels are considered as effective factors in declared GCA and SCA variances. Thus, the breeder should utilize the appropriate breeding method under each environment for developing desired wheat genotypes. Yadav and Singh (1988), Ahmed (1999) and Hamada (2003) also indicated that the interaction of both GCA and SCA with sowing dates were significant for days to heading and grain yield/plant, while Hendawy (1994) and Koumber and Esmail (2005) reported that the interactions of N-levels with both types of combining abilities were highly significant for the two traits.

General and specific combining ability effects

Days to heading

Estimates of GCA effects for days to heading are presented in Table (6). Since negative values of GCA would be of interest for earliness, the Line-3 followed by the cv. Sakha 93 and the Line-37 showed highly significant negative GCA values at each environment and combined analysis. These parents may be considered as good general combiners and can be used in breeding for improving earliness in headingt. On the other hand, the cv. Gemmeiza 9 followed by the cv. Sids 1, Line-47 and the cv.

Table 5. Mean squares of general (GCA) and specific (SCA) combining ability analysis for the traits studied in bread wheat genotypes as affected by two sowing dates and two N-fertilization levels and their combined analysis.

Source	D.f	D1+		D2		D.f	Combined	
		N1++	N2	N1	N2		D1	D2
Days to heading								
Genotypes (G)	27	281.09**	285.19**	80.37**	91.23**	27	563.87**	169.45**
G.C.A.	6	1153.98**	1170.07**	341.49**	375.08**	6	2323.38**	714.97**
S.C.A.	21	31.70**	32.36**	5.76**	10.13**	21	61.16**	13.58**
Environment (E)						1	54.75**	148.67**
G x E						27	2.40**	2.15**
G.C.A.x E						6	0.68	1.61**
S.C.A.x E						21	2.90**	2.31**
Error	54	1.151	0.859	0.333	0.414	108	0.503	0.186
G.C.A./S.C.A.		4.19	4.12	6.98	4.28		4.25	5.93
Grain yield/plant								
Genotypes (G)	27	17.93**	23.99**	24.56**	22.85**	27	38.10**	46.66**
G.C.A.	6	38.45**	71.32**	88.61**	83.23**	6	104.04**	170.20**
S.C.A.	21	12.07**	10.47**	6.26**	5.59**	21	19.26**	11.36**
Environment (E)						1	852.66**	353.65**
G x E						27	3.82**	0.75**
G.C.A.x E						6	5.72**	1.63**
S.C.A.x E						21	3.27**	0.50**
Error	54	0.612	0.664	0.473	0.396	108	0.319	0.217
G.C.A./S.C.A.		0.37	0.80	1.69	1.77		0.61	1.69
Grain protein content								
Genotypes (G)	27	4.05**	3.72**	3.22**	2.66**	27	7.45**	5.14**
G.C.A.	6	8.26**	8.90**	7.71**	6.88**	6	16.79**	14.06**
S.C.A.	21	2.85**	2.24**	1.94**	1.45**	21	4.78**	2.59**
Environment (E)						1	77.76**	100.02**
G x E						27	0.33**	0.75**
G.C.A.x E						6	0.37**	0.54**
S.C.A.x E						21	0.31**	0.81**
Error	54	0.056	0.038	0.044	0.041	108	0.024	0.021
G.C.A./S.C.A.		0.39	0.45	0.45	0.55		0.39	0.61
Fermentation test								
Genotypes (G)	27	504.92**	475.48**	592.75**	543.33**	27	858.67**	992.59**
G.C.A.	6	1531.26**	1193.34**	1616.83**	1459.86**	6	2544.55**	3006.12**
S.C.A.	21	211.69**	70.38**	300.16**	281.46**	21	376.99**	417.30**
Environment (E)						1	6905.49**	13906.62**
G x E						27	121.74**	143.48**
G.C.A.x E						6	180.05**	70.56**
S.C.A.x E						21	105.08**	164.32**
Error	54	0.434	0.697	0.863	0.626	108	0.282	0.372
G.C.A./S.C.A.		0.81	0.49	0.59	0.58		0.75	0.80

+ D1 and D2 = 8 Nov. and 8 Dec., respectively.
++N1and N2 = 40 and 80 kg N/ fed., respectively.
**** = significant differences at 0.01 level of probability**

Table 6. Estimates of general combining ability effects for days to heading of the seven bread wheat parents as affected by two sowing dates and two N-fertilization levels and their combined analysis.

	D1+			D2		
Parents	N1++	N2	Combined	N1	N2	Combined
P_1(Line 3)	-12.95**	-12.89**	-12.92**	-6.68**	-7.28**	-6.98**
P_2(Sakha93)	-1.95**	-2.12**	-2.03**	-1.57**	-1.57**	-1.57**
P_3(Line 37)	-1.54**	-1.49**	-1.51**	-1.05**	-0.72**	-0.88**
P_4(Giza 168)	2.39**	2.03**	2.21**	1.36**	1.39**	1.38**
P_5(Sids 1)	4.24**	4.37**	4.30**	2.65**	2.87**	2.76**
P_6(Line 47)	2.57**	2.51**	2.54**	1.07**	1.39**	1.23**
P_7(Gemmeiza 9)	7.24**	7.59**	7.41**	4.21**	3.91**	4.06**
S.E(gi)	0.33	0.29	0.22	0.18	0.20	0.13
LSD (gi-gj) 0.05	1.02	0.88	0.66	0.55	0.61	0.40
0.01	1.36	1.17	0.88	0.73	0.81	0.54

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
** = significant differences at 0.01 level of probability.

Giza 168 proved to be poor general combiners for earliness in heading as they attained positive significant GCA effects at all environments and combined data.

The SCA effects of different crosses for days to heading are given in Table (7). The cross P_3 x P_5 exhibited significant negative SCA effects under each environment and combined data followed by the three crosses; P_1 x P_7, P_2 x P_3 and P_2 x P_5 under all environments except under low N-level in late sowing date. These crosses are considered to be promising for varietal improvement for earliness as they showed highly SCA effects and involved at least one parent as good general combiner for this trait. Also, the two crosses; P_3 x P_4 and P_4 x P_6 under the two N-levels and combined data in early sowing date and combined data in late sowing date, the two crosses; P_1 x P_4 and P_2 x P_7 under high N-level and combined data in early sowing date and low N-level and combined data in late sowing date, the cross P_1 x P_5 under the two N-levels and combined data in late sowing date and combined data in early sowing date, the cross P_6 x P_7 under the two N-levels and combined data in early sowing date, the cross P_4 x P_5 under low N-level and combined data in late sowing date and the cross P_2 x P_6 under high N-level and combined data in late sowing date exhibited significant negative SCA effects under their respective environments. The cross P_2 x P_3 included two good general combiner parents, while eight of the above crosses included only one good general combiner parent only for earliness in heading.

Table 7. Estimates of specific combining ability effects for days to heading of 21 crosses of bread wheat as affected by two sowing dates and two N-fertilization levels and their combined analysis.

	D1+			D2		
Crosses	N1++	N2	Combined	N1	N2	Combined
$P_1 \times P_2$	-0.96	-0.03	-0.50	0.82	0.20	0.51
$P_1 \times P_3$	-0.70	-0.33	-0.52	0.63	0.35	0.49
$P_1 \times P_4$	-1.30	-3.18**	-2.24**	-1.11*	-1.09	-1.11**
$P_1 \times P_5$	-1.82	-0.86	-1.34*	-1.07*	-1.57**	-1.32**
$P_1 \times P_6$	0.85	-0.66	0.09	-0.48	-0.76	-0.62
$P_1 \times P_7$	-2.15*	-3.08**	-2.61**	-0.63	-1.61**	-1.12**
$P_2 \times P_3$	-3.37**	-1.78*	-2.57**	-0.48	-3.02**	-1.75**
$P_2 \times P_4$	1.04	-1.30	-0.13	2.78**	0.87	1.83**
$P_2 \times P_5$	-3.15**	-3.63**	-3.39**	-0.85	-1.95**	-1.40**
$P_2 \times P_6$	1.52	0.89	1.20	-0.92	-1.47*	-1.19**
$P_2 \times P_7$	-1.82	-2.52**	-2.17**	-1.41**	-0.32	-0.86*
$P_3 \times P_4$	-2.70**	-2.26**	-2.48**	-0.74	-0.98	-0.86*
$P_3 \times P_5$	-4.22**	-3.92**	-4.08**	-1.70**	-2.46**	-2.09**
$P_3 \times P_6$	1.44	1.26	1.35*	0.89	2.35**	1.62**
$P_3 \times P_7$	-0.23	-0.82	-0.52	0.74	1.50*	1.12**
$P_4 \times P_5$	-0.15	-0.11	-0.13	-1.78**	-0.24	-1.01*
$P_4 \times P_6$	-3.82**	-1.93*	-2.87**	-0.85	-1.09	-0.97*
$P_4 \times P_7$	2.19*	3.67**	2.92**	-0.67	-0.61	-0.64
$P_5 \times P_6$	6.34**	5.08**	5.70**	3.19**	3.43**	3.30**
$P_5 \times P_7$	1.00	-1.67	-0.33	0.37	0.91	0.64
$P_6 \times P_7$	-5.67**	-5.15**	-5.41**	-0.70	-0.28	-0.49
S.E(sij)	0.96	0.83	0.64	0.52	0.58	0.39
LSD (sij-sik) 0.05	2.87	2.48	1.87	1.55	1.72	1.14
0.01	3.83	3.31	2.49	2.06	2.30	1.51
LSD (sij-skl) 0.05	2.69	2.32	1.75	1.45	1.61	1.07
0.01	3.59	3.10	2.32	1.93	2.15	1.42

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
*and** = denote significant differences at 0.05 and 0.01 levels, respectively.
P_1 (Line 3), P_2 (Sakha 93), P_3 (Line 37), P_4 (Giza 168), P_5 (Sids 1), P_6 (Line 46) and P_7 (Gemmeiza 9).

Grain yield/plant

Estimates of GCA effects for grain yield/plant under different environments and combined analysis are presented in Table (8). Results indicate that the three parents; Giza 168, Sids 1 and Line-47 showed highly significant positive GCA values under all environments and combined data as well as the cv. Gemmeiza 9 in combined data in late sowing date. Therefore these parents appeared to be the best combiners for grain yield/plant and can be utilized as promising progenitors for high yielding ability. On the other hand, the two parents; Line-3 and Sakha 93 manifested highly significant negative GCA effects under all environments and

Table 8. Estimates of general combining ability effects for grain yield/plant of the seven bread wheat parents as affected by two sowing dates and two N-fertilization levels and their combined analysis.

Parents		D1+			D2	
	N1++	N2	Combined	N1	N2	Combined
P_1(Line 3)	-1.99**	-2.5**	-2.25**	-2.37**	-2.69**	-2.52**
P_2(Sakha93)	-0.89**	-1.61**	-1.25**	-2.33**	-2.08**	-2.21**
P_3(Line 37)	-0.11	-0.35	-0.23	-0.5*	0.04	-0.23
P_4(Giza 168)	0.87**	0.61*	0.74**	1.02**	1.25**	1.14**
P_5(Sids 1)	0.89**	2.04**	1.47**	2.16**	1.73**	1.94**
P_6(Line 47)	1.47**	1.49**	1.48**	1.61**	1.53**	1.57**
P_7(Gemmeiza 9)	-0.24	0.32	0.04	0.41	0.21	0.31*
S.E(gi)	0.24	0.25	0.18	0.21	0.19	0.14
LSD (gi-gj) 0.05	0.74	1.69	0.53	0.65	0.60	0.43
0.01	0.99	2.25	0.70	0.87	0.80	0.58

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
*and** = denote significant differences at 0.05 and 0.01 levels, respectively.

combined data as well as Line-37 under low N-level in late sowing date. Thus, these parents seemed to be poor combiners for this trait.

The SCA effects calculated for each cross are presented in Table (9). The two crosses; P_4 x P_5 and P_6 x P_7 exhibited significant positive SCA effects under all environments except under high N-level in early sowing date, followed by the cross P_5 x P_7 under all environments, except under low and high N-level in early and late sowing date, respectively. Also, the cross P_4 x P_7 under the two N-levels and combined data in early sowing date and the seven crosses; P_1 x P_2, P_1 x P_3, P_1 x P_4, P_1 x P_5, P_2 x P_6, P_2 x P_7 and P_5 x P_6 under one or two environments manifested significant positive SCA effects, revealing that the eleven crosses seemed to be good F_1-cross combinations for increasing grain yield/plant under their respective environments. Out of these crosses, the two crosses; P_4 x P_5 and P_5 x P_6 included high x high general combiner parents whereas seven crosses; P_1 x P_4, P_1 x P_5, P_2 x P_6, P_2 x P_7, P_4 x P_7, P_5 x P_7 and P_6×P_7 included low x high general combiner parents for this trait. In such crosses especially the two crosses P_4 x P_5 and P_5 x P_7, desirable transgressive segregants could be expected in the segregating generations and high yielding genotypes may be raised.

Table 9. Estimates of specific combining ability effects for grain yield/plant of 21 crosses of bread wheat as affected by two sowing dates and two N-fertilization levels and their combined analysis.

Crosses		D1+			D2	
	N1++	N2	Combined	N1	N2	Combined
P_1 x P_2	0.33	2.03**	1.18*	-0.28	-0.92	-0.60
P_1 x P_3	1.55*	0.96	1.26*	-0.31	-0.78	-0.55
P_1 x P_4	-0.48	1.55*	0.54	0.07	0.33	0.20
P_1 x P_5	0.55	-0.13	0.21	1.15	0.94	1.05*
P_1 x P_6	0.39	-1.14	-0.38	-0.84	-0.49	-0.66
P_1 x P_7	-3.92**	-2.55**	-3.24**	-1.52*	-2.03**	-1.77**
P_2 x P_3	-0.27	0.97	0.35	-1.03	-1.10	-1.07*
P_2 x P_4	0.67	0.34	0.50	0.89	0.61	0.75
P_2 x P_5	-3.99**	-3.2**	-3.59**	-3.15**	-2.65**	-2.9**
P_2x P_6	0.03	-0.64	-0.30	1.59*	0.84	1.22**
P_2 x P_7	0.96	0.46	0.71	0.87	1.08	0.97*
P_3 x P_4	-1.44*	-0.43	-0.93	-1.35*	-1.49*	-1.41**
P_3 x P_5	0.22	-1.67*	-0.72	0.31	0.97	0.64
P_3 x P_6	-0.26	-1.23	-0.75	0.78	0.59	0.68
P_3 x P_7	-3.71**	-2.91**	-3.31**	-1.46*	-1.16*	-1.31**
P_4 x P_5	3.14**	0.94	2.04**	2.58**	2.11**	2.35**
P_4 x P_6	-1.27	-0.80	-1.03*	-0.94	-0.79	-0.86*
P_4 x P_7	1.64*	2.27**	1.96**	-0.70	0.33	-0.19
P_5 x P_6	-0.24	1.87*	0.81	-0.77	-1.67**	-1.22**
P_5 x P_7	1.25	3.45**	2.35**	1.47*	1.03	1.25**
P_6 x P_7	2.98**	1.08	2.04**	1.97**	1.42*	1.7**
S.E(sij)	0.70	0.73	0.51	0.62	0.57	0.42
LSD (sij-sik) 0.05	2.10	2.18	1.49	1.84	1.69	1.23
0.01	2.80	2.91	1.98	2.46	2.25	1.64
LSD (sij-skl) 0.05	1.96	2.04	1.39	1.72	1.58	1.15
0.01	2.61	2.72	1.85	2.30	2.10	1.53

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
*and** = denote significant differences at 0.05 and 0.01 levels, respectively.
P_1 (Line 3), P_2 (Sakha 93), P_3 (Line 37), P_4 (Giza 168), P_5 (Sids 1), P_6 (Line 46) and P_7 (Gemmeiza 9).

Quality traits

The data of grain protein content given in Table (10) show that highly significant positive GCA effects detected for the two parents; Line-3 and Line-37 under all environments except under high N-level in late sowing date. Therefore, these two parents appeared to be the best combiners for grain protein content under these environments. However, the other 5 parents behaved as poor combiners for this trait. They manifested highly significant negative GCA effects under certain environments.

Table 10. Estimates of general combining ability effects for grain protein content of the seven bread wheat parents as affected by two sowing dates and two N-fertilization levels and their combined analysis.

	D1+			D2		
Parents	N1++	N2	Combined	N1	N2	Combined
P_1(Line 3)	0.72**	0.57**	0.65**	0.97**	0.73	0.85**
P_2(Sakha93)	-0.18*	0.10	-0.05	-0.06	-0.24	-0.15**
P_3(Line 37)	0.81**	0.88**	0.84**	0.27**	0.40	0.33**
P_4(Giza 168)	-0.18*	-0.09	-0.13**	0.05	0.10	0.08
P_5(Sids 1)	-0.61**	-0.61**	-0.60**	-0.76**	-0.79	-0.78**
P_6(Line 47)	-0.48**	-0.69**	-0.58**	-0.26**	-0.35	-0.30**
P_7(Gemmeiza 9)	-0.07	-0.16*	-0.11*	-0.21**	0.13	-0.04
S.E(gi)	0.07	0.06	0.05	0.07	0.62	0.04
LSD (gi-gj) 0.05	0.23	0.18	0.14	0.20	0.19	0.13
0.01	0.30	0.25	0.19	0.26	0.25	0.18

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
*and** = denote significant differences at 0.05 and 0.01 levels, respectively.

Results in Table (11) indicate that the cross P_1 x P_7 exhibited significant positive SCA effects under all environments and combined data along with the cross P_4 x P_7 under all environments excerpt under low N-level in late sowing date for grain protein content. Also, the cross P_1 x P_5 under high N-level in early sowing date and the two N-levels and combined data in late sowing date, the cross P_4 x P_6 under high N-level and combined data in early sowing date and low N-level and combined data in late sowing date, the four crosses; P_1 x P_3, P_3 x P_5, P_3 x P_7 and P_5 x P_6 under the two N-levels and combined data in early sowing date, the cross P_2 x P_3 under the two N-levels and combined data in late sowing date, the cross P_1 x P_2 under high N-level and combined data in late sowing date, the cross P_3 x P_6 under low N-level in early sowing date and high N-level in late sowing date and the two crosses; P_1 x P_6 and P_2 x P_6 under low N-level and combined data in early sowing date and low N-level and combined data in late sowing date, respectively had significant positive SCA effects. Thus, these crosses are considered as good F_1-hybrids for improving this trait. From these crosses, the cross P_1 x P_3 involved two good general combiner parents while, the eight crosses namely; P_1 x P_2, P_1 x P_5, P_1 x P_6, P_1 x P_7, P_2 x P_3, P_3 x P_5, P_3 x P_6 and P_3 x P_7 included high x low general combiner parents.

For fermentation test, estimates of GCA effects for each parent are presented in Table (12). The data indicate that the parental Line-37 and the cv. Giza 168 showed highly significant positive GCA values under all environments and combined data as well as the cv. Gemmeiza 9 under all environments except under low N-level in early sowing date and the

Table 11. Estimates of specific combining ability effects for grain protein content of 21 crosses of bread wheat as affected by two sowing dates and two N-fertilization levels and their combined analysis.

Crosses		D1+			D2	
	N1++	N2	Combined	N1	N2	Combined
P_1 x P_2	0.35	0.00	0.19	0.59**	0.02	0.31*
P_1 x P_3	0.72**	0.47**	0.59**	-0.08	-0.06	-0.06
P_1 x P_4	0.31	-0.38*	-0.04	-0.64**	-0.21	-0.43**
P_1 x P_5	-0.12	0.50**	0.18	1.16**	1.36**	1.26**
P_1 x P_6	0.55*	0.32	0.43**	-0.33	0.13	-0.10
P_1 x P_7	1.79**	1.71**	1.75**	1.08**	0.65**	0.87**
P_2 x P_3	0.26	0.05	0.17	1.18**	0.57**	0.88**
P_2 x P_4	-0.72**	-1.01**	-0.85**	-0.39*	-0.47*	-0.43**
P_2 x P_5	-0.61**	-0.06	-0.32*	-0.14	-0.69**	-0.41**
P_2 x P_6	-0.62**	-0.09	-0.34*	0.59**	0.32	0.45**
P_2 x P_7	-1.67**	-1.28**	-1.46**	-0.80**	-0.40*	-0.60**
P_3 x P_4	-1.29**	-1.26**	-1.28**	-0.72**	-1.16**	-0.94**
P_3 x P_5	0.54*	0.61**	0.57**	-1.14**	-0.21	-0.67**
P_3 x P_6	0.45*	-0.04	0.20	-0.17	0.46*	0.14
P_3 x P_7	0.57**	0.68**	0.62**	-1.02**	-0.14	-0.57**
P_4 x P_5	0.12	0.27	0.20	-0.58**	0.09	-0.25
P_4 x P_6	-0.11	0.72**	0.31*	0.59**	0.09	0.34*
P_4 x P_7	1.14**	0.60**	0.87**	0.04	1.28**	0.66**
P_5 x P_6	0.84**	0.42*	0.62**	-0.05	-0.69**	-0.37**
P_5 x P_7	-0.14	0.08	-0.03	-0.21	-1.05**	-0.63**
P_6 x P_7	-0.01	0.17	0.08	-0.71**	0.28	-0.22
S.E(sij)	0.21	0.18	0.14	0.19	0.18	0.13
LSD (sij-sik) 0.05	0.64	0.52	0.41	0.56	0.54	0.38
0.01	0.85	0.70	0.54	0.75	0.72	0.51
LSD (sij-skl) 0.05	0.59	0.49	0.38	0.53	0.51	0.36
0.01	0.79	0.65	0.51	0.70	0.68	0.48

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
*and** = denote significant differences at 0.05 and 0.01 levels, respectively.
P_1 (Line 3), P_2 (Sakha 93), P_3 (Line 37), P_4 (Giza 168), P_5 (Sids 1), P_6 (Line 46) and P_7 (Gemmeiza 9).

prenatal Line-3 under low N-level in early sowing date and low N-level and combined data in late sowing date. Thus, these parents are considered as good combiners for this trait. On the other hand, the three parents, Sakha 93, Sids 1 and Line-47 exhibited highly significant negative GCA effects under all environments and combined data as well as the Line-3 under high N-level in early sowing data and the cv. Gemmeiza 9 under low N- level in early sowing data, therefore these parents behaved as poor combiners for this trait.

Table 12. Estimates of general combining ability effects for fermentation test of the seven bread wheat parents as affected by two sowing dates and two N-fertilization levels and their combined analysis.

Parents	D1+			D2		
	N1++	N2	Combined	N1	N2	Combined
P_1(Line 3)	2.16**	-1.52**	0.32	1.82**	0.25	1.04**
P_2(Sakha93)	-6.56**	-8.24**	-7.40**	-8.85**	-7.47**	-8.16**
P_3(Line 37)	9.49**	6.98**	8.24**	2.93**	7.03**	4.98**
P_4(Giza 168)	10.21**	8.60**	9.41**	13.21**	10.64**	11.92**
P_5(Sids 1)	-8.23**	-4.35**	-6.29**	-6.24**	-7.91**	-7.08**
P_6(Line 47)	-5.18**	-5.85**	-5.51**	-6.52**	-5.75**	-6.13**
P_7(Gemmeiza 9)	-1.90**	4.37**	1.24**	3.65**	3.20**	3.42**
S.E(gi)	0.20	0.26	0.16	0.29	0.24	0.19
LSD (gi-gj) 0.05	0.63	0.79	0.5	0.88	0.75	0.57
0.01	0.83	1.05	0.66	1.17	1.00	0.75

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
** = significant differences at 0.01 level of probability.

Estimates of SCA effects (Table 13) reveal that the cross P_1 x P_6 manifested significant positive SCA effects under all environments and combined data as well as the two crosses, P_2 x P_4 and P_6 x P_7 under all environments except under low N- level in early sowing date, the cross P_1 x P_3 under all environments except under high N-level in early sowing date, the cross P_2 x P_3 under all environments except under low N-level in late sowing date which considered the best F_1-cross combinations for this trait. Also, the cross P_1 x P_7 under low N-level and combined data in both sowing dates, the two crosses; P_1 x P_4 and P_3 x P_7 under the two N-levels and combined data in early sowing date, the cross $P_4 \times P_5$ under the two N-levels and combined data in late sowing date and the five crosses; P_2 x P_7, P_3 x P_5, P_4 x P_6, P_5 x P_6 and P_5 x P_7; under one or two environments manifested significant positive SCA effects, therefore they also considered as good F_1-hybrids for improving this trait. From these crosses there are four crosses, viz., P_1 x P_3, P_1 x P_4, P_1 x P_7 and P_3 x P_7 involved high x high general combiner parents, while nine crosses, viz., P_1 x P_6, P_2 x P_3, P_2 x P_4, P_2 x P_7, P_3 x P_5, P_4 x P_5, P_4 x P_6, P_5 x P_7 and P_6 x P_7 included low x high general combiner parents.

Types of gene action, genetic ratios and heritability

According to Hayman's approach (1954 a and b), the half diallel analysis provides six genetic components, i.e., D, H_1, H_2, F, h^2 and E and several ratios could be derived from the analysis. As shown in Table (14), the values of additive genetic component (D) were significant for days to heading and the two quality traits under the four environments except, grain yield/plant under low N-level at early sowing date the value of component (D) was insignificant.

Table 13. Estimates of specific combining ability effects for fermentation test of 21crosses of bread wheat as affected by two sowing dates and two N-fertilization levels and their combined analysis.

Crosses		D1+			D2		
		N1++	N2	Combined	N1	N2	Combined
$P_1 \times P_2$		-4.67**	-11.14**	-7.90**	-9.74**	-19.75**	-14.74**
$P_1 \times P_3$		4.78**	0.14	2.46**	6.99**	3.75**	5.37**
$P_1 \times P_4$		10.56**	7.52**	9.04**	0.71	-3.36**	-1.33*
$P_1 \times P_5$		-5.50**	-16.03**	-10.76**	1.15	-2.31**	-0.58
$P_1 \times P_6$		13.44**	7.47**	10.46**	13.93**	10.03**	11.98**
$P_1 \times P_7$		3.17**	-1.25	0.96*	6.76**	0.58	3.67**
$P_2 \times P_3$		16.00**	11.36**	13.68**	-3.35**	18.47**	7.56**
$P_2 \times P_4$		-0.22	3.74**	1.76**	16.38**	3.36**	9.87**
$P_2 \times P_5$		-3.28**	-7.31**	-5.29**	-3.68**	-2.08**	-2.88**
$P_2 \times P_6$		-13.83**	-15.81**	-14.82**	-4.40**	-4.25**	-4.33**
$P_2 \times P_7$		-3.11**	-7.03**	-5.07**	3.93**	-3.69**	0.12
$P_3 \times P_4$		-19.78**	-9.98**	-14.88**	-20.90**	-6.64**	-13.77**
$P_3 \times P_5$		1.67**	-8.53**	-3.43**	9.04**	-7.58**	0.73
$P_3 \times P_6$		-2.39**	-5.03**	-3.71**	-17.18**	-13.75**	-15.47**
$P_3 \times P_7$		3.83**	1.75*	2.79**	-3.35**	0.81	-1.27*
$P_4 \times P_5$		-0.56	0.86	0.15	2.26**	4.81**	3.53**
$P_4 \times P_6$		4.39**	1.36	2.87**	-4.46**	-9.86**	-7.16**
$P_4 \times P_7$		-2.39**	-7.37**	-4.88**	-6.63**	-1.81*	-4.22**
$P_5 \times P_6$		4.83**	0.81	2.82**	-8.01**	-3.81**	-5.91**
$P_5 \times P_7$		2.06**	-4.42**	-1.18*	-1.18	-14.75**	-7.97**
$P_6 \times P_7$		-1.00	5.58**	2.29**	3.60**	9.58**	6.59**
S.E(sij)		0.59	0.75	0.48	0.83	0.71	0.55
LSD (sij-sik)	0.05	1.76	2.24	1.40	2.49	2.12	1.61
	0.01	2.35	2.98	1.86	3.32	2.82	2.14
LSD (sij-skl)	0.05	1.65	2.09	1.31	2.33	1.98	1.51
	0.01	2.20	2.79	1.74	3.10	2.64	2.00

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
*and** = denote significant differences at 0.05 and 0.01 levels, respectively.
P_1 (Line 3), P_2 (Sakha 93), P_3 (Line 37), P_4 (Giza 168), P_5 (Sids 1), P_6 (Line 46) and P_7 (Gemmeiza 9).

The presence of dominance effects were substantiated by significant estimates of H_1 for the four traits recorded under all environments. These results illustrate that both additive and dominance genetic components are important in the inheritance of the traits studied. However, values of D were greater than the respective H_1 for days to heading under all environments as well as grain yield/plant under the two N-levels at late sowing date, indicating that additive gene effects played the major role in the inheritance of these traits. On contrast, values of H_1 for grain protein content and fermentation test were greater than their respective D values under all environments, indicating that the dominance gene effects played the major

Table 14. Estimates of genetic and environmental components of variation and some of its derived ratios in F1 diallel crosses analysis for the traits studied in bread wheat genotypes on two sowing dates under two N-fertilization levels.

Traits	Days to heading				Grain yield/plant			
Genetic	D1+		D2		D1		D2	
parameters	N1++	N2	N1	N2	N1	N2	N1	N2
D	158.40**	164.54**	51.70**	45.00**	2.64	10.11**	8.28**	7.80**
H_1	34.59*	32.51**	6.53*	12.38*	15.41*	13.48*	7.58*	7.05**
H_2	31.16*	29.92**	6.16*	10.03	13.81*	11.32*	6.62*	5.97**
F	-12.64	-8.53	1.90	-11.5	-2.41	1.40	-5.26	-4.82*
h^2	32.31**	52.29**	1.47	6.24	0.03	-0.19	-0.23	0.67
E	2.04	1.87	0.48	0.64	0.66	0.72	0.57	0.38
$(H_1/D)^{0.5}$	0.47	0.44	0.36	0.52	2.42	1.15	0.96	0.95
$H_2/4H_1$	0.23	0.23	0.24	0.20	0.22	0.21	0.22	0.21
h^2/H_2	1.04	1.75	0.24	0.62	0.00	-0.02	-0.03	0.11
KD/KR	13.56	9.47	-0.85	12.25	3.22	-0.34	5.93	5.50
Hn.s.	89.87	90.38	92.54	90.34	44.75	60.53	76.56	78.51
r	0.87**	0.88**	0.87**	0.9**	-0.12	0.49	0.45	0.19
r^2	0.75	0.77	0.75	0.81	0.02	0.24	0.20	0.04
	Grain protein content				Fermentation test			
D	1.15*	2.32**	0.90*	0.55*	240.48**	121.22**	328.72**	186.30**
H_1	4.52**	3.54**	2.89**	2.09**	304.41*	343.15**	449.25*	355.99**
H_2	2.84*	2.21*	2.06**	1.66*	260.78*	291.91**	348.27*	338.18**
F	1.24	2.33*	0.35	-0.26	51.65	-31.3	193.56	-24.43
h^2	0.56	0.63	0.29	-0.02	6.59	302.23**	34.61	190.02**
E	0.06	0.04	0.05	0.04	0.47	0.73	0.84	0.62
$(H_1/D)^{0.5}$	1.98	1.24	1.79	1.96	1.13	1.68	1.17	1.38
$H_2/4H_1$	0.16	0.16	0.18	0.20	0.21	0.21	0.19	0.24
h^2/H_2	0.20	0.29	0.14	-0.01	0.03	1.04	0.10	0.56
KD/KR	0.03	-0.93	0.76	1.14	-50.56	32.22	-192.3	25.38
Hn.s.	50.99	52.55	54.89	57.5	63.9	58.02	57.32	57.3
r	0.21	-0.31	0.02	-0.65	-0.59	-0.82*	-0.62	-0.26
r^2	0.04	0.10	0.00	0.43	0.35	0.68	0.39	0.07

+D1 and D2 = 8 Nov. and 8 Dec., respectively. ++ N1and N2 = 40 and 80 kg N/ fed., respectively.
*and** = denote significant differences at 0.05 and 0.01 levels, respectively.
D = additive effects of genes.
H_1 = dominance effects of genes.
H_2 = dominance indicating symmetry of positive and negative effects of genes.
F = covariation of additive and dominance effects.
h^2 = dominance effect as the algebraic sum over all loci in heterozygous phases in all crosses.
E = the expected environmental component of variation.
$(H1/D)^{0.5}$ = measures the average degree of dominance over all loci.
$H_2/4H_1$ = the ratio of genes with positive and negative effects in the parents.
h^2/H_2 = number of groups of genes which control the character and exhibited dominance.
KD/KR = the ratio of total number of dominant to recessive alleles in all parents.
Hn.s. =heritability in narrow sense.
r = The coefficient of correlation between the parental order of dominance and parental measurement.
r^2 =prediction for measurement of completely dominant and recessive parents.

role in the inheritance of both traits under different environments. These findings coincided with those obtained previously from variance analysis of combining ability.

The component of variation due to dominance effects associated with gene distribution (H_2) was significant for grain yield/plant, grain protein content and fermentation test under all environments but it was only not significant for days to heading under high N-level at late sowing date. Moreover, H_2 values were smaller than H_1 values for all traits, which complies with theoretical assumption of Hayman (1954 a and b) and could be a further proof for the unequal proportions of positive and negative alleles in the parents at all loci for these traits.

The values of (F) which represent covariance of additive and dominance was insignificant for the majority of studied traits under all environments, revealing that no excess of either dominant or recessive alleles was verified.

The overall dominance effects of heterozygous loci (h^2) was significant for days to heading under the two N-levels at early sowing date and fermentation test under high N-level in both sowing dates, illustrating that the dominance effect was mainly attributed to heterozygous phase in all crosses for both traits. On the other hand, (h^2) was insignificant for the other two traits, revealing the little importance of dominance effects in the inheritance of these traits.

The environmental effects indicated by (E) values did not reach the significant level in all traits, revealing less sensitivity of the studied traits to environmental changes.

The degree of dominance $(H_1/D)^{0.5}$ was higher than unity for grain protein content and fermentation test under all environments as well as grain yield/plant under the two N-levels in early sowing date, indicating the presence of overdominance in the expression of these traits. On contrast, the ratio was less than unity for days to heading under all environments and grain yield/plant under the two N-levels in late sowing date, indicating the presence of partial dominance for both traits.

The ($H_2/4H_1$) value was used to estimate the average frequency of positive (v) vs. negative (u) alleles in the parental genotypes. The ratio theoretically equal 0.25 when the distribution of positive equal negative genes among the genetic makeup of parents. As shown in Table (14), these ratios were less than 0.25 for the traits studied under all environments, revealing asymmetric distributions of positive and negative alleles among parents.

The (h^2/H_2) values were calculated to determine the number of effective gene groups that control the character and exhibit dominance. Data in Table (14) show that about one effective gene group controlled the traits studied under all environments.

The ratio of (KD/KR) that represent the total number of dominant to recessive alleles in the parents was more than unity for fermentation test under all environments as well as days to heading under the two N-levels in early sowing date and high N-level in late sowing date, grain yield/plant under the two N-levels in late sowing date and low N-level in early sowing date and grain protein content under high N-level in late sowing date, suggesting greater frequency for dominant genes as compared with recessive ones in the parents regarding these traits. On the other hand, this proportion was less than unity for days to heading under low N-level in late sowing date, grain yield/plant under high N-level in early sowing date and grain protein content under the two N-levels in early sowing date and low N-level in late sowing date, indicating that the proportion of recessive alleles was greater for these traits.

The correlation coefficient (r) between the parental order of dominance (Wr + Vr) and the parental mean performance (Yr) was found to be positive and significant for days to heading under all environments, revealing that the dominant genes were operating towards decreasing this trait under these environments. On the other hand, significant negative correlation coefficients were detected for fermentation test under high N-level in early sowing date, indicating that the dominant genes were operating towards increasing this trait under these specific environments However, the other traits (grain yield/plant and grain protein content) were insignificant, indicating ambidirectional dominance.

The square values of (r^2) were less than unity for all traits studied under all environments, suggesting that none of parental genotypes was completely dominant or recessive for genes controlling any of traits under different treatments. Similar results concerning components of variation and ratios derived from Hayman's analysis were obtained for one or more of the traits studied by EL-Marakby *et al* (1993), Ahmed (1999), Salem *et al* (2000), Mostafa (2002), Hamada (2003) and Menshawy (2005) in wheat.

High estimates of narrow sense heritability (Hn.) were detected for days to heading under all environments, grain yield/plant under the two N-levels in late sowing date and high N-level in early sowing date and fermentation test under low N-level in early sowing date. Values of heritability for these two traits ranged from 60.53% for grain yield/plant under high N-level at early sowing date to 92.54% for days to heading under low N-level at late sowing date, indicating the importance of additive gene effects in the inheritance of these traits and consequently the effectiveness of selection for improving both traits in segregating generations under similar environments. EL-Marakby *et al* (1993). Ahmed (1999). Salem *et al* (2000), Hamada (2003) and Koumber and EL-Beially (2005) also found high narrow sense heritability values ranging from 60% to 89% for one or the two above traits. However, moderate heritability values were obtained for grain protein content under all environments, grain yield/plant under low N-level at early sowing date and fermentation test under high N-level in early sowing date and the two N-levels in late sowing date giving values ranging from 44.75 % for grain yield/plant under low N-level in early sowing date to 58.02 % for fermentation test under high N-level in early sowing date. These results are supported by findings of Ahmed (1999) and Koumber and Esmail (2005) who found narrow sense heritability values ranging from 40% to 60.59% for these traits in wheat.

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طبيعة الفعل الجيني في وراثة صفات التبكير والمحصول والجودة في هجن تبادلية من قمح الخبز تحت بيئات مختلفة

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اجرى هذاالبحث لدراسة سلوك احدي وعشرون هجينا فرديا مع اباتها الأصلية بالنسبة لصفات عدد الأيام من الزراعة حتي طرد 50 % من السنابل ومحصول حبوب النبات ونسبة البروتين بالحبوب وأختبار التخمر مع تقدير القدرة العامة والخاصة علي التألف وطبيعة الفعل الجيني وكفاءة التوريث تحت أربعة بيئات مختلفة. أجريت جميع التهجينات التبادلية دون العكسية في الموسم الزراعي 2003/2002 بين سبع تراكيب وراثية من قمح الخبز أشتملت علي أربعة أصناف تجارية هي سخا 93 (P_2)، جيزة 168(P_4) ، سدس 1 (P_5) ، جميزة 9 (P_7) وثلاث سلالات مبشرة هى السلالة 3 (P_1)، السلالة 37(P_3) والسلالة 47(P_6) حيث تم الحصول

علي بذرة الجيل الأول الهجين ثم قيمت هجن الجيل الأول وأباؤها فى المزرعة التجريبية لكلية الزراعة – جامعة عين شمس بشلقان – محافظة القليوبية خلال الموسم الزراعي 2004/2003 تحت ميعادين للزراعة (8 نوفمبر، 8 ديسمبر) ومستويين من التسميد النيتروجينى (40 ، 80 كجم ن / فدان) فى تصميم قطع منشقة مرة واحدة من ثلاث مكررات حيث خصص لكل ميعاد تجربة مستقلة. تم توزيع مستويي التسميد النيتروجيني بالقطع الرئيسية والتراكيب الوراثية بالقطع المنشقة. حللت البيانات إحصائيا لكل ميعاد زراعة على حده والميعادين معا.

أظهرت النتائج وجود اختلافات معنوية في سلوك التراكيب الوراثية (الأباء والهجن) تحت البيئات المختلفة والتحليل التجميعي بالنسبة للصفات المدروسة. أدي التأخير في ميعاد الزراعة (8 ديسمبر) ونقص معدل التسميد النيتروجيني (40 كجم ن / فدان) الي حدوث نقص معنوي في محصول الحبوب للنبات وصفتي الجودة، ، بينما حدثت زيادة في عدد الأيام من الزراعة حتي طرد السنابل في معظم التراكيب الوراثية بالتأخير في ميعاد الزراعة ولم يكن لمستوي التسميد النيتروجيني تأثير معنوي علي تلك الصفة. كانت السلالة 3 ابكر التراكيب الوراثية في طرد السنابل في حين كان الصنف جميزة 9 متأخر في الطرد عن التراكيب الوراثية الأخري تحت كل البيئات، كما سجلت الهجن $P_4 \times P_5, P_4 \times P_7, P_5 \times P_6, P_5 \times P_7, P_6 \times P_7$ أعلي قيم لمحصول النبات في حين سجل الهجين $P_1 \times P_7$ والصنف جيزة 168 أعلي قيم لنسبة البروتين بالحبوب وأختبار التخمر علي الترتيب تحت كل بيئات الدراسة.

أوضحت نتائج التقديرات الوراثية أن كل من التأثير الاضافي والسيادي مهم في وراثة الصفات المدروسة تحت البيئات المختلفة الا أن التأثير الأضافي للجينات كان أكثر أهمية في وراثة صفة عدد الأيام من الزراعة حتي طرد السنابل بينما كان التأثير السيادي هو الأهم في وراثة صفات محصول الحبوب/ نبات ونسبة البروتين بالحبوب وأختبار التخمر وقد تأثرت قيم تباين الفعل الجينى بميعادي الزراعة و مستويي التسميد النيتروجينى وأظهرت بعض الآباء قدرة عامة عالية على الائتلاف مثل السلالتين3، 37 والصنف سخا 93 لصفات التبكير فى الطرد ونسبة البروتين بالحبوب وأختبار التخمر والصنفين جيزة 168 و سدس 1 والسلالة 47 لصفة محصول الحبوب بالنبات. كما أظهرت النتائج بعض الهجن التى تميزت بقدرة خاصة عالية ومرغوبة علي الائتلاف في معظم البيئات وتضمنت علي الأقل أب ذو قدرة عامة عالية علي الأئتلاف وهذة الهجن هي: $P_2 \times P_3, P_2 \times P_5$ لصفات التبكير في طرد السنابل ونسبة البروتين بالحبوب وزمن التخمر والهجن $P_4 \times P_5, P_4 \times P_7, P_5 \times P_6, P_5 \times P_7, P_6 \times P_7$ لصفة محصول حبوب النبات وبذلك يمكن الأستفادة بتلك الهجن في تحسين محصول الحبوب والصفات الأخري المدروسة في برامج تربية القمح تحت البيئات المستهدفة. كانت قيم معامل التوريث بالمعنى الدقيق متوسطة الي عالية في هجن الجيل الاول لمعظم الصفات المدروسة تحت معظم البيئات حيث تروحت من 44.75 % لصفة محصول حبوب النبات تحت المستوي المنخفض من النيتروجين في ميعاد الزراعة المبكر الي 92.54% لصفة تاريخ الطرد تحت المستوي المنخفض من النيتروجين في الميعاد المتأخر.