J. Agric. Chemistry and Biotechnology, Mansoura Univ., Vol. (7):365-381, 2010

GENETICAL STUDIES ON SOME ECONOMICAL TRAITS IN BREAD WHEAT *(Triticum aestivum L.)*

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ABSTRACT

This investigation aimed to study; (1)The mean performance of ten parents and their F1 diallel crosses, involving some Egyptian and exotic wheat germplasm for yield and its components. (2)The potentiality of heterosis expression, (3) General and specific combining ability and their interactions under two nitrogen fertilization levels. The analytical methods were based largely on Griffing (1956) diallel cross analysis designated as method 2 model 1.

The wheat genotypes P_1, P_2, P_4, P_5, P_7, P_8, P_9 and P_{10} as well as their F1 crosses ($P_1 \times P_4$), ($P_1 \times P_5$), ($P_1 \times P_{10}$), ($P_4 \times P_7$) ($P_4 \times P_9$), ($P_4 \times P_{10}$), ($P_5 \times P_8$), ($P_7 \times P_{10}$), ($P_8 \times P_9$), ($P_8 \times P_{10}$) and ($P_9 \times P_{10}$) were superior for yield contributing characters under different cases. Significant heterobeltiosis was observed in the wheat cross ($P_2 \times P_3$) and highly significant for number of spikes / plant, ($P_3 \times P_4$), ($P_3 \times P_8$), ($P_4 \times P_5$), ($P_4 \times P_7$), ($P_4 \times P_8$), ($P_4 \times P_{10}$), ($P_5 \times P_7$), ($P_6 \times P_7$) and ($P_8 \times P_{10}$) for number of kernels / spike; ($P_3 \times P_4$) for 100- kernel weight and the crosses ($P_3 \times P_8$), ($P_6 \times P_8$), ($P_6 \times P_{10}$), ($P_7 \times P_9$), ($P_7 \times P_{10}$) , ($P_8 \times P_9$) and ($P_8 \times P_{10}$) for grain yield / plant under low nitrogen level. While, the two wheat crosses (P_3 ×P8) and (P_8 ×P9) showed highly significant heterosis under the combined.

Sids 1 was the best general combiner for number of spikes / plant under both environments and their combined data; P_1, P_4, P_9 and P_{10} for number of kernels / spike. In addition, P_{10} was the promising one for 100- kernel weight, number of kernels /spike and grain yield / plant.

The crosses ($P_6 \times P_7$)and($P_9 \times P_{10}$)showed significant and highly significant SCA for number of spikes / plant; ($P_2 \times P_3$), ($P_3 \times P_7$), ($P_3 \times P_8$) (P4 × P_5), ($P_4 \times P_7$),($P_5 \times P_7$) , ($P_5 \times P_9$) , ($P_5 \times P_{10}$) , ($P_6 \times P_7$) , ($P_6 \times P_8$) and($P_8 \times P_{10}$) for number of kernels / spike and ($P_1 \times P_4$) , ($P_7 \times P_9$) and ($P_7 \times P_{10}$) for grain yield / plant under the two nitrogen levels and their combined data .

INTRODUCTION

The occurrence of significant levels of heterosis in wheat is still an open question since positive and negative resultes have been reported. Several investigators have dealt with different hybrid combinations and evaluated them under different cultural practices. Singh *et al* (2002) found that general combining ability was comparatively high for 1000-grain weight and grain yield which indicate that additive gene action was predominate while specific combining ability was high for number of grains per spike. El-Beially and El-Sayed (2002) obtained significant mean squares for genotypes, parents, crosses for all traits studied. The maximum heterobeltiosis was recorded by Ijaz *et al.* (2002) for grain yield per plant (27.11%). Meanwhile, Hamada (2003) found that mean squares for parents vs crosses was significant as an indication for average heterosis overall crosses for the studied characters under three planting dates. While, Koumber *et al*. (2006) recorded positive heterotic effects over better parents for number of spikes /plant, number of kernels/spike, 1000-kernel weight, and grain yield /plant in some crosses. The cross PBW 459 x Raj 3777 made by Srivastava and Singh (2008) in India gave a 76.16% yield advantage over the standard parent (PBW 459).

This investigation was conducted to study heterosis, general and specific combining ability under different levels of N fertilization.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm of EL-Gemmeiza Agriculture Research Station, ARC, Egypt during two successive season of 2005/2006 and 2006/2007.

Genetic materials: Ten bread wheat parental genotypes were chosen on basis of the presence of wide differences among them with respect to their morphological characters and yield as well as its attributes. These parental genotypes including four commercial wheat cultivars named Gemmeiza 7, Giza 168, Sids 1 and Gemmeiza 10 in addition to six exotic wheat lines which symboled by Line 1, Line 2, Line 3, Line 4, Line 5 and Line 6. The pedigree and origin of the studied wheat parental genotypes are presented in Table 1.

Table (1): Pedigree and origin of the evaluated bread wheat genotypes.

Name	Pedigree	Origin
Gemmeiza 7	CMH74A.630/SX//SERI82/AGENT CGM4611-2GM-3GM-1GM-OGM.	Egypt
Giza 168	MRL/BUC//SERI CM 93046-8 M-OY-OM-2Y-OB-OGZ.	Egypt
Sids 1	HD2172/2/Pavon//1158.57/Maya74 SD46 -45D-15D-05D	Egypt
Gemmeiza 10	MAYA74"S"/on//1160147/3/BB/GLL/4/CHAT"S"/5/CROW"S" CGM4611-2GM-1GM-0GM	Egypt
Line 1	MUNIA /CHTO//AMSEL	CIMMYT
Line 2	SW89.5193/KAUZ	CIMMYT
Line 3	OPATA/RAYON// KAUZ	CIMMYT
Line 4	Prls/Tons//Attila	CIMMYT
Line 5	MILAN/MUNIA	CIMMYT
Line 6	OTUS/TOBA97	CIMMYT

During 2005/2006 growing season, grains from each parental wheat genotypes were sown and at time of anthesis, all possible hybrid combinations among them were made excluding reciprocals according to a half diallel cross mating design (Griffing, 1956). Method 2 Model (1).

In the second season of 2006 / 2007, the obtained 45 F1's seeds along with their 10 parental genotypes were evaluated under two nitrogen fertilization levels, i.e., 30 kg N/Fed (low level) and 70 kg N/Fed (normal level) in two adjacent experiments. Under each nitrogen level, a randomized complete block design with three replicates was used, each replicate consisted of ten parents and their forty five F1 hybrids and were sown in rows, 1.5 meter long; 20 cm. between rows and 10 cm apart.

Observations and measurments were recorded on 10 guarded plants chosen at random for both parents and their F_1 crosses from each plot for the following characters:

Number of spikes /plant: was counted at harvest.

Number of kernels /spike: number of kernels per main stem spike.

100-Kernel weight (gm): was recorded as the weight of 100 random wheat kernels /plant.

Grain yield / plant (gm): was recorded as the weight of the individual plant grain yield.

RESULTS AND DISCUSSION

A- Mean Performance

The obtained data were subjected firstly to analysis of variance to detect the significant differences between different items of the analysis of the studied characters (Table 2).

1- Number of spikes / plant:

Mean squares for genotypes, parents and F_1 crosses were highly significant at different levels of nitrogen fertilization and the combined, indicating the presence of considerable amount of genetic variability valid for further genetical studies. Mean squares for nitrogen levels were significant, revealing differences in behavior for number of spikes / plant under the tried N-environments. The mean squares of interaction between genotypes × N-levels, parents × N-levels and F_1 crosses × N-levels were highly significant, indicating that the studied wheat genotypes responded differently to the nitrogen environments, suggesting the importance of further testing in order to identify the best genotype for a particular environment. Hendawy (1993) came to the same conclusion. In continuous, and as shown in (Table 3), mean performance of wheat parental cultivars P_5 and P_9 as well as the combinations (P_9 × P_{10}), (P_2 x P_3), (P_2 x P_9), (P_3 ×P_5) and (P_4 × P_5) produced greatest number of spikes / plant at low, normal and the combined data, suggesting that these genotypes could be used for isolating new recombinants characterized by greater number of spikes / plant. This result may be due to the prominent role of nitrogen in building new merstimic cells, and stimulating cell differentiation which in consequence enhances spikes number / plant. Similar results were detected by Salem *et al*. (2000).

2- Number of kernels / spike:

Mean squares for genotypes, parents and F_1 crosses found to be highly significant (Table 2), this trend was maintained at different levels of nitrogen fertilizations and the combined data, suggesting that the parental cultivars were genetically different for genes controlling number of kernels / spike which reflected on the high performance of their F_1 crosses. In this respect, highly significant differences among wheat cultivars and their F_1 crosses were recorded by El-Beially and El-Sayed (2002) and Hamada (2003).

Parents vs. crosses mean squares as an indication of average heterosis overall crosses appeared to be highly significant for number of kernels / spike, which agreed with the findings of EL-Shami *et al* (1996). Nitrogen mean square was found to be insignificant, indicating that overall differences in number of kernels /spike was due to varying N environments. Various types of interactions were found to be highly significant, indicating that wheat genotypes differed significantly in their response to different nitrogen fertilization levels. In this respect, Hendawy (1994) showed that the interaction between cultivars × nitrogen fertilization level had a significant effect on number of kernels / spike. As shown in (Table 3) the parental wheat cultivars P_2 and P_9 as well as the F_1 crosses (P_1 ×P_4), (P_1 ×P_{10}), (P_4 ×P_5), (P_4 ×P_9), (P_8 ×P_{10}) and (P_2 ×P_3) produced the greatest number of kernels / spike.

This means that these genotypes could be used in the breeding program for selecting new recombinants characterized by greater number of kernels / spike. The increase in number of kernels / spike may be due to the ultimate role of N increment in increasing number of florets and hence number of fertile spikelets/spike. Similar interpretation was mentioned by Salem *et al* (2000).

3- 100- kernel weight:

Mean squares given in (Table 2) provide evidence for highly significant differences among wheat genotypes, parents and F_1 crosses for 100- kernel weight at different N- environments and the combined.

Parents vs. crosses mean squares were found to be highly significant for 100- kernel weight. Nitrogen fertilization mean square was significant, indicating overall differences in 100- kernel weight regarding the two nitrogen levels. The interaction between genotypes × N- levels, and crosses × N- levels was highly significant for 100- kernel weight, suggesting that these genotypes behaved differently from one environment to another. The abovementioned results are in agreement with the findings of El-Sayed (2004) who found a great difference among wheat cultivars for 100- kernel weight in their response to N increments.

The mean performance of 100- kernel weight (Table 3) indicate that the exotic cultivars P_9, P_8, P_{10} and P_7 as well as the combinations (P_8 × P_9), (P_4 × P_7), (P_9 × P_{10}), (P_5 × P_8) and (P_1× P_5) exhibited the heaviest 100- kernel weight at different nitrogen fertilization levels and the combined. Results of the present study indicate that these materials could be used through the wheat breeding programs in order to improve 100- kernel weight character. These findings are in agreement with those obtained by Hassan (1998) and EL-Sayed (1997) who mentioned that 1000- kernels weight showed downward trend with increasing nitrogen levels. However, Hamada (2003) found contradictable results in this respect.

4- Grain yield / plant (gm):

The results presented in Table 2 a showed highly significant difference in mean squares of grain yield / plant for wheat genotypes, parents and F_1 crosses under different nitrogen levels and the combined. These results provide evidence for the presence of great magnitude of genetic variability adequate for further biometrical assessments. Parents vs. crosses mean squares overall crosses were significant for grain yield / plant.

Table (3): Mean performance of ten parental wheat genotypes and their F_1 crosses for yield and its components under two nitrogen fertilization levels.

Genotypes	Number of spikes/ plant			Number of kernels / spike			100- kernel weight			Grain yield / plant		
	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.
P1	4.40	6.80	5.60	58.59	73.62	66.10	4.60	4.91	4.75	16.30	25.43	20.86
P2	3.46	6.08	4.77	52.53	67.55	60.04	4.17	4.62	4.39	18.71	28.86	23.78
P3	4.72	6.58	5.65	43.85	57.50	50.67	4.22	4.29	4.25	17.26	24.72	20.99
P4	5.16	6.11	5.63	46.55	57.96	52.25	4.30	4.55	4.42	19.03	26.86	22.94
P5	5.22	7.83	6.52	40.33	51.09	45.71	4.69	5.01	4.85	16.46	22.65	19.55
P6	5.95	6.23	6.09	38.34	49.05	43.69	4.74	4.95	4.84	14.65	24.31	19.48
P7	5.56	6.69	6.12	36.73	51.54	44.13	4.90	5.19	5.04	15.62	28.48	22.05
P8	5.14	5.71	5.42	38.09	56.39	47.24	4.62	5.31	4.96	14.48	24.65	19.56
P9	5.18	7.02	6.10	56.16	66.70	61.43	4.66	5.50	5.08	14.75	28.69	21.72
P10	5.33	6.72	6.02	47.96	62.61	55.28	4.85	5.24	5.04	19.36	26.14	22.75
P1 x P2	4.25	7.02	5.63	48.35	67.67	58.01	4.19	5.26	4.72	15.84	26.34	21.09
P1 x P3	4.13	6.99	5.56	48.006	61.95	54.97	4.38	5.16	4.77	15.39	23.27	19.33
P 1x P4	4.26	6.82	5.53	55.46	70.30	62.88	4.99	5.22	5.10	19.49	29.54	24.51
P1 x P5	4.67	6.90	5.78	49.10	62.62	55.86	4.99	5.47	5.23	16.90	27.63	22.26
P 1x P6	3.72	6.64	5.18	37.13	50.29	43.71	4.73	5.27	5.001	18.34	24.38	21.36
P1 x P7	4.09	6.88	5.48	39.97	53.18	46.57	4.56	5.14	4.85	16.78	22.23	19.50
P 1x P8	4.46	7.00	5.72	51.41	64.89	58.15	4.68	5.26	4.97	19.11	25.74	22.42
P1 x P9	3.68	6.36	5.01	56.02	67.75	61.88	4.72	5.07	4.89	16.33	25.22	20.77
P 1x P10	5.03	6.86	5.94	54.61	69.93	62.27	4.96	5.29	5.12	19.05	27.63	23.33
P 2x P3	5.53	7.52	6.52	57.20	68.95	63.08	4.29	4.80	4.54	16.19	26.24	21.21
P 2x P4	3.71	6.88	5.29	44.8	64.59	54.69	4.57	4.76	4.66	17.56	25.67	21.61
P 2x P5	4.66	7.11	5.88	37.14	53.90	45.52	4.23	4.77	4.50	14.53	21.89	18.21
P 2x P6	4.95	6.37	5.66	42.07	55.24	48.65	4.71	5.13	4.92	16.07	19.74	17.90
P 2x P7	5.35	6.33	5.84	44.62	55.20	49.91	4.95	4.76	4.85	17.5	24.68	21.09
P 2x P8	5.06	6.42	5.74	51.74	62.76	57.25	4.28	4.77	4.52	17.76	25.43	21.59
P 2x P9	4.90	7.33	6.11	55.02	67.93	61.47	4.89	4.47	4.68	15.67	26.66	21.16
P2 x P10	4.63	7.01	5.82	55.06	65.27	60.17	4.68	5.22	4.95	20.20	26.40	23.30
P3 x P4	3.64	7.05	5.34	53.84	66.29	60.06	4.80	5.04	4.92	15.72	26.01	20.86
P 3x P5	6.26	7.03	6.64	36.59	52.69	44.64	4.67	4.96	4.81	16.60	19.47	18.03
P 3x P6	5.24	6.93	6.08	41.86	53.63	47.74	4.41	5.25	4.83	18.793	25.61	22.2
P 3x P7	4.96	6.96	5.96	51.51	60.73	56.12	4.87	4.76	4.81	15.59	21.95	18.77
P 3x P8	5.41	6.65	6.02	56.06	68.44	62.25	4.64	5.27	4.95	23.41	27.50	25.45
P 3x P9	5.44	6.66	6.05	55.28	67.71	61.49	4.84	5.28	5.06	18.51	27.41	22.96
P3 x P10	5.65	5.78	5.71	51.83	64.18	58.008	5.39	4.93	5.16	18.21	24.86	21.54
P4 x P5	5.37	7.17	6.27	56.66	69.60	63.13	4.91	5.10	5.008	12.24	26.46	19.35
P 4x P6	4.31	6.23	5.27	47.19	60.44	53.82	5.09	5.40	5.24	14.03	20.77	17.4
P 4x P7	3.61	6.39	5.00	57.86	68.54	63.2	5.07	5.31	5.19	17.82	27.32	22.57
P 4x P8	4.09	6.31	5.20	53.41	68.11	60.76	4.53	5.26	4.89	16.66	26.35	21.50
P 4x P9	5.33	5.90	5.61	54.24	69.51	61.87	4.81	5.35	5.08	16.31	25.22	20.76
P 4x P10	5.27	5.85	5.55	54.82	68.95	61.88	4.45	5.34	4.89	21.83	27.39	24.60
P 5x P6	3.61	5.38	4.49	34.38	44.85	39.61	4.78	5.06	4.92	17.11	25.02	21.06
P 5x P7	4.85	5.64	5.24	45.08	59.47	52.27	4.83	5.27	5.05	15.53	26.41	20.96
P 5x P8	4.47	6.19	5.33	44.19	53.86	49.02	5.06	5.49	5.27	15.93	28.09	22.01
P 5x P9	4.22	6.16	5.19	53.55	66.67	60.11	4.66	5.10	4.88	13.08	24.07	18.57
P5 x P10	5.61	6.35	5.98	50.89	66.23	58.55	4.68	4.94	4.81	19.68	27.12	23.40
P6 x P7	5.82	6.99	6.40	45.93	58.18	52.05	4.73	5.32	5.02	15.67	22.16	18.91
P 6x P8	4.29	6.88	5.58	50.01	57.88	53.94	5.09	5.38	5.24	17.71	25.92	21.81
P 6x P9	5.06	5.57	5.32	46.95	61.75	54.35	4.69	5.31	5.001	16.623	29.08	22.85
P6 x P10	5.47	5.97	5.71	48.97	58.62	53.79	4.64	5.50	5.07	23.28	27.23	25.25
P7 x P8	5.08	6.42	5.74	44.92	58.52	51.72	4.81	5.41	5.11	18.52	26.91	22.71
P 7x P9	5.05	5.55	5.30	49.09	59.14	54.11	4.68	5.14	4.90	19.80	30.75	25.27
P7 x P10	5.61	7.09	6.35	49.87	57.99	53.92	4.68	5.29	4.98	23.31	31.02	27.16
P 8x P9	5.29	5.61	5.44	56.19	67.44	61.81	5.08	5.28	5.18	22.45	29.34	25.89
P8 x P10	5.61	6.39	6.005	55.12	69.02	62.06	4.99	5.26	5.12	22.48	28.03	25.25
P9 x P10	6.21	7.95	7.08	55.6	68.41	62.006	4.93	5.61	5.27	20.91	28.44	24.67
L S D5%	0.82	0.94	0.87	4.60	4.35	4.43	0.42	0.36	0.39	2.26	3.65	3.01
L S D1%	1.08	1.24	1.15	6.08	5.76	5.82	0.56	0.47	0.51	2.99	4.82	3.95

*** and ** is Significant at 0.05 and 0.01 levels of probability, respectively.**
L1 is Low nitrogen fertilization level. L2 is Normal nitrogen fertilization level.
Comb. is combined.

These findings are in agreement with those reported by EL-Shami *et al*. (1996) reflecting the response of grain yield / plant to the tried N environments.

Highly significant interaction between N-levels and both of genotypes and F_1 crosses for grain yield / plant revealed that genotypes behaved differently from one nitrogen level to another. Also, Abd EL-Moneim (1999)demonstrated significant interaction between genotype×nitrogen fertilization levels regarding grain yield / plant.

Mean square of parents × N - levels was insignificant, suggesting that the parental materials were not affected by nitrogen levels. Similar findings was reported by EL-Sayed (1997). The mean performance given in (Table 3) showed that the parental cultivar $P_{2,}$ P_9 and the P_7 and F_1 crosses (P_3 × P_8), (P_7 × P_{10}), (P_8 × P_{10}), (P_9 × P_{10}), (P_8 × P_9) and (P_6 x P_{10}) gave the highest mean values of grain yield / plant at low and normal nitrogen levels as well as their combined, suggesting that these genotypes could be considered as promising ones for high grain yield productivity.

B- Heterosis

Heterosis may be defined as the amount by which the mean of an F_1 hybrid exceeds its high performing parent. For example, heterosis for a character such as yield usually implies that the F_1 has greater yield than its better yielding parent. Heterosis in wheat has not been exploited yet, although several investigators detected significant heterosis in most F_1 crosses for yield and it's contributing characters and may produce transgressive segregantes which could be selected to release new recombinant lines characterized by high yielding ability.

1- Number of spikes / plant:

It is obvious from the results given in (Table 4) that the magnitude of heterobeltiosis for number of spikes / plant differed from one nitrogen level to another. Only one cross (P_2 × P_3) out of the forty five wheat crosses under study exhibited positive and significant heterobeltiosis over its superior parent. This result holds true at normal N-fertilization level and the combined data and considered to be promising for practical breeding programs. Meanwhile, the wheat cross (P_5 ×P_6) exhibited negative and highly significant heterobeltiosis amounted -0.39, -31.28 and -31.13% under the two N levels and the combined data respectively. Moreover, the wheat cross (P_3 × P_5) attained positive and significant useful heterosis only at low nitrogen level. The obtained results are partially in accordance with those reported by Singh (2003) who found a significant useful heterosis for number of spikes / plant.

2- Number of kernels / spike:

The values of useful heterosis for number of kernels / spike varied form one nitrogen fertilization level to another. The results revealed that nine wheat crosses (P_3 × P_4), (P_3 × P_8), (P_4 × P_5), (P_4 × P_7), (P_4 × P_8), (P_4 × P_{10}), (P_5 × P_7), (P_6 × P_7) and (P_8 × P_{10}) were superior in their number of kernels / spike under the two N levels and the combined data, and could be considered as promising ones for wheat breeding programs aiming to improve number of kernels / spike. These results indicating accumulation of increasing alleles adding to increase number of kernels /spike. Similar results were found by Qaisar *et al*. (2005) and Koumber *et al*. (2006).

3- 100- kernel weight:

The amounts of heterosis for 100 - kernel weight were fluctuated from one nitrogen level to another (Table 4).The wheat cross (P_4×P_6) exhibited positive and significant heterobeltiosis amounted 9.09 and 8.26% under normal nitrogen fertilization level as well as the combined, respectively.

The two wheat crosses (P_3 × P_{10}) and (P_8 × P_9) showed positive and significant useful heterosis under low nitrogen fertilization level.

Furthermore, the results indicated that one wheat cross (P_3 × P_4) was superior in 100- kernel weight under the two levels and the combined and could be used in practical breeding programs aiming to improve 100- kernel weight. These results revealing accumulation of dominant alleles which increasing 100- kernel weight. In this connection, El- Sayed (1997), Hamada *et al*. (1997), Qaisar *et al*. (2005) and Koumber *et al*. (2006) found positive and significant useful heterosis for 100- kernel weight.

4- Grain yield / plant

It is evident from the data presented in (Table 4) that heterosis for grain yield / plant varied from one nitrogen level to another. At low nitrogen fertilization level, ten wheat crosses exhibited positive and highly significant heterobeltiosis and varied from 16.11% in the combination (P_8 × P_{10}) to 52.20% in the cross (P_8 × P_9). However, at normal nitrogen level, nine combinations showed negative and highly significantly inferior than their corresponding better parents, with negative heterotic effect of -24.15 and -31.60% in the crosses (P_2 × P_5) and (P_2 × P_6) respectively. Similar results were found by Ijaz *et al*. (2002), Qaisar *et al*. (2005) and Koumber *et al*. (2006) who reported significant heterobeltiosis for grain yield / plant.

C- Combining ability:

Estimating combining ability helps the breeder in selecting desirable parents for making well planned crosses with maximum potential of gene exploitation. The present study was performed to assess general and specific combining ability at each nitrogen level separately and the pooled data over two nitrogen levels as well as the interaction between both types of general (GCA) and specific (SCA) combining ability with nitrogen levels (Table 5).

1- Number of spikes / plant;

Mean squares of GCA and SCA were found to be highly significant under the two nitrogen levels and the combined data, suggesting the importance of both additive and non- additive gene effects in the inheritance of number of spikes / plant with the predominance of additive gene effects as indicated by GCA/ SCA ratio which was more than unity, consequently, phenotypic selection procedure would be very successful for improving this character. The obtained results are in agreement with those reported by Borghi and Perenzin (1994), Hendawy (1994), El-Hennawy (1996), Hendawy (1997), Patil *et al*. (1997), Khalifa *et al*. (1998), El - Hosary *et al*. (2000) ,Singh *et al* (2002) and Hamada (2003). The insignificancy of GCA under different nitrogen levels for number of spikes / plant, reverted stability of both types of gene effects over nitrogen level (Table 6). The cross combination, (P_6 × P_7) and (P9 × P10) showed positive and significant SCA effects under low and normal nitrogen fertilization levels and the combined. (Table 7),

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Table (7): Estimation of specific combining ability effects for yield and its components under two nitrogen fertilization levels and their combined data.

Genotypes	Number of spikes / plant			Number of kernels / spike			100 –kernel weight			Grain yield / plant		
	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.
P1 x P2	0.22	0.06	0.14	-2.43	1.53	-0.45	-0.26	0.36**	0.05	-1.05	0.97	-0.04
P1 x P3	-0.37	-0.02	-0.19	-2.68	-2.77	-2.73	-0.20	0.19	-0.01	-1.86*	-1.35	-1.60
P 1x P4	0.24	0.14	0.19	2.14	2.03	2.09	0.32*	0.09	0.20	2.51**	3.53**	3.02**
P1 x P5	0.29	-0.01	0.14	2.71	1.86	2.29	0.28	0.32*	0.30*	1.19	3.04*	2.12*
P 1x P6	-0.67*	0.08	-0.30	-7.83**	-7.71**	-7.77**	0.01	0.00	0.01	1.60*	0.03	0.81
P1 x P7	-0.40	0.13	-0.14	-7.59**	-7.75**	-7.67**	-0.21	-0.07	-0.14	-0.37	-3.94**	-2.15*
P 1x P8	0.09	0.44	0.27	0.78	-0.17	0.30	-0.04	-0.05	-0.04	1.03	-0.62	0.21
P1 x P9	-0.81**	-0.35	-0.58*	0.80	-1.15	-0.17	-0.02	-0.20	-0.11	-0.60	-2.05	-1.33
P 1x P10	0.19	0.02	0.10	1.19	2.36	1.78	0.18	0.00	0.09	-1.09	0.62	-0.24
P 2x P3	0.79**	0.59	0.69*	7.86**	5.84**	6.85**	-0.10	0.14	0.02	-0.96	1.79	0.41
P 2x P4	-0.55*	0.27	-0.14	-7.17**	-2.09	-4.63**	0.09	-0.06	0.01	0.67	-0.17	0.25
P 2x P5	0.05	0.27	0.16	-7.90**	-5.26**	-6.58**	-0.28	-0.07	-0.18	-1.09	-2.53*	-1.81
P 2x P6	0.32	-0.12	0.10	-1.55	-1.16	-1.35	0.18	0.17	0.18	-0.58	-4.44**	-2.51*
P 2x P7	0.62*	-0.34	0.14	-1.59	-4.12**	-2.85	0.37*	-0.13	0.12	0.44	-1.32	-0.44
P 2x P8	0.45	-0.06	0.20	2.45	-0.71	0.87	-0.25	-0.22	-0.24	-0.23	-0.76	-0.49
P 2x P9	0.17	0.70*	0.43	1.15	0.63	0.89	0.34*	-0.49**	-0.07	-1.17	-0.44	-0.81
P2 x P10	-0.45	0.25	-0.10	2.99*	-0.70	1.15	0.09	0.24	0.17	0.16	-0.43	-0.14
P3 x P4	-1.10**	0.39	-0.35	1.97	1.04	1.51	0.19	0.15	0.17	-1.52*	0.92	-0.30
P 3x P5	1.17**	0.15	0.66*	-8.35**	-5.05**	-6.70**	0.03	0.04	0.03	0.63	-4.20**	-1.78
P 3x P6	0.13	0.39	0.26	-1.66	-1.35	-1.50	-0.25	0.23	-0.01	1.79*	2.18	1.99*
P 3x P7	-0.25	0.24	0.00	5.40**	2.83*	4.11**	0.16	-0.20	-0.02	-1.81*	-3.30	-2.56
P 3x P8	0.32	0.12	0.22	6.87**	6.40**	6.64**	-0.03	0.21	0.09	5.07**	2.07	3.57**
P 3x P9	0.23	-0.02	0.11	1.51	1.83	1.67	0.16	0.25*	0.20	1.32	1.06	1.19
P3 x P10	0.09	-1.03**	-0.47	-0.14	-0.37	-0.26	0.66**	-0.12	0.27*	-2.18**	-1.22	-1.70
P4 x P5	0.76**	0.61	0.68*	9.10**	8.30**	8.70**	0.17	0.04	0.10	-3.46**	1.40	-1.03
P 4x P6	-0.32	0.02	-0.15	1.05	1.91	1.48	0.34*	0.22	0.28*	-2.70**	-4.05**	-3.38**
P 4x P7	-1.12**	-0.01	-0.56	9.12**	7.08**	8.10**	0.27	0.19	0.23	0.68	0.68	0.68
P 4x P8	-0.51	0.11	-0.20	1.60	2.51	2.05	-0.23	0.05	-0.09	-1.41	-0.47	-0.94
P 4x P9	0.61*	-0.46	0.07	-2.16	0.07	-1.04	0.04	0.17	0.10	-0.61	-2.52*	-1.56
P 4x P10	0.19	-0.64*	-0.22	0.22	0.84	0.53	-0.36*	0.14	-0.11	1.70*	-0.09	0.81
P 5x P6	-1.37**	-1.06**	-1.22**	-4.84**	-6.18**	-5.51**	0.00	-0.14	-0.07	1.64*	1.62	1.63
P 5x P7	-0.23	-0.99**	-0.61*	3.27*	5.52**	4.40**	-0.01	0.13	0.06	-0.34	1.18	0.42
P 5x P8	-0.48	-0.24	-0.36	-0.69	-4.22**	-2.46	0.27	0.24	0.26	-0.87	2.68*	0.91
P 5x P9	-0.86*	-0.43	-0.64*	4.08**	4.76**	4.42**	-0.14	-0.11	-0.13	-2.58**	-2.25	-2.42
P5 x P10	0.18	-0.37	-0.10	3.21*	5.63**	4.42**	-0.16	-0.29*	-0.23	0.81	1.06	0.94
P6 x P7	0.72**	0.71*	0.71*	5.55**	6.99**	6.27**	-0.12	0.07	-0.02	-1.24	-2.82*	-2.03
P 6x P8	-0.69*	0.80*	0.06	6.55**	2.56	4.55**	0.29	0.03	0.16	-0.13	0.76	0.31
P 6x P9	-0.03	-0.67*	-0.35	-1.09	2.59	0.75	-0.13	-0.01	-0.07	-0.07	3.00*	1.47
P6 x P10	0.02	-0.40	-0.19	2.72	0.78	1.75	-0.22	0.15	-0.03	3.38**	1.41	2.40*
P7 x P8	0.01	0.15	0.08	-1.14	0.27	-0.43	-0.04	0.12	0.04	0.28	-0.08	0.10
P 7x P9	-0.14	-0.87**	-0.51	-1.55	-2.94*	-2.25	-0.19	-0.12	-0.16	2.71**	2.85*	2.78**
P7 x P10	0.06	0.54	0.30	1.02	-2.77	-0.87	-0.23	0.01	-0.11	3.01**	3.38**	3.20**
P 8x P9	0.22	-0.62	-0.20	2.47	1.22	1.85	0.25	-0.08	0.09	4.42**	1.26	2.84**
P8 x P10	0.19	0.04	0.11	3.20*	4.12**	3.66*	0.13	-0.13	0.00	1.24	0.21	0.72
P9 x P10	0.67*	1.44**	1.05**	-0.91	-0.32	-0.61	0.05	0.26*	0.15	0.83	-0.29	0.27
L.S.D(sij)5%	0.54	0.61	0.57	2.98	2.83	2.88	0.29	0.24	0.27	1.47	2.37	1.95
L.S.D(sij)1%	0.71	0.80	0.75	3.92	3.71	3.79	0.39	0.32	0.35	1.94	3.11	2.57
LSD(sij-skl)5%	0.79	0.90	0.84	4.38	4.15	4.23	0.43	4.53	0.39	2.16	3.48	2.87
LSD(sij-skl)1%	1.04	1.18	1.11	5.76	5.46	5.57	0.57	6.002	0.52	2.85	4.57	3.78

*** and ** is Significant at 0.05 and 0.01 levels of probability, respectively.**
L_1 is Low nitrogen fertilization level
L_2 is Normal nitrogen fertilization level
Comb. is combined

2- Number of kernels / spike:

Regarding number of kernels / spike, both GCA and SCA mean squares were highly significant under the two levels of nitrogen fertilization and the combined data, revealing the importance of both additive and non-additive gene effects. Additive effects appeared to be the most important factor contributing for these character. Similar results were reported by Borghi and

Perenzin (1994), El - Hennawy (1996), El- Sayed (1997), Hendawy (1997), Patil *et al.* (1997), Khalifa *et al.* (1998) and El- Hosary *et al.* (2000). Mean squares of interactions between both types of combining ability and nitrogen levels were not significant.

Estimates of GCA effects (gi) are shown in (Table 6). The wheat cultivars P_1, P_4, P_9 and P_{10} proved to be the best combiners, since, both of them having the most increasing alleles for giving more number of kernels / spike under both environments. Meanwhile, the cultivar P_{10} was excellent general combiner for number of kernels / spike, 100-kernel weight, as well as grain yield/plant, thus it could be used for improving grain yield / plant in the breeding program. Positive and highly significant SCA effects were attained for number of kernels / spike in the combinations ($P_2 \times P_3$), ($P_3 \times P_7$), ($P_3 \times P_8$), ($P_4 \times P_5$), ($P_4 \times P_7$), ($P_5 \times P_7$), ($P_5 \times P_9$), ($P_5 \times P_{10}$), ($P_6 \times P_7$), and ($P_8 \times P_{10}$) under different nitrogen levels and the combined analysis. Thus, it could be considered stable crosses under different environments. Meanwhile, the cross ($P_6 \times P_8$) showed positive and significant SCA effects under low and the combined.

3- 100 - kernel weight:

Mean squares of GCA and SCA were found to be highly significant under the two levels of nitrogen fertilization and the combined data (Table 5), revealing the importance of both additive and non-additive gene action in the inheritance of this character. GCA/SCA ratio was greater than unity, indicating prevalence of additive gene action. Similar results have been reported by El - Hennawy (1996), El- Sayed (1997), Hendawy (1997), Khalifa *et al*. (1998), EL-Hosary *et al*. (2000), Singh *et al*. (2002) and Hamada (2003).

The mean squares of interactions between both types of combining ability and nitrogen fertilization levels were highly significant, indicating that the magnitude of both types of gene action were fluctuated from one environment to another. Significant interactions in this respect were reported by Hendawy (1994), El - Sayed (1997) and El-Hosary *et al*. (2000).

Estimates of GCA effects (gi) are given in (Table 6) .The results revealed that the exotic cultivar P_{10} proved to be the best combiner for 100-kernel weight character and have the most favorable additive genes in this respect. This performance was assured under various environments. However, P_8 and P_9 were found to be a good combiner under normal nitrogen level and the combined as well. Positive and significant SCA effects were observed in four crosses ($P_1 \times P_2$), ($P_1 \times P_5$),

($P_3 \times P_9$) and ($P_9 \times P_{10}$) under normal nitrogen level. However, the cross combinations ($P_1 \times P_4$), ($P_2 \times P_7$), ($P_2 \times P_9$), ($P_3 \times P_{10}$) and ($P_4 \times P_6$) had positive and significant SCA effects under low nitrogen level. Moreover, the wheat crosses ($P_1 \times P_5$), ($P_3 \times P_{10}$) and ($P_4 \times P_6$) exhibited also positive and significant SCA effects under the combined data.

4- Grain yield / plant:

The analysis of variance of general (GCA) and specific (SCA) combining abilities for grain yield showed highly significant mean squares for GCA and SCA under the two level of nitrogen fertilization and the pooled data(Table 5), suggesting that both additive and non-additive gene effects were involved in the inheritance of this character.

The estimates of mean squares due to GCA were much higher in magnitude than those of the SCA. (GCA/ SCA ratio >1) showing the preponderance of additive genetic variance in governing grain yield/plant, consequently, phenotypic selection procedure could be very successful in improving shuch trait. The importance of additive gene effects in the inheritance of wheat grain yield have also been reported by several investigators among whome were Borghi and perenzin (1994), El-Hennawy (1996), El -Sayed (1997), Khalifa *et al*.(1998), Singh *et al*. (2002) and Hamada (2003).

The mean squares of interactions between both types of combining ability and nitrogen fertilization levels were highly significant, indicating inconsistency in performance of both types, thus more environments would be required for evaluating the studied materials in respect to general and specific combining ability assessments. Significant interactions in this respect were reported by Hendawy (1994), El- Sayed (1997) and El - Hosary *et al*. (2000).

The results also revealed that the wheat cultivar P_{10} was the best general combiner and possessed more favorable additive genes for increasing grain yield / plant under various environments (Table 6). Moreover, the exotic cultivar P_8 gave a significant GCA value under low and the pooled data while, the wheat cultivar P_9 exhibited positive and significant GCA effects under normal nitrogen level and the pooled data.

Estimates of SCA effects (Table 7) showed that the combinations ($P_1 \times P_4$), ($P_7 \times P_9$) and ($P_7 \times P_{10}$) showed positive and significant SCA effects thus, it could be considered a stable crosses under different environments, and had a great value in practical breeding programs to produce higher yielding genotypes.

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دراسات وراثية على بعض الصفات الاقتصادية في القمح

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أجريت هذه الدراسة في محطة البحوث الزراعية بالجميزة - مركز البحوث الزراعية و ذلك بهدف دراسة كل من قوة الهجين و القدرة العامة والخاصة على التآلف وتفاعلاتها مع مستويين من التسميد الآزوتى. وقد استخدم لتنفيذ هذه الدراسة عشرة أصناف من قمح الخبز متباينة في صفاتها المورفوفسيولوجية والمحصولية ، أربع منها محلية هي جميزة 7 ، جيزة 168 ،سدس1وجميزة 10 ، وست سلالات من المستوردات وأجرى التهجين بينها في الموسم الزراعي 2005 / 2006م ، وفى موسم 2006 / 2007 م تم تقييم هذه الأصناف و السلالات بالإضافة إلى جميع الهجن الممكنة الناتجة عنها في تجربتين مستقلتين ، التجربة الأولى منها تحت مستوى تسميد آزوتى منخفض (30كجم ن / ف) و الثانية تحت مستوى تسميد آزوتى عادى (70كجم ن / ف) وقد نفذت كل تجربة على حدة في تصميم قطاعات كاملة العشوائية في ثلاث مكررات وذلك لدراسة الصفات التالية :-

1- عدد السنابل / نبات.
2- عدد الحبوب / السنبلة.
3- وزن ال-100 حبة (جم) .
4- محصول حبوب النبات الفردي (جم).

وقد تم تحليل البيانات إحصائيا بواسطة طريقة (جرفنج 1956) الطريقة الثانية الموديل الأول.

ويمكن تخليص أهم النتائج المتحصل عليها فيما يلي :

أ- متوسط السلوك:

1- أشارت النتائج أن أفضل الآباء والهجن للمحصول ومكوناته تحت مستويي التسميد الآزوتى والتحليل المشترك هي الأب 1 ، الأب 2 ، الأب 4 ، الأب 5 ، الأب 7 ، الأب 8 ،الأب 9 والأب 10 وكذلك الهجن الداخلة فيها (1 × 4) ، (1 × 5) ،(1 × 10) ،(4 × 7) ،(4 × 9) ، (4 × 10) ، (5 × 8) ، (7 × 10) ، (8 × 9)،(8 × 10) و (9 × 10) .

ب- قـــوة الهجـــين:

1- أظهرت نتائج الدراسة وجود قوة هجين موجبة وعالية المعنوية في بعض الهجن لصفات المحصول ومكوناته ،وكانت أفضل الهجن هي (2× 3) لصفة عدد السنابل / نبات ، (3 × 4) ، (3 × 8) ، (4 × 5) ، (4 × 7) ، (4 × 8) ، (4 × 10) ، (5 × 7) ، (6 × 7) و (8 × 10) لصفة عدد حبوب السنبلة ؛ (3 × 4) لصفة وزن أل 100 حبه، والهجن ،(3 × 8) ، (6 × 8) ، (6 × 10)، (7 × 9) ، (7 × 10) ، (8 × 9) و (8 × 10) ، لصـــــــفة محصول حبوب النبات الفردي و ذلك تحت مستويي التسميد النيتروجين و التحليل التجميعي للبيانات.

جـ- القدرة العامة و الخاصة على الائتلاف وتفاعلاتها مع مستويات التسميد الآزوتى :

1- أشارت النتائج إلى تميز الصنف سدس 1 بقدرة ائتلافيه عامة ومعنوية لصفة عدد السنابل / نبات تحت معظم مستويات التسميد الآزوتى والتحليل المشترك ، بينما كانت الآباء 1، 4، 9و 10 أكثر قدرة عامة على التآلف لصفة عدد حبوب /السنبلة بينما كان الأب 10 له قدرة عامة و عالية على التآلف لصفتي وزن المائة حبه و محصول النبات الفردي.

2- أظهرت النتائج أن أعلى قيم للتأثيرات الراجعة للقدرة الخاصة على الائتلاف كانت في الهجن (6 × 7) و (9 × 10) لصفة عدد السنابل / النبات، والهجن (2 × 3)، (3 × 7)، (3 × 8)، (4 × 5)، (4 × 7)، (5 × 7)، (5 × 9)، (5 × 10)، (6 × 7) (6 × 8) و (8 × 10)لصفة عدد الحبوب /السنبلة، بينما كانت الهجن (1 × 4)، (7 × 9) و (7 × 10) أفضل الهجن المبشرة لصفة محصول حبوب النبات الفردي تحت مستويات التسميد المختلفة والتحليل المشترك بينهم.

قام بتحكيم البحث

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Table (2): Mean squares of ANOVA for yield and its components under two nitrogen fertilization levels and their combined data.

Source	d.F	d.F comb	Number spikes / plant			Number of kernels / spike			100- kernel weight			Grain yield / plant		
			Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.
Nitrogen level	-	1	-	-	236.10*	-	-	13919.89*	-	-	13.71*	-	-	5722.34*
Rep. / N. level	2	4	1.03*	3.21**	2.12**	0.86	9.56	5.21	0.11	0.09	0.10	0.70	10.11	5.40
Genotype	54	54	1.50**	0.98**	1.38**	131.48**	135.44**	257.55**	0.21**	0.23**	0.31**	19.77**	19.14**	29.62**
Parents	9	9	1.42**	1.06**	1.43**	184.07**	194.99**	369.21**	0.20*	0.43**	0.55**	10.38**	13.38**	14.22**
Crosses	44	44	1.53**	0.99**	1.39**	116.35**	121.23**	228.20**	0.19**	0.17**	0.23**	21.43**	20.73**	33.20**
PVs F1	1	1	0.70	0.00	0.40	324.01**	224.93**	544.44*	0.73**	1.06**	1.77*	31.06**	0.97	10.54
Genotype x N	-	54	-	-	1.11**	-	-	9.37	-	-	0.13**	-	-	9.28**
Parents. x N	-	9	-	-	1.05**	-	-	9.86	-	-	0.08	-	-	9.55**
Crosses. x N	-	44	-	-	1.13**	-	-	9.38	-	-	0.14**	-	-	8.95**
Par.vs.cr.vs.N	-	1	-	-	0.31	-	-	4.51	-	-	0.01	-	-	21.49*
Error	108	216	0.26	0.34	0.30	8.11	7.27	7.69	0.08	0.05	0.07	1.98	5.10	3.54

***and ** is Significant at 0.05 and 0.01 levels of probability, respectively.**
L1 is Low nitrogen fertilization level. **L2 is Normal nitrogen fertilization level.**
Comb. is combined.

Table (4): Heterosis as percentage of high performing parent "heterobeltiosis" for yield and its components in ten -parent diallel cross of bread wheat.

Genotypes	Number of spikes /plant			Number of kernels /spike			100 - grain weight			Grain yield/plant		
	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level2	Comb.	Level 1	Level 2	Comb.
P1 x P2	-3.40	3.23	0.53	-17.47**	-8.08**	-12.23**	-8.91	7.12	-0.63	-15.33*	-8.73	-11.31
P1 x P3	-12.50	2.79	-1.59	-18.06**	-15.85**	-16.83**	-4.78	5.09	0.42	-10.83	-8.49	-7.90
P 1x P4	-17.44	0.29	-1.77	-5.34	-4.50	-4.87	8.47	6.31	7.36	2.41	9.97	6.84
P1 x P5	-10.53	-11.87	-11.34	16.19**	-14.94**	-15.49**	6.39	9.18*	7.83	2.67	8.65	6.71
P 1x P6	-37.47**	-2.35	-14.94**	-36.62**	-31.68**	-33.87**	-0.21	6.46	3.32	12.51	-4.12	2.39
P1 x P7	-26.43**	1.17	-10.45	-31.78**	-27.76**	-29.54**	-6.93	-0.96	-3.76	2.94	-21.94**	-11.56
P 1x P8	-13.22	2.94	2.14	-12.25**	-11.85**	-13.54**	1.29	-0.94	0.20	*17.23	1.21	7.47
P1 x P9	-28.95**	-9.40	-17.86*	-4.38	-7.97**	-6.38	1.28	-7.81*	-3.74	0.18	-12.09	-4.37
P 1x P10	-5.62	0.88	-1.32	-6.79	-5.01	-5.79	2.26	0.95	1.58	-1.60	5.70	2.54
P 2x P3	17.16	*14.28	*15.39	8.89*	2.07	5.06	1.65	3.89	3.41	-13.46*	-9.07	-10.80
P 2x P4	-28.10**	12.60	-6.03	-14.71**	-4.38	-8.91*	6.27	3.03	5.42	-7.72	-11.05	-9.12
P 2x P5	-10.72	-9.19	-9.81	-29.29**	-20.20**	-24.18**	-9.80*	-4.79	-7.21	-22.34**	-24.15**	-23.42**
P 2x P6	-16.80*	2.24	-7.06	-19.91**	-18.22**	-18.97**	-0.63	3.63	1.65	-14.11*	-31.60**	-24.72**
P 2x P7	-3.77	-5.38	-4.57	-15.05**	-18.28**	-16.87**	1.02	-8.28*	-3.76	-6.46	-14.48*	-11.31
P 2x P8	-1.55	5.59	5.90	-1.50	-7.09*	-4.64	-7.35	-10.16**	-8.87*	-5.07	-11.88	-9.20
P 2x P9	-5.40	4.41	0.16	-2.02	0.56	0.06	4.93	-18.72**	-7.87*	-16.24**	-7.62	-11.01
P2 x P10	-13.13	4.31	-3.32	4.81	-3.37	0.21	-3.50	-0.38	-1.78	4.33	-8.52	-2.01
P3 x P4	-29.45**	7.14	-5.48	15.66**	14.37**	14.94**	11.62*	10.76**	11.31*	-17.39**	-3.16	-9.06
P 3x P5	*19.92	-10.21	1.84	-16.55**	-8.36*	-11.90**	-0.42	-0.99	-0.82	-3.82	-21.23**	-14.10
P 3x P6	-11.93	5.31	-0.16	-4.53	-6.73	-5.78	-6.96	6.06	-0.20	8.86	3.60	5.76
P 3x P7	-10.79	4.03	-2.61	17.46**	5.61	10.75*	-0.61	-8.28*	-4.56	-9.67	-22.92**	-14.87
P 3x P8	5.25	1.06	**6.54	27.84**	19.02**	22.85**	0.43	-0.75	-0.20	**35.63	11.24	**21.24
P 3x P9	5.01	-5.12	-0.81	-1.56	1.51	0.09	3.86	-4.00	-0.39	7.24	-4.46	5.70-
P3 x P10	6.003	-13.98	-5.14	8.06	2.50	4.93	11.13*	-5.91	2.38	-5.94	-4.89	-5.31
P4 x P5	2.87	-8.42	-3.83	21.71**	20.08**	20.82**	4.69	1.79	3.25	-35.68**	-1.48	-15.64*
P 4x P6	-27.56**	0.00	-13.46	1.37	4.27	3.004	7.38	9.09*	8.26*	-26.27**	-22.67**	-24.14**
P 4x P7	-35.07**	-4.48	-18.30*	24.29**	18.25**	20.95**	3.46	2.31	2.97	-6.35	-4.07	-1.61
P 4x P8	-20.73*	3.27	-7.63	14.73**	17.51**	16.28**	-1.94	-0.94	-1.41	-12.45*	-1.89	-6.27
P 4x P9	2.89	-15.95*	-8.03	-3.41	4.21	0.71	-10.30	-2.72	0.03	-14.29	-12.09	-9.50*
P 4x P10	-1.12	-12.94	-7.80	14.30**	10.12**	11.93**	-8.24	1.90	-2.97	*12.75	1.97	7.23
P 5x P6	-0.39**	-31.28**	-31.13**	-14.75*	-12.21**	-13.34**	0.84	0.99	0.01	3.94	2.92	7.72
P 5x P7	-12.76	-27.96**	-19.63**	11.77*	15.38**	14.35**	-1.42	1.54	0.19	-5.65	-7.26	-4.94
P 5x P8	-14.36	-20.94**	-18.25**	9.57	-4.48	3.76	7.88	3.38	6.25	-3.21	13.95	12.52
P 5x P9	-19.15*	-21.32**	-20.39**	-4.64	-0.04	-2.14	-0.63	-7.27*	-3.93	-20.53**	-16.10*	-14.50**
P5 x P10	5.25	-18.90**	-8.28	6.10	5.78	5.91	-3.50	-5.72	-4.56	1.65	3.74	2.85
P6 x P7	-2.18	4.48	4.57	19.79**	12.88**	17.94**	-3.46	2.50	-0.39	0.32	-22.19**	-14.24*
P 6x P8	-27.89**	10.43	-8.37	30.43**	2.64	14.18**	7.38	1.31	5.64	**20.88	5.15	11.50
P 6x P9	-14.95	-20.65**	-12.78**	-16.39**	-7.42*	-11.52**	-1.05	-3.45	-1.55	12.67	1.35	5.20
P6 x P10	8.06	-11.16	-6.23	2.10	-6.37	-2.69	-4.32	4.96	0.59	**20.24	4.16	10.98
P7 x P8	-8.63	-4.03	-6.20	17.93**	3.77	9.48*	-1.83	1.88	1.38	*18.56	-5.51	2.99
P 7x P9	-9.17	-20.94**	-13.39*	-12.58**	-11.33**	-11.91**	-4.48	-6.54	-3.54	**26.76	7.18	*14.60
P7 x P10	0.89	5.50	3.75	3.98	-7.37*	-2.46	-4.48	0.95	-1.19	**20.40	8.91	*19.38
P 8x P9	2.12	-20.08**	-10.81	0.05	1.10	0.61	9.01	-4.00	1.96	**52.20	2.26	**19.19
P8 x P10	5.25	-4.91	-0.24	4.79**	10.23**	12.26**	2.88*	-0.94	1.58	**16.11	7.23	10.98
P9 x P10	*16.51	13.24	*16.06	-0.99	9.26	0.93	1.64	2.00	3.74	8.006	-0.87	8.43
L S D5%	0.82	0.94	0.87	4.60	4.35	4.43	0.42	0.36	0.39	2.26	3.65	3.01
L S D1%	1.08	1.24	1.15	6.08	5.76	5.82	0.56	0.47	0.51	2.99	4.82	3.95

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

L1 is Low nitrogen fertilization level **L2 is Normal nitrogen fertilization level.**

Comb. is combined.

Table (5): Mean squares of general (gca) and specific combining ability (sca) and their interactions with nitrogen levels for yield and its components.

Genotypes	df	df comb	Number of spikes / plant			Number of kernels / spike			100- kernel weight			Grain yield / plant		
			Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.
G .C.A	9	9	1.11**	0.37**	0.58**	130.38**	166.15**	292.39**	0.12**	0.22**	0.32**	16.05**	12.35**	22.51**
S .C.A	45	45	0.38**	0.32**	0.44**	26.52**	20.95**	44.54**`	0.06**	0.05**	0.06**	4.70**	5.18**	7.35**
G.C.A x N	-	9	-	-	0.91**	-	-	4.14	-	-	0.03	-	-	5.89**
S.C.A x N	-	45	-	-	0.26**	-	-	2.92	-	-	0.05**	-	-	2.54**
Error	108	216	0.09	0.11	0.10	2.70	2.42	2.56	0.03	0.02	0.02	0.66	1.70	1.18
G.C.A / S.C.A	-	-	2.95	1.17	1.32	4.92	7.93	6.56	2.04	4.59	5.20	3.42	2.38	3.06
G.C.A x N/ S.C.A	-	-	-	-	1.58	-	-	0.01	-	-	0.08	-	-	0.26
S.C.A x N/G.C. A	-	-	-	-	0.60	-	-	0.07	-	-	0.76	-	-	0.35

***and ** is Significant at 0.05 and 0.01 levels of probability, respectively.**
L1 is Low nitrogen fertilization level. L2 is Normal nitrogen fertilization level.
Comb. is combined.

Table (6): Estimation of general combining ability effects for the parental cultivars under two nitrogen fertilization levels and their combined data for yield and its components.

Genotypes	Number of spikes / plant			Number of kernels / spike			100-kernel weight			Grain yield / plant		
	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.	Level 1	Level 2	Comb.
P1	-0.54**	0.24*	-0.15	1.62**	2.93**	2.28**	-0.04	0.05	0.00	-0.30	-0.19	-0.24
P2	-0.30**	0.16	-0.07	0.28	1.33**	0.80	-0.23**	-0.27**	-0.25**	-0.39	-0.36	-0.38
P3	0.17*	0.21*	0.19*	0.18	-0.09	0.04	-0.10*	-0.20**	-0.15**	-0.04	-1.11**	-0.58
P4	-0.31	-0.12	-0.22*	2.80**	3.47**	3.13**	0.00	-0.04	-0.02	-0.31	0.28	-0.01
P5	0.05	0.11	0.08	-4.12**	-4.05**	-4.09**	0.03	-0.02	0.00	-1.58**	-1.13**	-1.35**
P6	0.06	-0.23	-0.09	-5.55**	-6.81**	-6.18**	0.04	0.09*	0.07	-0.54*	-1.38**	-0.96**
P7	0.16*	-0.05	0.05	-2.95**	-3.89**	-3.42**	0.09*	0.03	0.06	-0.14	0.44	0.15
P8	0.04	-0.25**	-0.11	0.12	0.25	0.19	0.04	0.13**	0.09*	0.80**	0.63	0.71*
P9	0.16*	-0.09	0.03	4.71**	4.09**	4.40**	0.06	0.10**	0.08*	-0.35	1.54**	0.59*
P10	0.51**	0.04	0.27**	2.91*	2.76**	2.84**	0.10*	0.12**	0.11**	2.85**	1.28**	2.07**
L.S.D(gi)5%	0.16	0.18	0.17	0.89	0.84	0.86	0.09	0.07	0.08	0.44	0.70	0.58
L.S.D(gi) 1%	0.21	0.24	0.22	1.17	1.10	1.13	0.11	0.10	0.10	0.58	0.93	0.76
L.S.D (gi - gi)5%	0.24	0.27	0.25	1.32	1.25	1.28	0.13	0.11	0.12	0.65	1.05	0.87
L.S.D (gi - gi)1%	0.31	0.36	0.33	1.74	1.65	1.68	0.17	0.14	0.16	0.86	1.38	1.14

***and ** is Significant at 0.05 and 0.01 levels of probability, respectively.**
L1 is Low nitrogen fertilization level. L2 is Normal nitrogen fertilization level.
Comb. is combined.