

Useful Heterosis Estimates under Different Nitrogen Fertilizer Levels in Half Diallel Crosses of Wheat

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ABSTRACT

The breeding materials used herein included eight genotypes of wheat *i.e.*, CHAM-6/MayoN's, LAKTA-1, MELLAL-1, NABEK-4, Gemmeiza 7, Gemmeiza 9, Gemmeiza 10 and Sakha 94. These genotypes were crossed in half diallel mating system in 2003/04 season at the experimental farm of Gemmeiza Agriculture Research Station, Egypt. The parental genotypes and their crosses were evaluated in 2004/05 season under three nitrogen fertilizer levels *i.e.*, 25, 50 and 75 kg N/fad. The reduction in yield and its components under the lowest N level relative to the highest one ranged from 16% to 25%, while the present materials were earlier under the lowest N level relative to the highest one by 13.75% and 4.73% for heading and maturity date, respectively. This would revealed the possibility to minimize the losses of yield and maximize the earliness of the present materials by suitable breeding program under the lowest N level which consider as one of the ways to safe the environment from the pollution. The significant mean squares of genotypes, parents and crosses, where its magnitudes were several times larger than their corresponding mean square of error, indicating the successful of the planned crosses due to the presence of sufficient variability. Parents vs crosses mean squares were found to be highly significant for all studied traits at all nitrogen fertilizer levels and their combined data. The interaction of parents vs crosses. N fertilizer levels was found to be significant for most traits, indicating that average heterosis overall crosses changed from environment to another. The range of mid-parental heterosis was -0.58% to -1.84% under 25 kg N/fad., -0.52% to -2.38% under 50 kg N/fad. and 0.00 to -1.15 under 75 kg N/fad. for earliness attributes. For yield, the range of mid- parental heterosis was 2.76% to 27.71% under 25 kg N/fad., 2.25 % to 23.34% under 50 kg N/fad. and 2.34 % to 32.60 % under 75 kg N/fad. However, in most cases the mid-parental heterosis were due to over-dominance as the potency ratios pointed out. On the other hand, the range of better parental heterosis (useful heterosis) was 2.31 to 26.75% under 25 kg N/fad., 2.72 to 22.86% under 50 kg N/fad. and 2.37 to 25.53 % under 75 kg N/fad. This would indicate that comparable useful heterosis was detected under the lowest level of N (25 kg) which considered as a favorable environment which had low level of pollution in comparison with the other N levels. However, it could be concluded also that the cross- combinations; LAKTA-1 x Sakha 94 and METLLAL-1 x Gemmeiza 10 could be used in breeding programs with low level of N fertilization according to their mean performance and the results of heterosis for most studied traits. The estimates of narrow-sense heritability confirmed the above results.

Keywords: Breeding, diallel mating system, fertilization, genotypes, heritability, heterosis, nitrogen levels, wheat.

INTRODUCTION

Wheat (*Triticum aestivum vulgar L.*) is one of the most important major cereal crop overall the world. Wheat breeding program played the major role in the developing new high yielding varieties. Increasing wheat production as a national goal could be achieved through increasing the production per unit area. On the other hand, the safe of environment from the pollution became included in the notebook of the breeders. In Egypt, the total cultivation area of wheat was about 3.000 million faddan (1faddan =0.42 hectar) yielded about 8.185 million ton, with an average yield of about 2.728 ton/fad. (season 2004/05). This amount is not enough, but need about 4 million ton or more to cover all needs, which imported from abroad.

Evaluation of the performance of a genotype under different nitrogen levels as environment to chose the genotype which yielded well under the lowest level of nitrogen became one of the main goal of the breeder for many purposes, the more important one is the safe of the

environment from the pollution which negatively affect the human health. So, it is important to more fully understand the nature of genotype x nitrogen interaction to make testing and selection of genotypes which achieve that purpose.

Heterosis is a complex genetical phenomenon, which depends on the balance of different combinations of gene effects as well as on the distribution of plus and minus alleles in the parents of a mating. Heritability values especially that in narrow-sense make it possible to plan the suitable breeding program and the type of selection in the segregating generations. However, the objective of the present study is establish (i) the performance of eight genotypes of wheat and their half-diallel crosses under three different nitrogen levels, (ii) the comparison between these genotypes and chose that, relatively high yielding potentiality under the lowest N level and (iii) potentiality of heterosis expression as well as narrow-sense heritability for yield and its components.

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MATERIALS AND METHODS

This study was carried out at the experimental farm of Gemmeiza Agricultural Research Station, Agricultural Research Center, Egypt during the two successive seasons 2003/04 and 2004/05. Eight parental genotypes of wheat i.e., CHAM-6/MayoN's, LAKATA-1, MELLAL-1, NABEK-4, Gemmeiza 7, Gemmeiza 9, Gemmeiza 10 and Sakha 94 which represented a wide range of variability in most studied traits were crossed in half-diallel mating system in 2003/04 season. The parental genotypes and their twenty-eight crosses were evaluated in 2004/05 season under three nitrogen fertilization levels, *i.e.*, 25, 50 and 75 Kg N/fad., each in a separate experiment, where the RCB design with three replications was used. The experimental plot consisted of three rows, 3 meters long with 30 cm between rows, plants within rows were 10 cm apart allowing a total of 30 plants/row in order to minimize border effects. The middle row was sown by the cross while the outer two rows sown by the two parents, one row for each. Adjacent plots were spaced by 60 cm. Heading and maturity dates were recorded on an individual plant basis. Ten gaurded plants at maturity were selected at random from each row to measured: spike length, no. of spikes/plant, no. of kernels/spike, 1000-kernel weight and grain yield/plant.

The data were analyzed on the mean of ten individual plants chosen at random. An ordinary analysis of variance was firstly performed for each experiment separately for the diallel cross set including parents. The effects of both blocks and genotypes were assumed to be fixed. Combined analysis of the three N fertilizer experiments was carried out wherever homogeneity of variance was detected for the studied traits using Bartlett test outlined by Snedecor and Cochran, 1982.

Heterosis was determined for individual cross as the percentage deviation of F_1 mean performance from either mid-parents (MP) value or the better parent mean (BP) for each level of nitrogen as well as the combined data. The estimates of potency ratio as well as heritability in narrow-sense were calculated according to Mather and Jinks (1971).

Table (1): The names, pedigree and origin of the parental genotypes.

No.	Names and Pedigree	Origin
1	CHAM-6/MayoN's	CIMMYT
2	LAKTA-1	CIMMYT
3	MELLAL-1	ICARDA
4	NABEK-4	ICARDA
5	Gemmeiza 7=CMH 74A.630/SX/SERL 82/AGENT CGM 4611-2GM-3GM-1GM-0GM.	Egypt
6	Gemmeiza9=Ald"S"/Huac//CMH74.A.630/SXC GM 4583- 5GM - 1GM-0GM	Egypt
7	Gemmeiza10=MAYA74"S"/on//1160/47/3/BB/ GLL4/CHAT"S"/5/CROW"S"CGM4611- 2GM- 0GM.	Egypt
8	Sakha 94=Opata / Rayon/Kauz CMBW 90Y3180OTOPM-/Egypt/3Y-010M-10M010Y- 6M-OS	Egypt

RESULTS AND DISCUSSION

Mean performance

The mean performance of eight parental genotypes and their 28 crosses of wheat at three nitrogen levels as well as combined data are presented in Tables (2-5). Gemmeiza 7 and Sakha 94 were the earliest genotypes as the data of heading and maturity pointed out, especially at the lowest N level. On the other hand, the crosses; LAKTA-1 x Sakha 94 and Gemmeiza 7 x Sakha 94 were the earliest ones at the lowest level of N. The earliness of these crosses could be attributed to the earliness of Gemmeiza 7, Sakha 94 which may possessed the genes controlling earliness. Gemmeiza 7 had the longest spike, the highest no. of kernels/spike, the highest weight of 1000 kernels. The crosses; MEUAL-1 x Gemmeiza 10, Gemmeiza 7 x Gemmeiza 9 and Gemmeiza 9 x Sakha 94 ranked the first for spike length, no. of kernels/spike, 1000-kernels weight and grain yield /plant under the three N fertilizer levels as well as the combined data.

However, the increasing of N fertilizer rates might be raised the rate of cell elongation and cell division which resulted in long spike, it might also increase the tiller formation and this might be because its favorable on enhancing spike paranoia formation.

Table (2): Mean performances of eight wheat genotypes and their F_1 crosses for heading date and maturity date studied at three nitrogen levels as well as combined data.

Genotypes	Heading date day				Maturity date, day			
	25 kg/fed	50 kg/fed	75 kg/fed	Comb.	25 kg/fed	50 kg/fed	75 kg/fed	Comb.
CHAM-6 / MayoN's (P_1)	94.333	99.333	104.667	99.444	149.333	152.333	156.667	152.778
LAKTA-1 (P_2)	93.667	101.667	106.333	100.556	146.333	149.333	151.667	149.111
MELLAL-1 (P_3)	93.333	99.333	104.333	99.000	143.667	147.333	152.333	147.778
NABEK-4 (P_4)	95.333	100.333	106.667	100.778	145.667	148.333	151.667	148.556
Gemmeiza7 (P_5)	89.333	92.333	98.333	93.333	143.333	146.333	151.667	147.111
Gemmeiza9 (P_6)	95.667	100.667	105.667	100.667	146.667	150.667	155.333	150.889
Gemmeiza10 (P_7)	95.667	101.333	106.000	101.000	150.333	152.333	154.333	152.333
Sakha 94 (P_8)	89.667	94.333	97.667	93.889	143.667	147.333	149.333	146.778
$P_1 \times P_2$	95.333	103.333	109.333	102.667	151.667	153.333	158.667	154.556
$P_1 \times P_3$	93.333	105.333	110.667	103.111	149.333	151.333	156.333	152.333
$P_1 \times P_4$	99.333	105.333	109.333	104.667	146.667	150.333	156.333	151.111
$P_1 \times P_5$	91.000	95.333	100.333	95.556	149.667	151.667	157.333	152.889

P ₁ XP ₆	96.333	104.333	109.333	103.333	151.333	152.667	156.667	153.556
P ₁ XP ₇	95.333	104.667	109.333	103.111	150.667	152.667	157.333	153.556
P ₁ XP ₈	92.667	99.000	105.667	99.111	148.667	152.333	154.333	151.778
P ₂ XP ₃	94.000	101.333	104.667	100.000	143.333	146.667	152.667	147.556
P ₂ XP ₄	95.333	101.000	106.667	101.000	151.333	153.667	155.333	153.444
P ₂ XP ₅	92.667	99.333	104.667	98.889	151.667	153.333	156.667	153.889
P ₂ XP ₆	93.333	101.000	107.667	100.667	149.333	152.333	157.333	153.000
P ₂ XP ₇	95.333	103.000	107.667	102.000	148.333	161.667	155.667	155.222
P ₂ XP ₈	91.333	95.667	104.333	97.111	142.333	145.333	152.667	146.778
P ₃ XP ₄	93.667	102.000	112.333	102.667	147.667	152.333	156.333	152.111
P ₃ XP ₅	92.667	99.000	104.333	98.667	149.667	152.667	156.667	153.000
P ₃ XP ₆	95.333	101.667	107.667	101.556	148.667	151.333	154.667	151.556
P ₃ XP ₇	96.333	103.667	109.667	103.222	149.667	152.667	156.667	153.000
P ₃ XP ₈	95.333	102.667	107.667	101.889	149.333	151.667	155.333	152.111
P ₄ XP ₅	92.333	102.333	105.667	100.111	148.667	151.667	154.667	151.667
P ₄ XP ₆	97.333	104.667	109.667	103.889	150.333	153.667	156.667	153.556
P ₄ XP ₇	95.667	106.333	110.333	104.111	150.667	153.333	156.333	153.444
P ₄ XP ₈	95.667	103.333	108.667	102.556	147.667	150.667	152.333	150.222
P ₅ XP ₆	93.333	102.333	108.333	101.333	148.333	152.667	155.667	152.222
P ₅ XP ₇	92.333	107.000	111.333	103.556	150.667	153.667	157.333	153.889
P ₅ XP ₈	93.333	107.333	112.333	104.333	142.667	146.333	152.333	147.111
P ₆ XP ₇	95.333	108.333	112.667	105.444	150.667	153.333	159.667	154.556
P ₆ XP ₈	91.667	99.333	106.000	99.000	146.333	149.667	156.667	150.889
P ₇ XP ₈	95.667	102.000	108.333	102.000	149.333	152.667	154.333	152.111
Average	94.120	101.667	107.065	100.951	148.157	151.380	155.167	151.568
L.S.D 5%	0.954	2.688	1.014	1.747	0.929	0.994	0.975	0.966
L.S.D 1%	1.268	3.575	1.348	2.324	1.235	1.322	1.297	1.285
Reduction	-8.018	-13.754			-2.175	-4.731		

Table (3): Mean performances of eight wheat genotypes and their F₁ crosses for spike length and number spikes per plant studied at three nitrogen levels as well as combined data.

Genotypes	Spike length, cm				Number of spikes / plant			
	25 kg/fed	50 kg/fed	75 kg/fed	Comb.	25 kg/fed	50 kg/fed	75 kg/fed	Comb.
CHAM-6 / MayoN"s (P ₁)	10.770	11.963	13.310	12.014	23.067	26.403	29.010	26.160
LAKTA-1 (P ₂)	11.653	12.627	13.477	12.586	17.093	18.667	20.747	18.836
MELLAL-1 (P ₃)	11.150	13.210	12.920	12.427	20.613	23.037	26.400	23.350
NABEK- 4 (P ₄)	11.863	12.917	14.717	13.166	17.860	21.320	24.220	21.133
Gemmeiza7 (P ₅)	13.587	15.170	16.150	14.969	16.837	22.870	26.203	21.970
Gemmeiza9 (P ₆)	12.093	13.543	14.747	13.461	22.963	25.267	27.280	25.170
Gemmeiza10 (P ₇)	12.000	11.883	12.790	12.224	20.960	24.527	28.140	24.542
Sakha 94 (P ₈)	10.633	11.790	13.277	11.900	22.617	25.877	29.390	25.961
P ₁ XP ₂	12.073	13.603	15.737	13.804	22.450	25.523	27.517	25.163
P ₁ XP ₃	11.850	13.170	14.060	13.027	21.877	26.197	30.240	26.104
P ₁ XP ₄	13.060	13.637	14.667	13.788	23.043	25.717	31.397	26.719
P ₁ XP ₅	11.970	14.053	15.973	13.999	21.660	26.197	30.040	25.966
P ₁ XP ₆	10.927	12.717	14.653	12.766	21.737	24.523	30.173	25.478
P ₁ XP ₇	11.907	12.823	14.310	13.013	20.810	24.863	28.980	24.884
P ₁ XP ₈	11.733	12.677	13.867	12.759	22.673	25.553	29.697	25.974
P ₂ XP ₃	11.983	13.163	14.807	13.318	19.763	22.973	25.247	22.661
P ₂ XP ₄	12.780	13.943	14.827	13.850	18.547	20.883	28.317	22.582
P ₂ XP ₅	11.967	12.653	14.833	13.151	21.667	24.647	29.870	25.394
P ₂ XP ₆	11.787	12.817	14.193	12.932	21.197	25.177	31.843	26.072
P ₂ XP ₇	12.903	13.060	14.720	13.561	19.930	23.543	28.300	23.924
P ₂ XP ₈	12.413	12.977	14.907	13.432	23.203	24.453	31.590	26.416
P ₃ XP ₄	12.563	14.120	15.997	14.227	20.330	22.087	23.680	22.032
P ₃ XP ₅	11.870	13.320	15.447	13.546	22.140	25.063	30.203	25.802
P ₃ XP ₆	11.193	12.420	13.797	12.470	21.163	24.033	29.133	24.777
P ₃ XP ₇	13.107	14.723	15.817	14.549	22.103	25.647	30.467	26.072
P ₃ XP ₈	10.650	12.693	15.067	12.803	21.980	23.350	27.617	24.316
P ₄ XP ₅	12.730	13.733	15.620	14.028	17.483	22.637	27.083	22.401
P ₄ XP ₆	12.997	13.923	14.737	13.886	22.707	23.750	30.137	25.531
P ₄ XP ₇	12.000	13.663	14.837	13.500	18.867	21.863	22.397	21.042
P ₄ XP ₈	13.000	14.837	16.647	14.828	21.137	22.987	24.453	22.859
P ₅ XP ₆	13.637	14.367	16.730	14.911	23.703	24.810	28.343	25.619
P ₅ XP ₇	13.577	14.873	15.477	14.642	21.923	23.670	27.280	24.291
P ₅ XP ₈	12.933	14.723	16.823	14.827	17.537	24.683	26.240	22.820
P ₆ XP ₇	12.527	12.963	15.047	13.512	21.627	24.500	28.767	24.964
P ₆ XP ₈	13.147	14.873	16.033	14.684	23.220	25.663	31.270	26.718
P ₇ XP ₈	13.233	14.600	16.667	14.833	21.437	25.173	23.950	23.520
Average	12.230	13.451	14.936	13.539	21.053	24.115	27.934	24.367
L.S.D 5%	0.853	0.804	0.764	0.808	1.611	1.210	1.985	1.633
L.S.D 1%	1.134	1.070	1.016	1.074	2.143	1.610	2.640	2.172
Reduction	18.117	9.942			24.633	13.672		

Useful heterosis estimates under different nitrogen fertilizer levels in half diallel crosses of wheat

Table (4): Mean performances of eight wheat genotypes and their F₁ crosses for number of kernels / spike and 1000-kernel weight studied at three nitrogen levels as well as combined data.

Genotypes	Number of kernels / spike				1000 kernel weight, gm			
	25 kg/fed	50 kg/fed	75 kg/fed	Comb.	25 kg/fed	50 kg/fed	75 kg/fed	Comb.
CHAM-6 / MayoN"s (P ₁)	60.227	68.580	78.137	68.981	36.761	39.134	44.107	40.001
LAKTA-1 (P ₂)	69.147	79.140	90.413	79.567	34.670	37.917	42.743	38.443
MELLAL-1 (P ₃)	73.783	84.103	95.053	84.313	36.983	40.710	43.153	40.282
NABEK- 4 (P ₄)	73.490	81.493	94.263	83.082	38.847	42.490	45.607	42.314
Gemmeiza7 (P ₅)	77.163	84.793	96.157	86.038	42.700	44.737	48.583	45.340
Gemmeiza9 (P ₆)	72.537	84.380	93.630	83.516	38.123	43.050	46.747	42.640
Gemmeiza10 (P ₇)	76.433	84.793	95.463	85.563	32.907	36.741	40.157	36.602
Sakha 94 (P ₈)	69.327	80.543	86.310	78.727	37.557	42.687	46.043	42.096
P ₁ xP ₂	62.517	76.580	86.250	75.116	34.067	36.010	41.073	37.050
P ₁ xP ₃	75.093	84.023	94.140	84.419	34.643	39.683	45.873	40.067
P ₁ xP ₄	61.003	66.817	76.807	68.209	35.913	39.777	45.103	40.264
P ₁ xP ₅	82.627	90.623	100.353	91.201	38.107	43.183	47.770	43.020
P ₁ xP ₆	68.477	78.707	95.853	81.012	38.713	44.223	47.530	43.489
P ₁ xP ₇	61.270	68.413	77.643	69.109	37.727	41.220	45.003	41.317
P ₁ xP ₈	65.380	74.487	82.233	74.033	38.080	42.087	45.920	42.029
P ₂ xP ₃	74.500	82.010	93.093	83.201	36.133	38.627	43.227	39.329
P ₂ xP ₄	70.723	79.850	91.200	80.591	37.823	41.083	46.107	41.671
P ₂ xP ₅	80.423	93.170	100.803	91.466	40.767	42.843	49.803	44.471
P ₂ xP ₆	70.138	81.360	92.790	81.429	36.810	39.707	43.253	39.923
P ₂ xP ₇	68.613	74.300	81.367	74.760	35.050	36.920	41.097	37.689
P ₂ xP ₈	75.237	86.677	101.377	87.763	37.160	41.100	43.857	40.706
P ₃ xP ₄	74.913	85.857	99.217	86.662	37.717	42.037	45.983	41.912
P ₃ xP ₅	77.680	84.437	95.540	85.886	38.837	43.913	47.217	43.322
P ₃ xP ₆	76.190	83.040	89.413	82.881	41.820	44.803	47.280	44.634
P ₃ xP ₇	80.070	91.187	107.340	92.866	38.833	43.317	46.503	42.884
P ₃ xP ₈	70.450	85.407	96.323	84.060	37.170	41.133	44.083	40.796
P ₄ xP ₅	68.440	76.613	88.770	77.941	40.820	44.863	48.89	44.85
P ₄ xP ₆	79.313	83.583	98.410	87.102	39.050	43.790	47.820	43.553
P ₄ xP ₇	76.393	84.157	96.413	85.654	35.240	37.783	42.107	38.377
P ₄ xP ₈	77.063	85.800	97.257	86.707	40.920	45.103	47.790	44.604
P ₅ xP ₆	69.597	81.787	87.063	79.482	41.900	45.777	50.300	45.992
P ₅ xP ₇	80.735	90.367	106.490	92.531	38.873	42.850	46.653	42.792
P ₅ xP ₈	72.150	80.363	101.300	84.604	41.237	44.717	49.150	45.034
P ₆ xP ₇	72.303	88.287	109.153	89.914	36.063	40.183	42.673	39.640
P ₆ xP ₈	74.217	84.137	95.270	84.541	38.090	43.233	47.233	42.852
P ₇ xP ₈	76.177	82.370	87.113	81.887	36.200	41.233	43.783	40.406
Average	72.606	82.006	93.289	82.634	37.842	41.630	45.265	41.579
L.S.D 5%	2.024	4.022	2.156	2.882	1.199	0.922	4.972	3.776
L.S.D 1%	2.692	5.350	2.868	3.834	1.595	1.226	6.613	3.991
Reduction	22.171	12.095			16.399	8.030		

Table (5): Mean performances of eight wheat genotypes and their F₁ crosses for 1000 kernel weight and grain yield / plant studied at three nitrogen levels as well as combined data.

Genotypes	Grain yield / plant, gm			
	25 kg/fed	50 kg/fed	75 kg/fed	Comb.
CHAM-6 / MayoN"s (P ₁)	41.217	50.220	60.497	50.644
LAKTA-1 (P ₂)	35.677	40.237	51.227	42.380
MELLAL-1 (P ₃)	38.353	44.293	56.477	46.374
NABEK- 4 (P ₄)	37.690	39.773	58.233	45.232
Gemmeiza7 (P ₅)	44.957	44.933	49.493	46.461
Gemmeiza9 (P ₆)	45.353	48.537	59.163	51.018
Gemmeiza10 (P ₇)	43.127	48.440	62.947	51.504
Sakha 94 (P ₈)	44.717	46.813	53.077	48.202
P ₁ xP ₂	42.697	51.173	60.933	51.601
P ₁ xP ₃	47.090	48.610	57.267	50.989
P ₁ xP ₄	40.563	50.860	55.733	49.052
P ₁ xP ₅	45.020	51.677	63.053	53.250
P ₁ xP ₆	43.117	47.267	60.020	50.134
P ₁ xP ₇	39.833	47.700	57.200	48.244
P ₁ xP ₈	43.617	49.393	61.540	51.517
P ₂ xP ₃	45.063	45.763	54.267	48.364
P ₂ xP ₄	43.187	46.673	51.510	47.123
P ₂ xP ₅	43.413	52.417	60.400	52.077
P ₂ xP ₆	42.983	49.293	57.167	49.814
P ₂ xP ₇	40.897	45.620	56.840	47.786
P ₂ xP ₈	43.957	48.703	58.807	50.489

Table (5) continue

P ₃ XP ₄	36.027	42.840	50.603	43.157
P ₃ XP ₅	37.370	48.670	59.227	48.422
P ₃ XP ₆	40.890	47.157	58.133	48.727
P ₃ XP ₇	48.050	54.373	70.077	57.500
P ₃ XP ₈	43.697	47.837	51.400	47.644
P ₄ XP ₅	43.153	42.983	66.667	50.934
P ₄ XP ₆	45.120	52.090	60.580	52.597
P ₄ XP ₇	36.633	40.807	58.970	45.470
P ₄ XP ₈	41.627	47.807	47.040	45.491
P ₅ XP ₆	45.103	48.313	55.217	49.544
P ₅ XP ₇	42.050	49.487	54.243	48.593
P ₅ XP ₈	38.053	44.890	54.670	45.871
P ₆ XP ₇	43.710	55.487	56.107	51.768
P ₆ XP ₈	43.693	49.830	58.097	50.540
P ₇ XP ₈	41.117	43.767	44.743	43.209
Average	42.189	47.631	56.990	48.937
L.S.D 5%	1.850	1.300	1.268	1.497
L.S.D 1%	2.460	1.730	1.687	1.991
Reduction	25.971	16.422		

Increasing N fertilizer rates might be increase the store assimilates and its translocation from sources to sink resulting in high and full grain filling which might be effected to heavy kernel weight. These results are in good agreement with those reported by Mosalem (1993), Shalaby *et al.* (1993), Darwiche (1994), Dawood and Kheiralla (1994), Mavi *et al.* (2003), Ram *et al.* (2003), and Bahrman *et al.* (2004).

From the same Tables, it could be concluded that, the reduction in heading reached -8.02% and -13.75% under 50 and 75 kg N/fed. relative to 25 kg N/fed. level, respectively, while it reached -2.17% and -4.73% under 50 and 75 kg N/fed. relative to 25 kg N/fed., respectively for maturity date.

The reduction in spike length at 25 and 50 kg N /fed. relative to 75 kg N/fed. reached 18.12% and 9.94%, respectively , while it was 24.63% and 13.67% in the same order for no. of spikes/plant, and reached to 22.17% and 12.09%, respectively for no. of kernels/spike. The reduction in 1000-kernels weight at 25 and 50 kg N/fed. relative to 75 Kg N /fed level was 16.40% and 8.03%, respectively, while it was 25.97% and 16.42% in the same order for grain yield/plant.

However, it could be concluded that the reduction in yield and its components under the lowest N level relative to the highest one ranged from 16% to 25%, while the present materials were earlier under the lowest N level relative to the highest one by 13.75% and 4.73%

for heading and maturity date, respectively. This would revealed the possibility to minimize the losses of yield and maximize the earliness of the present material by suitable breeding program under the lowest N level which consider as the way to safe the environment from the pollution.

Analysis of variance

Mean squares of genotypes, parents and crosses were highly significant for all studied traits under the three N levels as well as their combined analysis (Tables 6-9). The significance of mean squares of genotypes, parents and crosses where its magnitudes were several times larger than their corresponding mean square of error, indicate the successful of the planned crosses due to the presences of sufficient variability.

The interactions of genotypes, parents and crosses with N levels were found to be highly significant for all studied traits with two exceptions, i.e., parents x N interaction for no. of kernels/spike and 1000-kernel weight where they did not reach the level of significance. This would indicate that the performance of genotypes, parents and crosses would be changed from N level to another, for the exception traits the performance was the same under the three N levels. Hamada (1993), Shalaby *et al.* (1993), Saadalla and Hamada (1994), Ram *et al.* (2003), and Nazeer *et al.* (2004) came to the same conclusions.

Table (6): Mean square estimates of combining ability analysis for heading date and maturity date studied at three nitrogen levels as well as the combined data.

Genotypes	df	df comb	Heading date			Maturity date			Comb	
			25 kg/fed	50 kg/fed	75 kg/fed	Comb	25 kg/fed	50 kg/fed		
GCA	7	7	13.234**	19.187**	17.434**	47.987**	14.228**	15.326**	12.394**	38.706**
SCA	28	28	2.177**	11.243**	10.950**	17.951**	5.828**	7.328**	3.437**	12.493**
GCA/N		14				0.934**				1.623**
SCA/N		56				3.209**				2.050**
Error	70		0.114	0.903	0.128	0.382	0.108	0.123	0.119	0.117
GCA/SCA			6.079	1.706	1.592	2.673	2.441	2.091	3.606	3.098
GCA x N/GCA						0.019				0.042
SCA x N/SCA		210				0.179				0.164

* Significant at 0.05 and 0.01 levels of probability respectively

Table (7): Mean square estimates of combining ability analysis for spike length and number spikes per plant at three nitrogen levels as well as the combined data.

Genotypes	df	df comb	Spike length			Number of spikes / plant			
			25 kg/fed	50 kg/fed	75 kg/fed	Comb	25 kg/fed	50 kg/fed	75 kg/fed
GCA	7	7	1.442**	1.287**	1.949**	4.138**	8.725**	9.353**	10.079**
SCA	28	28	0.518**	0.722**	0.969**	1.835**	2.376**	1.267**	6.633**
GCA/ N		14				0.270**			1.179**
SCA/ N		56				0.187**			1.707**
Error	70		0.091	0.081	0.073	0.082	0.325	0.183	0.493
GCA/SCA			2.783	1.782	2.011	2.255	3.686	7.382	1.519
GCA x N/GCA						0.065			0.046
SCA x N/SCA		210				0.102			0.249

* Significant at 0.05 and 0.01 levels of probability respectively

Table (8): Mean square estimates of combining ability analysis for number of kernels per spike and 1000- kernel weight at three nitrogen levels as well as the combined data.

Genotypes	df	df comb	Number of kernels / spike			1000 - kernel weight			
			25 kg/fed	50 kg/fed	75 kg/fed	Comb	25 kg/fed	50 kg/fed	75 kg/fed
GCA	7	7	74.436**	81.535**	105.244**	255.552**	18.598**	24.774**	23.150**
SCA	28	28	22.218**	26.153**	53.073**	83.782**	2.165**	2.275**	2.432*
GCA/ N		14				2.831**			0.980**
SCA/ N		56				8.831**			0.493**
Error	70		0.512	2.022	0.581	1.386	0.180	0.0106	0.168
GCA/SCA			3.350	3.118	1.983	3.050	8.590	10.890	9.519
GCA x N/GCA						0.011			0.015
SCA x N/SCA		210				0.101			0.084

* Significant at 0.05 and 0.01 levels of probability respectively

Table (9): Mean square estimates of combining ability analysis for grain yield per plant at three nitrogen levels as well as the combined data.

Genotypes	df	df comb	Grain yield / plant			
			25 kg/fed	50 kg/fed	75 kg/fed	Comb
GCA	7	7	10.026**	20.302**	26.804**	39.222**
SCA	28	28	9.435**	11.826**	26.245**	27.002**
GCA/ N		14				8.955**
SCA/ N		56				10.252**
Error	70		0.428	0.211	0.201	0.280
GCA/SCA			1.063	1.083	1.021	1.452
GCA x N/GCA						0.228
SCA x N/SCA		210				0.380

* Significant at 0.05 and 0.01 levels of probability respectively

However, the presence of these significant interactions between genotypes and N levels were expected since most of the parents were derived from different origins which broad the genotypic variation among crosses. The genotypic variation would insure the validity of the comparisons between the means of these genotypes.

Heterosis

(A) Heterosis over mid-parents (average heterosis)

Mean squares of parents vs. crosses as an indication of average heterosis overall crosses were highly significance for all studied traits under the three N levels and their combined analysis, Tables (6-9). On the other hand, highly significant mean squares of parents vs. crosses x N levels interaction were detected for heading date, spike length, no. of spikes/plant and grain

yield/plant, indicating that the test of potential parents for the expression of heterosis would be necessarily conducting over a number of environmental conditions and the average heterosis overall crosses would be changed from environment to another. These results were in the same trend with those reported by Shreekanth *et al.* (1993), Chakraborty and Tewari (1995), Hassan and Saad (1996), El-Sayed (1997), Munir *et al.* (1999), and Hamada (2003).

Two, one, one crosses were expressed negative significant mid-parental heterosis under 25, 50 and 75 kg N/fed., respectively for heading date (Tables 10-16). The range of mid-parental heterosis under 25, 50 and 75 kg N/fed was -1.08 to -1.42%, -0.52 to -2.38% and -0.63 to -1.15%, respectively. Partial dominance was the type of dominance causing such heterosis in most cases. Three and two crosses were expressed negative

Table (10): Percentage of heterosis over both mid parents (M.P), better parent (B.P) and potency ratio (P) for heading date at three nitrogen fertilizer levels as well as the combined data.

Genotypes	Heading date											
	25 kg/fed			50 kg/fed			75 kg/fed			Comb.		
	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P
P ₁ xP ₂	1.418**	4.000	1.779**	2.819*	2.429	4.027**	3.633**	4.600	4.459**	2.667**	4.800	3.240*
P ₁ xP ₃	-0.533	-1.000	0.000	6.040**	0.002	6.040**	5.901**	37.000	6.070**	3.919**	17.500	4.153**
P ₁ xP ₄	4.745**	9.000	5.300**	5.509**	11.000	6.040**	3.470**	3.667	4.459**	4.550**	6.833	5.251**
P ₁ xP ₅	-0.907	-0.333	1.866*	-0.522	-0.143	3.249*	-1.149*	-0.368	2.034**	-0.865	-0.273	2.381
P ₁ xP ₆	1.404**	2.000	2.120**	4.333**	6.500	5.034**	3.962**	8.333	4.459**	3.276**	5.364	3.911*
P ₁ xP ₇	0.351	0.500	1.060*	4.319**	4.333	5.369**	3.797**	6.000	4.459**	2.882**	3.714	3.687*
P ₁ xP ₈	0.725	0.286	3.346**	2.238	0.867	4.947**	4.448**	1.286	8.191**	2.529**	0.880	5.562**
P ₂ xP ₃	0.535	3.000	0.714	0.829	0.714	2.013	-0.633	-0.667	0.319	0.223	0.286	1.010
P ₂ xP ₄	0.882	1.000	1.779**	0.000	0.000	0.664	0.156	1.000	0.313	0.331	3.000	0.442
P ₂ xP ₅	1.275*	0.538	3.731**	2.405*	0.500	7.581**	2.280**	0.583	6.441**	2.006**	0.538	5.952**
P ₂ xP ₆	-1.42**	-1.333	-0.356	-0.165	-0.333	0.331	1.572**	5.000	2.215**	0.055	1.000	0.110
P ₂ xP ₇	0.704	0.667	1.779**	1.478	9.000	1.645	1.413**	9.000	1.572**	1.213	5.500	1.436
P ₂ xP ₈	-0.364	-0.167	1.859**	-2.381*	-0.636	1.413	2.288**	0.538	6.826**	-0.114	-0.033	3.432*
P ₃ xP ₄	-0.707	-0.667	0.357	2.170	4.333	2.685	6.477**	5.857	7.668**	2.781**	3.125	3.704*
P ₃ xP ₅	1.460**	0.667	3.731**	3.304**	0.905	7.220**	2.961**	1.000	6.102**	2.600**	0.882	5.714**
P ₃ xP ₆	0.882	0.714	2.143**	1.667	2.500	2.349	2.540**	4.000	3.195**	1.725**	2.067	2.581
P ₃ xP ₇	1.940**	1.571	3.214**	3.322**	3.333	4.362**	4.279**	5.400	5.112**	3.222**	3.222	4.265**
P ₃ xP ₈	4.189**	2.091	6.320**	6.024**	2.333	8.834**	6.601**	2.000	10.239**	5.645**	2.130	8.521**
P ₄ xP ₅	0.000	0.000	3.358**	6.228**	1.500	10.830**	3.089**	0.760	7.458**	3.148**	0.821	7.262**
P ₄ xP ₆	1.920**	11.000	2.098**	4.146**	25.000	2.326**	3.297**	7.000	2.524**	3.144**	57.000	3.201*
P ₄ xP ₇	0.175	1.000	0.350	5.455**	11.000	5.980**	3.762**	12.000	4.088**	3.194**	29.000	3.308*
P ₄ xP ₈	3.423**	1.118	6.691**	6.164**	2.000	9.541**	6.362**	1.444	11.263**	5.365**	1.516	9.231**
P ₅ xP ₆	0.901	0.294	4.478**	6.045**	1.400	10.830**	6.209**	1.727	10.169**	4.467**	1.182	8.571**
P ₅ xP ₇	-0.180	-0.059	3.358**	10.499**	2.259	14.440**	8.972**	2.391	13.220**	6.575**	1.667	10.952**
P ₅ xP ₈	4.283**	23.000	4.478**	15.000**	14.000	16.245**	14.626**	43.000	15.017**	11.454**	38.600	11.786**
P ₆ xP ₇	-0.348	-0.003	-0.348	7.261**	22.000	7.616**	6.457**	41.000	6.625**	4.573**	27.667	4.746**
P ₆ xP ₈	-1.079*	-0.333	2.230**	1.880	0.579	5.300**	4.262**	1.000	8.532**	1.770*	0.508	5.444**
P ₇ xP ₈	3.237**	1.000	6.691**	4.259**	1.190	8.834**	6.383**	1.560	10.922**	4.675**	1.281	8.639**
L.S.D.5%	0.928		0.950	2.330		2.690	0.880		1.010	1.480		3.060
L.S.D.1%	1.230		1.270	3.100		3.570	1.170		1.350	1.940		4.010

Table (11): Percentage of heterosis over both mid parents (M.P), better parent (B.P) and potency ratio (P) for maturity date at three nitrogen fertilizer levels as well as the combined data.

Genotypes	Maturity date											
	25 kg/fed			50 kg/fed			75 kg/fed			Comb.		
	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P
P ₁ xP ₂	2.593**	-2.556	3.645**	1.657**	1.667	2.679**	2.919**	1.800	4.615**	2.392**	1.970	3.651**
P ₁ xP ₃	1.934**	-1.000	3.944**	1.001**	0.600	2.715**	1.187**	0.846	2.626**	1.368**	0.822	3.083**
P ₁ xP ₄	-0.565	0.455	0.686*	0.000	0.000	1.348**	1.405**	0.867	3.077**	0.295	0.211	1.720**
P ₁ xP ₅	2.278**	-1.111	4.419**	1.563**	0.778	3.645**	2.054**	1.267	3.736**	1.964**	1.039	3.927**
P ₁ xP ₆	2.252**	-2.500	3.182**	0.770**	1.400	1.327**	0.427	1.000	0.858**	1.134**	1.824	1.767**
P ₁ xP ₇	0.556*	1.667	0.893**	0.219	0.003	0.219	1.179**	1.571	1.944**	0.655**	4.500	0.802**
P ₁ xP ₈	1.479**	0.765	3.480**	1.669**	1.000	3.394**	0.871**	0.364	3.348**	1.335**	0.667	3.407**
P ₂ xP ₃	-1.149**	-1.250	-0.232	-1.124**	-1.667	-0.452	0.439	2.000	0.659**	-0.599**	-1.333	-0.150
P ₂ xP ₄	3.653**	16.000	3.890**	3.247**	9.667	3.596**	2.418**	5.500	2.418**	3.098**	16.600	3.291**
P ₂ xP ₅	4.718**	4.556	5.814**	3.720**	3.667	4.784**	3.297**	0.002	3.297**	3.901**	5.778	4.607**
P ₂ xP ₆	1.934**	17.000	2.050**	1.556**	3.500	2.009**	2.497**	2.091	3.736**	2.000**	3.375	2.608**
P ₂ xP ₇	0.000	0.000	1.367**	7.182**	7.222	8.259**	1.743**	2.000	2.637**	2.986**	2.793	4.098**
P ₂ xP ₈	-1.839**	-2.000	-0.928*	-2.022**	-3.000	-1.357**	1.440**	1.857	2.232**	-0.789**	-1.000	0.000
P ₃ xP ₄	2.074**	3.000	2.784**	3.044**	9.000	3.394**	2.851**	13.000	3.077**	2.662**	10.143	2.932**
P ₃ xP ₅	4.297**	37.000	4.419**	3.973**	11.667	4.328**	3.070**	14.000	3.297**	3.768**	16.667	4.003**
P ₃ xP ₆	2.411**	2.333	3.480**	1.566**	1.400	2.715**	0.542	0.556	1.532**	1.488**	1.429	2.556**
P ₃ xP ₇	1.814**	0.800	4.176**	1.891**	1.133	3.620**	2.174**	3.333	2.845**	1.962**	1.293	3.534**
P ₃ xP ₈	3.944**	0.003	3.944**	2.941**	0.002	2.941**	2.983**	3.000	4.018**	3.282**	9.667	3.634**
P ₄ xP ₅	2.884**	3.571	3.721**	2.941**	4.333	3.645**	1.978**	0.001	1.978**	2.593**	5.308	3.097**
P ₄ xP ₆	2.851**	8.333	2.517**	2.787**	3.571	2.921**	2.063**	1.727	1.758**	2.560**	3.286	3.366**
P ₄ xP ₇	1.802**	1.143	3.432**	1.996**	1.500	3.371**	2.179**	2.500	3.077**	1.994**	1.588	3.291**
P ₄ xP ₈	2.074**	3.000	2.784**	1.917**	5.667	2.262**	1.218**	1.571	2.009**	1.731**	2.875	2.347**
P ₅ xP ₆	2.299**	2.000	3.488**	2.806**	1.923	4.328**	1.412**	1.182	2.637**	2.163**	1.706	3.474**
P ₅ xP ₇	2.611**	1.095	5.116**	2.902**	1.444	5.011**	2.832**	3.250	3.736**	2.783**	1.596	4.607**
P ₅ xP ₈	-0.581*	-5.000	-0.465	-0.341	-1.000	0.000	1.218**	1.571	2.009**	0.113	1.000	0.227
P ₆ xP ₇	1.459**	1.182	2.727**	1.210**	2.200	1.770**	3.122**	9.667	3.456**	1.942**	4.077	2.430**
P ₆ xP ₈	0.804**	0.778	1.856**	0.447	0.400	1.584**	2.845**	1.444	4.911**	1.381**	1.000	2.801**
P ₇ xP ₈	1.587**	0.700	3.944**	1.891**	1.133	1.327**	1.647**	1.000	3.348**	1.709**	0.920	3.634**
L.S.D.5%	0.800		0.930	0.860		0.990	0.840		0.970	0.470		0.550
L.S.D.1%	1.070		1.230	1.140		1.320	1.120		1.300	0.620		0.720

*Significant at 0.05 and 0.01 levels of probability respectively

Useful heterosis estimates under different nitrogen fertilizer levels in half diallel crosses of wheat

Table (12): Percentage of heterosis over both mid parents (M.P), better parents (B.P) and potency ratio (P) for spike length at three nitrogen fertilizer levels as well as the combined data.

Genotypes	Spike length											
	25 kg/fed			50 kg/fed			75 kg/fed			Comb.		
	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P
P ₁ xP ₂	7.685*	1.951	3.604	10.641**	3.945	7.735*	17.496**	28.120	16.770**	12.231**	5.268	9.685**
P ₁ xP ₃	8.120*	4.684	6.278	4.635	0.936	-0.303	7.205**	4.846	5.635	6.596*	3.911	4.828
P ₁ xP ₄	15.405**	3.189	10.087**	9.620**	2.510	5.574	4.662	0.929	-0.340	9.514**	2.081	4.726
P ₁ xP ₅	-1.711	-0.148	-11.90**	3.587	0.304	-7.361**	8.441**	0.876	-1.094	3.760	0.343	-6.480
P ₁ xP ₆	-4.418	-0.763	-9.647**	-0.288	-0.046	-6.104*	4.455	0.870	-0.633	0.218	0.038	-5.167
P ₁ xP ₇	4.582	0.848	-0.778	7.548*	22.500	7.189*	9.655**	4.846	7.513*	7.376*	8.513	6.453
P ₁ xP ₈	9.640**	15.098	8.945*	6.736*	9.231	5.963	4.313	34.400	4.182**	6.704*	14.010	6.196
P ₂ xP ₃	5.102	2.311	2.832	1.897	0.840	-0.353	12.186*	5.778	9.869**	6.490**	10.217	5.818
P ₂ xP ₄	8.689**	9.730	7.727*	9.174**	8.080	10.428**	5.179*	1.177	0.747	7.568**	3.360	5.199
P ₂ xP ₅	-5.177	-0.676	-11.92**	-8.958**	-0.979	-16.59**	0.135	0.015	-8.153**	-4.545	-0.525	-12.14**
P ₂ xP ₆	-0.730	-0.394	-2.536	-2.051	-0.585	-5.365	0.579	0.129	-3.752	-0.700	-0.208	-3.929
P ₂ xP ₇	9.104**	6.212	7.528*	6.569*	2.166	3.432	12.081**	4.621	9.226**	9.320**	6.403	7.751*
P ₂ xP ₈	11.397**	2.490	6.522	6.294*	1.837	2.772	11.438**	15.300	10.611**	9.715**	3.470	6.727*
P ₃ xP ₄	9.183**	2.963	5.901	8.089**	7.205	6.889*	15.764**	2.425	8.698**	11.180**	3.872	8.060**
P ₃ xP ₅	-4.029	-0.409	-12.64**	-6.131*	-0.888	-12.20**	6.272**	0.564	-4.355	-1.111	-0.120	-9.509**
P ₃ xP ₆	-3.686	-0.908	-7.442*	-7.152**	-5.740	-8.294**	-0.265	-0.040	-6.442*	-3.661	-0.916	-7.363*
P ₃ xP ₇	13.233**	3.604	9.222*	17.349**	3.281	11.456**	23.039**	45.564	22.420**	18.038**	21.989	17.078**
P ₃ xP ₈	-2.219	-0.935	-4.484	1.547	0.272	-3.911	15.027**	11.037	13.482**	5.262	2.430	3.031
P ₄ xP ₅	0.039	0.006	-6.305*	-2.207	-0.275	-9.470**	1.210	0.260	-3.282	-0.280	-0.044	-6.287
P ₄ xP ₆	8.501**	8.855	9.427**	5.241	2.213	2.806	0.034	0.333	-0.068	4.298	3.872	3.153
P ₄ xP ₇	0.573	1.000	0.000	10.188**	2.445	5.781	7.877*	1.125	0.815	6.341*	1.711	2.540
P ₄ xP ₈	15.573**	2.848	9.581**	20.103**	4.408	14.865**	18.933**	3.681	13.114**	18.312**	3.627	12.626**
P ₅ xP ₆	6.205**	1.067	0.368	0.070	0.012	-5.296	8.296	1.827	3.591	4.897*	0.923	-0.386
P ₅ xP ₇	6.123*	0.987	-0.074	9.956**	0.819	-1.956	6.957**	0.599	-4.169	7.690**	0.762	-2.182
P ₅ xP ₈	6.799*	0.558	-4.809	9.224**	0.736	-2.944	14.341**	1.469	4.169	10.363**	0.907	-0.950
P ₆ xP ₇	3.985*	10.286	3.583	1.966	0.301	-4.283	9.285*	1.307	2.034	5.213	1.083	0.380
P ₆ xP ₈	15.694**	2.443	8.710*	17.421**	2.517	9.820**	14.428**	2.751	8.725**	15.803**	2.567	9.088**
P ₇ xP ₈	16.937**	2.805	10.278**	23.346**	59.214	22.861**	27.877**	14.932	25.534**	22.973**	17.082	21.342**
L.S.D.5%	0.740		0.850	0.700		0.804	0.660		0.760	0.680		0.790
L.S.D.1%	0.980		1.130	0.930		1.070	0.880		1.020	0.900		1.040

*Significant at 0.05 and 0.01 levels of probability respectively

Table (13): Percentage of heterosis over both mid parents (M.P), better parent (B. P) and potency ratio (P) for number of spikes per plant at three nitrogen fertilizer levels as well as the combined data.

Genotypes	Number of spikes /plant											
	25 kg/fed			50 kg/fed			75 kg/fed			Comb.		
	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P
P ₁ xP ₂	11.803***	0.794	-2.673	13.261**	0.773	-3.333	10.605**	0.639	-5.148	11.848**	0.728	-3.810
P ₁ xP ₃	0.168	0.030	-5.159	5.974**	0.877	-0.783	9.150**	1.943	4.240	5.451	0.960	-0.212
P ₁ xP ₄	12.608**	0.991	-0.101	7.774**	0.730	-2.601	17.966**	1.997	8.227*	12.992**	1.222	2.136
P ₁ xP ₅	8.562*	0.548	-6.098	6.332**	0.883	-0.783	8.814**	1.734	3.551	7.898**	0.907	-0.743
P ₁ xP ₆	-5.554	-24.74	-5.766	-5.077*	-2.308	-7.120**	7.207*	2.345	4.010	-0.729	-0.378	-2.608
P ₁ xP ₇	-5.466	-1.142	-9.783**	-2.363	-0.641	-5.833*	1.417	0.931	-0.103	-1.841	-0.577	-4.876
P ₁ xP ₈	-0.737	-0.748	-1.705	-2.244	-2.228	-3.219	1.701	-2.614	2.367	-0.330	-0.866	-0.709
P ₂ xP ₃	4.827	0.517	-4.124	10.175**	0.971	-0.275	7.098	0.592	-4.369	7.435*	0.695	-2.950
P ₂ xP ₄	6.122	2.791	3.845	4.451**	0.671	-2.048	25.945**	3.359	16.914**	12.999**	2.261	6.856
P ₂ xP ₅	27.714**	36.636	26.755**	18.674**	1.845	7.769**	27.242**	2.344	13.993**	24.466**	3.185	15.587**
P ₂ xP ₆	5.833	0.398	-7.693*	14.613**	0.973	-0.356	32.607**	2.397	16.728**	18.495**	1.285	3.585
P ₂ xP ₇	4.748	0.467	-4.914	9.014**	0.664	-4.009	15.778**	1.043	0.569	10.307**	0.783	-2.517
P ₂ xP ₈	16.864**	1.212	2.594	9.796**	0.605	-5.500*	26.016**	1.509	7.486*	17.935**	1.128	1.750
P ₃ xP ₄	5.684	0.794	-1.375	-0.413	-0.107	-4.124	-6.440	1.495	-10.30**	-0.942	-0.189	-5.644
P ₃ xP ₅	18.238**	1.808	7.406	9.193**	25.320	8.798**	14.834**	39.678	14.407**	13.867**	4.554	10.502**
P ₃ xP ₆	-2.869	-0.532	-7.839*	-0.490	-0.106	-4.881*	8.544**	5.212	6.794	2.130	0.568	-1.563
P ₃ xP ₇	6.334	7.596	5.455	7.842**	2.503	4.566	11.722**	3.674	8.268*	8.879**	3.567	6.234*
P ₃ xP ₈	1.689	0.364	-2.815	-4.525**	-0.779	-9.764**	-0.998	-0.186	-6.034	-1.379	-0.260	-6.339*
P ₄ xP ₅	0.778	0.264	-2.109	2.452	0.699	-1.020	7.424*	1.887	3.358	3.941	2.031	1.962
P ₄ xP ₆	11.244**	0.899	-6.648	1.961	0.231	-0.369*	17.036**	2.867	-12.21**	10.278**	1.179	1.435
P ₄ xP ₇	-2.799	-0.351	-9.987*	-4.624	-0.661	-10.86**	-14.45**	-1.930	-20.41**	-7.862*	-1.053	-14.26**
P ₄ xP ₈	4.439	0.378	-6.544	-2.592	-0.268	-11.17**	-8.773**	-0.910	-16.80**	-2.923	-0.285	-11.95**
P ₅ xP ₆	19.112**	1.242	3.223	3.082	0.619	-1.807	5.989	2.975	3.898	8.693**	1.281	1.783
P ₅ xP ₇	16.007**	1.467	4.596	-0.120	-0.034	-3.493	0.399	0.112	-3.056	4.450	0.805	-1.023
P ₅ xP ₈	-11.10**	-0.758	-22.461	1.272	0.206	-4.612	-5.600	-0.977	-10.72**	-4.780	-0.574	-12.10**
P ₆ xP ₇	-1.525	-0.334	-5.821	-1.593	-1.072	-3.034	3.813	2.457	2.227	0.436	0.345	-0.817
P ₆ xP ₈	1.887	2.481	1.118	0.358	0.301	-0.824	10.358**	2.782	6.397	4.507	2.913	2.915
P ₇ xP ₈	-1.614	-0.425	-5.217	-0.112	-0.042	-2.718	-16.74**	-7.704	-18.51**	-6.858*	-2.441	-9.403**
L.S.D.5%	1.390		1.610	1.050		1.210	1.720	1.980	1.380		1.600	
L.S.D.1%	1.860		2.140	1.390		1.610	2.290	2.640	1.820		2.090	

* Significant at 0.05 and 0.01 levels of probability respectively

Table (14): Percentage of heterosis over both mid parents (M.P), better parent (B. P) and potency ratio (P) for number of kernel per spike at three nitrogen fertilizer levels as well as the combined data.

Genotypes	Number of kernels /spike													
	25 kg/fed				50 kg/fed				75 kg/fed				Comb.	
	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P		
P ₁ xP ₂	-3.355*	-0.487	-9.588**	3.683	0.515	-3.235	2.344*	0.322	-4.605**	1.133	0.159	-5.594**		
P ₁ xP ₃	12.071**	1.193	1.775	10.062**	0.990	-0.095	8.713**	0.892	-0.961	10.140**	1.014	0.125		
P ₁ xP ₄	-8.757**	-0.883	-16.99**	-10.96**	-1.273	-18.01**	-10.90**	-1.165	-18.52**	-10.29**	-1.110	-17.90**		
P ₁ xP ₅	20.280**	1.645	7.080**	18.174**	1.719	6.876**	15.155**	1.466	4.364**	17.665**	1.605	6.001**		
P ₁ xP ₆	3.156*	0.340	-5.597**	2.911	0.282	-6.724**	11.609**	1.287	2.375*	6.248**	0.656	-2.997		
P ₁ xP ₇	-10.33**	-0.871	-19.84**	-10.79**	-1.021	-19.32**	-10.55**	-1.057	-18.67**	-10.56**	-0.985	-19.23**		
P ₁ xP ₈	0.931	0.133	-5.693**	-0.101	-0.013	-7.520**	0.012	0.002	-4.723**	0.243	0.037	-5.962**		
P ₂ xP ₃	4.247**	1.309	0.971	0.476	0.156	-2.489	0.388	0.155	-2.062	1.539	0.531	-1.319		
P ₂ xP ₄	-0.834	-0.274	-3.77**	-0.581	-0.397	-2.017	-1.233	-0.591	-3.250**	-0.902	-0.417	-2.998		
P ₂ xP ₅	9.936**	1.813	4.225**	13.668**	3.963	9.879**	8.060**	2.618	4.832**	10.463**	2.678	6.309**		
P ₂ xP ₆	-0.993	-0.415	-3.307*	-0.489	-0.153	-3.579	0.835	0.478	-0.897	-0.137	-0.057	-2.498		
P ₂ xP ₇	-5.738**	-1.146	-10.2**	-9.353**	-2.712	-12.38**	-12.45**	-4.583	-14.77**	-9.453**	-2.603	-12.63**		
P ₂ xP ₈	8.666**	66.667	8.525**	8.561**	9.741	7.615**	14.729**	6.344	12.126**	10.887**	20.516	10.302**		
P ₃ xP ₄	1.734	8.705	1.532	3.694	2.344	5.354	4.816**	11.540	4.380**	3.542*	4.816	2.786		
P ₃ xP ₅	2.924*	1.306	0.670	-0.014	-0.034	-0.421	-0.068	-0.118	-0.641	0.834	0.823	-0.177		
P ₃ xP ₆	4.142**	4.861	5.037*	-1.426	-8.687	-1.588	-5.224**	-6.925	-5.934**	-1.231	-2.591	-1.699		
P ₃ xP ₇	6.606**	3.745	4.758**	7.979**	19.531	7.540**	12.683**	58.935	12.441**	9.333**	12.684	8.534**		
P ₃ xP ₈	-1.544	-0.496	-4.52**	3.745	1.732	4.802	6.221**	1.291	1.336	3.116*	0.909	-0.300		
P ₄ xP ₅	-9.142**	-3.750	-11.3**	-7.854**	-3.958	-9.647**	-6.764**	-6.803	-7.682**	-7.827	-4.479	-9.411**		
P ₄ xP ₆	8.629**	13.217	5.018**	0.780	0.448	-2.382	4.751**	14.095	-7.585**	4.566**	17.554	4.295*		
P ₄ xP ₇	1.910	0.973	-0.052	1.219	0.614	-0.751	1.634**	2.583	0.995	1.579	1.073	0.106		
P ₄ xP ₈	7.919**	2.717	4.862**	5.902**	10.067	5.285*	7.720**	1.753	3.176**	7.172**	2.664	4.362*		
P ₅ xP ₆	-7.018**	-2.271	-9.81**	-3.310	-13.548	-3.546	-8.251**	-6.198	-9.457**	-6.245**	-4.198	-7.619**		
P ₅ xP ₇	5.126**	10.785	4.629**	6.573**	0.003	6.573**	11.147**	30.808	10.746**	7.844**	28.370	7.546**		
P ₅ xP ₈	-1.495	-0.279	-6.50*	-2.788	-1.085	-5.224*	11.034**	2.045	5.349**	2.697	0.608	-1.666		
P ₆ xP ₇	-2.929*	-1.120	-5.40**	4.374*	17.903	4.120	15.449**	15.935	14.341**	6.358**	5.250	5.085**		
P ₆ xP ₈	4.631**	2.047	2.316*	2.031	0.873	-0.288	5.891**	1.448	1.752	4.216**	1.428	1.228		
P ₇ xP ₈	4.523**	0.928	-0.336	-0.361	-0.140	-2.858	-4.152**	-0.824	-8.747**	-0.314	-0.076	-4.297**		
L.S.D.5%	1.750		2.020	3.480		4.020	1.870		2.160	2.440		2.820		
L.S.D.1%	2.330		2.690	4.630		5.340	2.480		2.870	3.200		3.700		

* Significant at 0.05 and 0.01 levels of probability respectively

Table (15): Percentage of heterosis over both mid parents (M.P), better parent (B.P) and potency ratio (P) for 1000 kernel weight at three nitrogen fertilizer levels as well as the combined data.

Genotypes	1000 kernel weight													
	25 kg/fed				50 kg/fed				75 kg/fed				Comb.	
	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P		
P ₁ xP ₂	-4.617**	-1.577	-7.33**	-6.530**	-4.131	-7.984**	-5.415**	-3.450	-6.877**	-5.538**	-2.789	-7.38**		
P ₁ xP ₃	-6.045**	-20.08	-6.33**	-0.598	-0.303	-2.522*	5.142**	4.706	4.005**	-0.186	-0.532	-0.535		
P ₁ xP ₄	-5.001**	-1.813	-7.55**	-2.537*	-0.617	-6.386**	0.550	0.329	-1.104	-2.170	-0.772	-4.85**		
P ₁ xP ₅	-4.088**	-0.547	-10.76**	2.975**	0.445	-3.472**	3.075**	0.637	-1.674	0.819	0.131	-5.12**		
P ₁ xP ₆	3.395*	1.866	1.548	7.620**	1.599	2.726*	4.630**	1.593	1.676	5.248**	1.643	1.991		
P ₁ xP ₇	8.304**	1.501	2.626	8.651**	2.743	5.329**	6.816**	1.454	2.033	7.873**	1.774	3.290*		
P ₁ xP ₈	2.479	2.316	1.393	2.875*	0.662	-1.406	1.875	0.873	-0.268	2.389	0.936	-0.158		
P ₂ xP ₃	0.856	0.265	-2.298	-1.747	-0.492	-5.118**	0.648	1.358	0.170	-0.086	-0.037	-2.367		
P ₂ xP ₄	2.897*	0.510	-2.634	2.189*	0.385	-3.311**	4.373**	1.349	1.096	3.200**	0.668	-1.520		
P ₂ xP ₅	5.381**	0.518	-4.528**	3.670**	0.445	-4.232**	9.066**	1.418	2.511*	6.157**	0.748	-1.916		
P ₂ xP ₆	1.136	0.239	-3.445*	-1.918	-0.303	-7.766**	-3.334**	-0.745	-7.473**	-1.525	-0.295	-6.37**		
P ₂ xP ₇	3.734*	1.431	1.096	-1.096	-0.696	-2.629*	-0.852	-0.273	-3.852**	0.444	0.181	-1.962		
P ₂ xP ₈	2.898*	0.725	-1.056	1.981	0.335	-3.717**	-1.209	-0.325	-4.749**	1.083	0.239	-3.30**		
P ₃ xP ₄	-0.523	-0.213	-2.909	1.050	0.491	-1.067	3.613**	1.307	0.826	1.486	0.604	-0.951		
P ₃ xP ₅	-2.522	-0.352	-9.048**	2.785**	0.591	-1.840	2.940**	0.497	-2.813*	1.194	0.202	-4.45**		
P ₃ xP ₆	11.362**	7.485	9.697**	6.980**	2.499	4.073**	5.184**	1.297	1.141	7.654**	2.692	4.677**		
P ₃ xP ₇	11.127**	1.908	5.002**	11.855**	2.314	6.403**	11.639**	3.236	7.763**	11.557**	2.414	6.460**		
P ₃ xP ₈	-0.268	-0.349	-1.030	-1.355	-0.572	-3.639**	-1.155	-0.356	-4.257**	-0.955	0.434	-3.088*		
P ₄ xP ₅	0.114	0.024	-4.403**	2.866**	1.113	0.283	3.811**	1.206	-21.352	2.351*	0.681	-8.915		
P ₄ xP ₆	1.468	1.562	-6.813	2.385*	3.643	-4.220	3.559**	2.883	-6.339	2.533*	6.611	2.142		
P ₄ xP ₇	-1.775	-0.214	-9.284**	-4.625**	-0.637	-11.08**	-1.807	-0.284	-7.674**	-2.740*	-0.379	-9.31**		
P ₄ xP ₈	7.116**	4.214	5.337**	5.905**	25.576	5.661**	4.288**	9.000	3.794**	5.685**	21.924	5.412**		
P ₅ xP ₆	3.683**	0.650	-1.874	4.291**	2.233	2.325*	5.528**	2.869	3.533**	4.552**	1.483	1.439		
P ₅ xP ₇	2.830*	0.219	-8.962**	5.182**	0.528	-4.217**	5.146**	0.542	-3.973**	4.446**	0.417	-5.62**		
P ₅ xP ₈	2.762*	0.431	-3.427*	2.299*	0.980	-0.045	3.882**	1.446	1.166	3.012**	0.812	-0.674		
P ₆ xP ₇	1.544	0.210	-5.404**	0.721	0.091	-6.659**	-1.791	-0.236	-8.714**	0.049	0.006	-7.04**		
P ₆ xP ₈	0.661	0.882	-0.087	0.851	2.009	0.426	1.807	2.384	1.041	1.143	1.780	0.498		
P ₇ xP ₈	2.748	0.416	-3.612*	3.826**	0.511	-3.405**	1.585	0.232	-4.908**	2.686*	0.385	-4.02**		
L.S.D.5%	1.040		1.200	0.800		0.920	1.000		1.160	0.930		1.080		
L.S.D.1%	1.380		1.600	1.060		1.220	1.340		1.540	1.220		1.410		

* Significant at 0.05 and 0.01 levels of probability respectively

Table (16): Percentage of heterosis over both mid parents (M.P), better parent (B.P) and potency ratio (P) for grain yield/plant at three nitrogen fertilizer levels as well as the combined data.

Genotypes	Grain yield/plant											
	25 kg/fed			50 kg/fed			75 kg/fed			Comb.		
	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P	M.P	P	B.P
P ₁ xP ₂	11.054**	1.534	3.591	13.144**	1.191	1.898	9.079**	1.094	0.722	10.941**	1.232	1.889
P ₁ xP ₃	18.361**	5.102	14.250**	2.864*	0.457	-3.206*	-2.086*	-0.607	-5.339**	5.111**	1.161	0.680
P ₁ xP ₄	2.813	0.629	-1.585	13.031**	1.123	1.274	-6.118**	-3.209	-7.874**	2.324	0.412	-3.144*
P ₁ xP ₅	4.487*	1.034	0.141	8.618**	1.551	2.901*	14.653**	1.465	4.226**	9.674**	2.246	5.145**
P ₁ xP ₆	-0.389	-0.081	-4.932*	-4.277**	-2.509	-5.881**	0.318	0.285	-0.788	-1.371	-3.732	-1.731
P ₁ xP ₇	-5.545**	-2.449	-7.636*	-3.304**	-1.831	-5.018**	-7.326**	-3.691	-9.129**	-5.541**	-6.581	-6.330**
P ₁ xP ₈	1.513	0.371	-2.460	1.807	0.515	-1.646	8.371**	1.281	1.725	4.236**	1.714	1.722
P ₂ xP ₃	21.743**	6.014	17.495**	8.277**	1.725	3.319*	0.771	0.158	-3.913**	8.985**	1.996	4.291**
P ₂ xP ₄	17.728**	6.460	14.584**	16.669**	28.784	15.997**	-5.883**	-0.919	-11.55**	7.573**	2.326	4.181*
P ₂ xP ₅	7.681**	0.667	-3.433	23.087**	4.187	16.654**	19.936**	11.585	17.907**	17.236**	3.752	12.087**
P ₂ xP ₆	6.092**	0.510	-5.226*	11.054**	1.182	1.559	3.572**	0.497	-3.375**	6.672**	0.721	-2.359
P ₂ xP ₇	3.794	0.401	-5.171*	2.891	0.312	-5.822**	-0.432	-0.042	-9.701**	1.797	0.185	-7.221**
P ₂ xP ₈	9.354**	0.832	-1.700	11.897**	1.575	4.037**	12.761**	7.195	10.796**	11.476**	1.785	4.744**
P ₃ xP ₄	-5.247*	-6.015	-6.066*	1.919	0.357	-3.281*	-11.77**	-7.687	-13.10**	-5.778**	-4.634	-6.939**
P ₃ xP ₅	-10.29**	-1.298	-16.88**	9.093**	12.677	8.316**	11.780**	1.788	4.869**	4.318**	46.256	4.221**
P ₃ xP ₆	-2.302	-0.275	-9.841**	1.598	0.350	-2.843*	0.542	0.233	-1.741	0.063	0.013	-4.491**
P ₃ xP ₇	17.943**	3.063	11.416**	17.268**	3.862	12.249**	17.358**	3.204	11.327**	17.492**	3.337	11.641**
P ₃ xP ₈	5.204**	0.679	-2.281	5.012**	1.812	2.186	-6.164**	-1.986	-8.989**	0.753	0.390	-1.157
P ₄ xP ₅	4.428**	0.504	-4.011	1.487	0.244	-4.340**	23.770**	2.930	14.482**	11.097**	8.280	9.628**
P ₄ xP ₆	8.666**	0.939	-0.514	17.971**	1.811	7.321**	3.206**	4.047	2.395*	9.292*	1.546	3.095*
P ₄ xP ₇	-9.342**	-1.389	-15.06**	-7.482**	-0.762	-15.76**	-2.674**	-0.687	-6.318**	-5.992**	-0.924	-11.72**
P ₄ xP ₈	1.027	0.120	-6.910**	10.425**	1.282	2.122	-15.48**	-3.341	-19.22**	-2.625	-0.826	-5.624**
P ₅ xP ₆	-0.114	-0.261	-0.551	3.377**	0.876	-0.460	1.635	0.184	-6.671**	1.652	0.353	-2.888*
P ₅ xP ₇	-4.522*	-2.177	-6.465**	5.997**	1.597	2.161	-3.516**	-0.294	-13.83**	-0.795	-0.154	-5.652**
P ₅ xP ₈	-15.13**	-56.53	-15.36**	-2.144	-1.046	-4.109**	6.600**	1.889	3.002*	-3.086*	-1.678	-4.836**
P ₆ xP ₇	-1.198	-0.476	-3.623	14.433**	144.793	14.319**	-8.105**	-2.616	-10.87**	0.988	2.082	0.511
P ₆ xP ₈	-2.979	-4.215	-3.660	4.520**	2.501	2.665	3.522**	0.650	-1.803	1.875	0.661	-0.936
P ₇ xP ₈	-6.386**	-3.528	-8.051**	-8.105**	-4.746	-9.648**	-22.87**	-2.689	-28.92**	-13.33**	-4.024	-16.11**
L.S.D.5%	1.600		1.850	1.130		1.300	1.100		1.270	1.270		1.470
L.S.D.1%	2.130		2.460	1.500		1.730	1.460		1.690	1.660		1.920

* Significant at 0.05 and 0.01 levels of probability respectively

significant mid-parental heterosis under 25 and 50 kg N/fed., while no crosses exhibited heterosis in negative direction under 75 kg N/fed. for maturity date. The range of mid-parental heterosis was -0.58 to -1.84% and -1.12 to -2.02 % under the two N levels, respectively due to over-dominance. However, the combination crosses; LAKTA-1 x Sakha 94 and LAKTA-1 x MELAL-1 had mid-parental heterosis in negative direction for earliness, especially under the lowest N level.

For spike length, seventeen, fifteen and nineteen crosses out of twenty-eight ones showed positive significant mid-parental heterosis ranged from 3.98 to 16.93%, 6.57 to 23.34 % and 5.18 to 27.87 % under 25,50 and 75 kg N/fed., respectively, due to over-dominance in most cases. For no. of spikes/plant, nine, twelve and fourteen crosses out of all ones exhibited significant mid-parental heterosis ranging from 8.56 to 27.71%, 4.45 to 18.67% and 7.20 to 32.60% under 25, 50 and 75 kg N/fed., respectively, a result of partial and over-dominance. Thirteen, eight and fifteen crosses had significant mid-parental heterosis in positive direction for no. of kernels/spike ranging from 4.41 to 20.28%, 4.37 to 18.17% and 2.34 to 15.15% under 25,50 and 75 kg N/fed., respectively, due to over-dominance in most cases and partial dominance in few ones. For 1000-kernel weight, twelve, sixteen and sixteen crosses showed significant positive mid-parental heterosis

ranging from 2.76 to 11.36%, 2.29 to 11.85% and 2.94 to 11.64% under 25,50 and 75 kg N/fed., respectively, due to partial dominance in some cases and over-dominance in some other ones. For grain yield/plant, twelve crosses out of all combinations expressed significant mid-parental heterosis in positive direction ranged from 4.42 to 21.74%, 2.86 to 23.08% and 3.20 to 23.77% under 25, 50 and 75 kg N/fed., respectively. In most cases, over-dominance was the type of dominant genes expressed such heterosis as the potency ratio pointed out.

From the above results, it could be concluded that comparable mid-parental heterosis was detected under the three N levels for the studied traits, it could be concluded also that the cross; LAKTA-1 x Sakha 94 expressed significant negative mid-parental heterosis for earliness and significant positive heterosis for yield and its components especially under the lowest N level, i.e., 25 kg N, promoting the breeder to use it in breeding program aim to earliness and high yielding potentiality with low fertilization level of N which safe the environment from pollution. Some other crosses; MELLAL-1x Gemmeiza 10, CHAM-6 /MayoN"s X Gemmeiza 7, LAKTA-1 x Gemmeiza 7 and Gemmeiza 7 X Gemmeiza 10 could be use also for high yielding under the lowest N level. Heterosis over mid-parents for yield and its components in wheat had been reported by several investigators among them, Hassan and Saad

Table (17): Heritability in narrow-sense (h^2) for earliness, yield and its components of wheat under three N fertilizer levels.

Traits	h^2		
	25 Kg N/fed.	50 Kg N/fed.	75 Kg N/fed.
Heading date	0.553	0.293	0.280
Maturity date	0.361	0.347	0.482
Spike length	0.362	0.277	0.323
No.of spikes/plant	0.380	0.599	0.340
No.of kernels/spike	0.410	0.394	0.300
1000-kernels weight	0.575	0.710	0.687
Grain yield/plant	0.161	0.256	0.236

(1996), Khan and Khan (1996), Sharma and Tandon (1996), Nehvi *et al.* (2000), Hussain *et al.* (2004) and Jahanzeb and Ihsan (2004).

(B) Heterosis over better parent (useful heterosis)

No heterotic effect over better parent in negative direction was detected in the present material for heading and maturity dates (Table 7 and 8). Concerning yield and its components, it could be observed that eight, eight and eleven crosses showed useful heterosis for spike length ranged from 7.52 to 10.27%, 6.88 to 22.86 and 4.18 to 25.53% under 25, 50 and 75 kg N/fed., respectively. Tow, two and seven crosses expressed useful heterosis for no. of spikes/plant ranged from 7.40 to 26.75 %, 7.77 to 8.80% and 7.48 to 16.91% under the three N levels, respectively. For no. of kernels/spike, nine, six and ten crosses out of all ones exhibited significant positive heterosis over better parent ranged from 2.31 to 8.52%, 5.28 to 9.88% and 2.37 to 14.34% under 25, 50 and 75 kg N/fed., respectively. Three, five and five crosses had useful heterosis for 1000-kernel weight ranged from 5.00 to 9.70%, 2.72 to 6.40% and 2.51 to 7.76% under the three N levels, respectively. For grain yield /plant, four, nine and eight crosses ranged from 11.41 to 17.49%, 2.90 to 16.65% and 2.39 to 17.90% under 25, 50 and 75 kg N/fed., respectively. However, it could be concluded that comparable estimates of useful heterosis were detected under the three N levels. The cross; MELLAL-1 x Gemmeiza 10 had useful heterosis for grain yield and most of its components studied herein, especially under the lowest N level which considered as favourable environment. The progeny of this cross could be used in suitable breeding program to improve the potentiality of grain yield under the lowest level of N fertilization.

Useful heterosis in wheat was previously reported by El-Sayed (1997), Patil *et al.* (1998), El-Seidy and Hamada (2000) and Jahanzeb and Ihsan (2004).

Heritability in narrow-sense (Table 17) was relatively high for heading date at the lowest N level, no. of spikes/plant at the middle N level and 1000-kernel weight at the three N levels, suggesting that indirect selection based on these traits under these conditions could be effective to improve wheat genotypes. High values of narrow-sense heritability were also reported by Ikram and Tanach (1991), Kheiralla *et al.* (1993),

Salem *et al.* (2000), Hamada (2003) and Hendawy and Maustafa (2003).

Low estimates of narrow-sense heritability were observed for no. of spikes/plant, no. of kernels/spike and grain yield/plant at the three N levels, indicating that most of genetic variance may be due to non-additive gene effect. These findings support the previous results of heterotic effects. Therefore, the breeding program based on bulk method might be quite promising to improve the present material. These results are in good agreement with those reported by Hassan and Abd El-Moniem (1991), Al-Kaddoussi (1996), Salem *et al.* (2000) and Hamada (2003).

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تقدير قوة الهجين تحت مستويات تسميد نيتروجيني مختلفه في التهجينات نصف الدائرية للقمح

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الملخص العربي

احتوت المادة الوراثية المستخدمة في هذا البحث على ثمانية تراكيب وراثية للقمح وهي: CHAM-6/MayoN's, NABEK-4,MELLAL-1, LAKTA-1 وجيمزة 7 ، جيمزة 9 ، جيمزة 10 ، سخا 94 والذى تمثل مدى واسع من التباينات لمعظم الصفات. هذه التراكيب الوراثية هجنت بنظام التهجين نصف الدائري فى موسم 2003/2004 بمزرعة محطة البحوث الزراعية بالجيزة - جمهوريه مصر العربيه. قيمت الآباء وهجنهما فى موسم 2004/2005 تحت ثلاث مستويات من السماد النيتروجيني هي 25 ، 50 ، 75 كجم N /فدان وكانت النتائج المتحصل عليها مایلى:

- تراوح النقص في المحصول ومكوناته تحت مستوى النتروجين المنخفض نسبة لمستوى النتيروجين المرتفع من 16% إلى 25% ، بينما كانت الهجن أكثر تبكيراً تحت مستوى النتيروجين المنخفض نسبة إلى التسميد المرتفع بحوالى 13.75% ، لصفتى ميعاد طرد السنابل وميعاد النضج على التوالى. ومن ذلك يتضح أنه بالإمكان تقليل الفقد في المحصول وتعظيم التبكيير في الهجن تحت الدراسة بإختيار برنامج التربية المناسب تحت مستوى التسميد المنخفض والذي يعتبر أحد أوجه حماية البيئة من التلوث.

- كان التباين بين كل التراكيب الوراثية، الآباء والهجين معنوياً وكانت قيم هذه التباينات أعلى من تباين الخطأ التجاربي لمرات عديدة مما يدل على نجاح الهدف من التهجينات لوجود الفرق الكافى من الاختلافات بين الصفات. كان تباين متوسط قوة الهجين لجميع التهجينات على المعنوية للصفات المدروسة وتحت جميع مستويات النتيروجين. وكان التفاعل بين تباين متوسط قوة الهجين ومستويات النتيروجين معنوياً لمعظم الصفات مما يدل على تغير متوسط قوة الهجين من بيئه إلى أخرى.

- تراوح المدى لقوة الهجين بناء على متوسط الأبوين من 0.58% إلى 0.84% تحت مستوى 25 كجم N/فدان، 0.52% إلى 0.38% تحت مستوى 50 كجم N/فدان ومن صفر إلى 1.15% تحت مستوى 75 كجم N/فدان لصفات التبكيير، وفي معظم الحالات كانت قوة الهجين راجعه للسيادة المتفوقة. وكان المدى لقوة الهجين بناء على متوسط الأبوين لصفة المحصل ومتكوناته من 2.76% إلى 27.71% تحت مستوى التسميد 25 كجم /فدان، 2.29% إلى 23.34% تحت مستوى 50 كجم /فدان و 2.34% إلى 32.6% تحت مستوى 75 كجم/فدان.

- على الجانب الآخر، تراوح المدى لقوة الهجين بناء على الأب الأفضل من 2.31% إلى 26.75% تحت مستوى 25 كجم N/فدان، 2.72% إلى 22.86% تحت مستوى 50 كجم N/فدان ومن 2.37% إلى 25.53% تحت مستوى 75 كجم N/فدان لصفات المحصل ومتكونات المحصل تحت الدراسة. وتشير هذه النتائج إلى تقارب قيم قوة الهجين تحت المستوى المنخفض من النتيروجين وهو المستوى (قليل التلوث للبيئة) نسبة إلى المستوى العالى والذى يحدث تلوثاً للبيئة بنسبة أعلى.

- على كل فإنه يمكن استنتاج أن الهجن: LAKTA-1 × سخا 94-1 METLLAL × جيمزة 10 يمكن استخدامها في برامج تربية تحت ظروف التسميد المنخفض بناء على متوسط سلوكها ونتائج قوة الهجين بها لمعظم الصفات تحت الدراسة. هذا إلى جانب أن تقديرات المكافئ الوراثي بمعناه الضيق تؤيد النتائج السابقة.