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INHERITANCE OF YIELD AND ITS COMPONENTS IN F_1 CROSSES OF WHEAT USING DIALLEL CROSSES UNDER THREE NITROGEN RATES

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ABSTRACT

A half diallel cross between eight common bread wheat varieties and/or lines (*Triticum aestivum vulgare* L.) was evaluated under three different nitrogen rates for six quantitative characters in RCBD with three replications. Nitrogen rates, genotypes, parents, hybrids, genotypes x nitrogen rates interaction and hybrids x nitrogen rates mean squares were significant for all traits under study. General and specific combing ability mean squares were found to be significant for all traits. High ratios which largely exceeded the unity were obtained for all studied traits except grain yield/plant in low and normal nitrogen fertilization rates indicating that large part of the total genetic variability associated with these traits was additive and additive by additive gene action. For the exceptional case GCA/SCA ratios was less than unity, therefore, it could be concluded that the large portion of the total genetic variability associated with this case is due to non-additive gene action. The largest heterotic magnitude express by the previous traits. May strength ened the conclusion about the 9 importance of non-additive gene effects in their inheritance. For grain yield/plant; eight, ten, eight and sit crosses expressed significant and positive ($\hat{S}_{ij}$) effects in zero, low, normal nitrogen levels and the combined analysis, respectively. However, the most desirable ($\hat{S}_{ij}$) effect were recorded for the crosses 3 x 6, 1 x 8, 2 x 4, 6 x 7 and 5 x 6 in the respective cases. Also, the cross 1 x 2 (8.40**) in zero nitrogen level, 2 x 4 (13.14**) in low nitrogen level and 1 x 8 (22.10**) in normal nitrogen level ranked the first best ($\hat{S}_{ij}$) effects in the respective cases.

It could be concluded that the parental genotype P2 and P3 seemed to be the best general combiner for grain yield/plant and some of its components in the combined analysis of the three nitrogen rates. Also, P2 and P5 gave the best combiner for heading date. The most desirable ($\hat{S}_{ij}$) effect were recorded by the crosses P3 x P6, P1 x P8, P2 x P4, P6 x P7 and P5 x P6 in the respective cases. Also, the cross 1 x 2 (8.40**) in zero nitrogen rate, P2 x P4 (13.14**) in low nitrogen rate and P1 x P8 (22.10**) in normal nitrogen rate ranked the first best ($\hat{S}_{ij}$) effects.

INTRODUCTION

Wheat (*Triticum aestivum* L.), as a nutritive crop, is considered one of the most important cereal crops in Egypt as well as in many parts of the world. The local production of wheat is not sufficient to cover the local consumption in Egypt.

Success of any plant breading program depends largely upon a better understanding of the genetic basis of yield and its contributing characters. Information about heterosis, general and specific combining abilities and the types of gene action may help the wheat breeder of formulate the most efficient breeding procedure for achievement of maximum genetic improvement among a particular set of genotypes. Besides, to identify desirable parents and cross combinations as genetic resources for improving yield and yield contributing charters. The long-term objective of the most plant breeding programs is to increase the unit area yield of high quality crop. Development of commercial (F_1) hybrid wheat may be one way of increasing yield one of the most important factors in determining the feasibility of hybrid wheat is the nature and amount of heterosis.

Grain yield is a complex trait made up of the interaction between different yield components and environmental effects. Because of these complex interaction, it is difficult to improve yield through breeding (especially in the early generation) if yield is the only factor recorded, suggesting that component traits should also be used as selection criteria for yield improvement. This is the reason why it is necessary to know the genetic architecture of yield components (Misra *et al.,*1994)

The ability of some crop cultivars to perform well over a wide range of environmental conditions has been long appreciated by the agronomist and plant breeder. The understanding of genotype-environment interaction in plant breeding is a matter of great interest, since genotype-environmental interaction usually hamper selection of the genotypes which consistently show superior performance over a series of environments. So that, the genotype-environment interaction variance should be partitioned into its components of variation.

The present investigation was carried out to study: 1- Mean performance of parental wheat cultivars, F1's crosses for heding date, plant yield and its components., 2- Estimation of general and specific combining abilities and their interactions with three different nitrogen fertilization levels, as three different environmental conditions, three nitrogen fertilization by application of Griffing method 2, model 1 (1956).

MATERIALS AND METHODS

This investigation was carried out at Etay EL-Baroud Agricultural Research Station, Behaira Governorate, Egypt during the two successive growing seasons of 2008/2009 and 2009/2010. Eight common bread wheat varieties and/or lines (*Triticum aestivum* L.), representing a wide divergent origin were used as parents, for make a diallel cross. The code number, name, pedigree and origin of these parental genotypes are presented in Table 1.

In 2008/2009 season, grains from each of the parental varieties and or lines were sown at various dates in order to overcome the differences in time of flowering during this season. All possible cross combinations without reciprocals were made among the eight genotypes to produce 28 F_1 seed hybrids.

Table 1: Genotype names, pedigree and origin of the eight bread wheat varieties and or lines.

No.	Variety and/or line	Pedigree	Origin
1	Sakha 94	OPATA / RAYON // KAUZ CMBW90Y3180-0TOPM-3Y-010M-010M-010Y-10M-015Y-0Y-0AP-0S	Egypt
2	Sids 12	BUC//7C/ALD/5/MAYA74/ON//1160.147/3/BB/GLL/4/ CHAT"S"/6/MAYA/VUL//CMH74A.630/4*SX SD7096-4SD-1SD-1SD-0SD	Egypt
3	Line 1	SSER 11/ MLAN	Egypt
4	Line 2	TUKURU / PASTOR	Egypt
5	Line 3	PG0 / SER1 // BAV92	Egypt
6	Line 4	NINGMAI9415-16 // SHA4 / CHIL /3/ NINGMAI50	Egypt
7	Line 5	CMH83.2578 \ ELVIRA	Mexico
8	Line 6	MILAN \ S87230 \\ BABAX	Mexico

In 2009/2010 season, 25th of November, the parental genotypes and their respective 28 hybrids were sown in three adjacent experiments were conducted three nitrogen fertilization rates, i.e., zero (low rate), 35 (low rate) and 70 (normal rate) Kg N/fad. Randomized complete block design with three replicates was used. Each plot consisted of two rows and each row was three meters long and 30cm apart. Plants within row were 20cm a part. Dry method of planting was used in this concern. The other cultural practices of growing wheat were properly practiced.

Data were recorded on ten individual guarded plants, chosen at random from each plot for F_1. for heading date, number of spikes/ plant, number of spikelets/ spike, number of kernels/ Spike, 1000- kernel weight and grain yield / plant.

The obtained data were statistically analyzed for analysis of variance by using computer statistical program MSTAT-C. General and specific combining ability estimates were estimated according to Griffing's (1956) diallel cross analysis designated as method 2 model I for each experiment. The combined analysis of the three experiments was carried out whenever homogeneity of variance was detected (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The analysis of variance for all studied traits at each nitrogen rates and across them is presented in Table 2. Results indicated that mean squares due to nitrogen rates were significant for all studied traits indicating over all differences between the three nitrogen rates. Significant genotypes mean squares were observed for all studied traits in each nitrogen rates and the combined data, indicating a wide diversity among the investigated wheat materials. Also, significant genotypes x nitrogen rates interaction mean squares were obtained for all studied traits. Such results clarified that the studied wheat genotypes differed from nitrogen rates to another. Results also, showed mean squares due to parents and crosses were significant for all studied traits at the three nitrogen rates as well as the combined data.

Such results indicate the presence of wide genetic variability among the tested parents and hybrids of wheat. Significant interaction between nitrogen rates and both of parent or crosses were detected for all studied traits. This means that the tested wheat parents and their F_1 hybrids responded differently to the three nitrogen rates.

The mean performances of the tested parent and hybrids for all traits studied in the three nitrogen rates as well as the combined data over them are presented in Table 3. For heading date the parental variety Sids (12), line 3 and line 6 gave lowest values of these traits. On the other hand, line 1 exhibited significantly latest for this trait in the combined analysis. Regarding crosses mean performance, it is clear that the crosses P7 x P8 (line 5 x line 6) and P2xP8 (Sids 12 x line 6) were the earliest crosses at the three nitrogen rates and the combined data since it expressed the lowest mean values for heading date being 85.78 and 86.78 in the combined data.

Earliness if found in wheat is favorable for escaping destructive injuries caused by wheat leaf rust like *Puccinia triticina* causes " black rust", *Puccinia recondite* causes " brown rust" and *P. sriformis* causes " yellow rust " it is the most prevalent of all the wheat rust disease, occurring in most wheat growing regions. Also, earliness is favorable for escaping destructive injuries in seed sating caused by high temperature at the end of season. For parent mean performance, it is clear that increasing the rate fertilization it gave increasing in number of spikes/plant. In this context, Sakha 94, line 1 and line 2 showed high number of spikes/plant at the normal rates of fertilization and the combined analysis. Also, the parent combination 1 x 8, 3 x 4, and 5 x 7 exhibited the highest mean values for this trait at the normal rates of fertilization and the combined analysis. For number of spikelets/spike, parents Sids 12, line 1, line 2, line 5 and line 6 were the best among the studied parents. Meanwhile, the single crosses P1xP8, P2xP4, P2xP 6, P2xP7, P3xP4, P3xP7, P4xP6, P4xP7, P4xP8, P5xP7, P6xP7, and P6 x P8 were the best among the studied crosses for this trait. Since these crosses recorded values from 24 for the cross 3 x 4 to 25.19 for the cross 4 x 7 in the combined analysis. The parent Sids 12 gave the best values for number of grains/spike since it recorded the highest values 82.33, 118.22, 98.00 and 99.52 in zero, low, normal and the combined analysis, respectively. The crosses P2 xP4 (Sids 12 x line 3) and P2xP8 (Sids 12 x line 6) exhibited the highest significant mean values which recorded 73.61, 83.44, 83.67 and 80.24 at zero, low, normal nitrogen rates and the combined analysis, respectively and the cross (P2 x P8) and 73.20, 89.53, 86.63 and 83.12 at zero, low, normal nitrogen rates and the combined analysis, respectively.

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Table 3: Mean performance of eight parental wheat genotypes and their F_1 crosses for all studied traits under three levels of nitrogen and their combined data.

	Heading date (day)				Number of spikes/ plant (No.)				Number of spikelets / spike (No.)			
	Fer. 1	Fer. 2	Fer.3	Comb.	Fer. 1	Fer. 2	Fer.3	Comb.	Fer. 1	Fer. 2	Fer.3	Comb.
1x1	91.33	94.33	96.33	94.00	7.42	17.86	20.92	15.40	20.24	22.83	23.22	22.10
2x2	88.00	89.67	90.33	89.33	8.00	9.05	8.20	8.42	22.83	24.11	24.47	23.80
3x3	95.00	95.67	96.67	95.78	9.80	16.22	19.15	15.06	23.67	23.66	24.33	23.89
4x4	80.33	98.67	99.33	92.78	9.20	19.39	18.00	15.53	23.13	24.00	24.33	23.82
5x5	89.00	92.00	92.33	91.11	7.08	15.28	17.67	13.34	19.08	20.44	21.67	20.40
6x6	92.33	93.00	100.67	95.33	10.14	12.27	17.66	13.36	20.16	23.20	23.44	22.27
7x7	89.33	92.00	93.00	91.44	14.22	15.16	15.16	14.85	24.67	26.55	25.50	25.57
8x8	89.67	90.67	90.67	90.33	7.45	8.17	7.93	7.85	24.29	25.28	25.77	25.11
1x2	87.33	89.67	91.00	89.33	10.05	16.22	16.30	14.19	23.44	22.72	23.55	23.24
1x3	89.00	89.67	91.67	90.11	9.67	18.66	16.75	15.03	22.73	23.55	23.83	23.37
1x4	93.33	96.00	96.33	95.22	11.25	13.68	20.00	14.98	22.50	23.53	24.60	23.54
1x5	90.33	93.33	95.00	92.89	8.67	17.97	13.45	13.36	19.77	22.50	22.63	21.64
1x6	94.33	95.33	96.33	95.33	7.40	19.55	16.50	14.48	21.40	23.66	23.43	22.83
1x7	90.33	92.33	93.33	92.00	8.28	12.40	15.78	12.15	22.67	24.47	24.28	23.80
1x8	90.67	91.67	92.67	91.67	10.09	13.08	23.05	15.41	23.84	24.17	25.78	24.60
2x3	88.67	90.33	93.00	90.67	9.64	9.81	13.44	10.96	22.83	24.09	24.44	23.79
2x4	90.67	91.67	92.33	91.56	11.50	19.39	16.26	15.72	23.61	25.11	25.22	24.65
2x5	89.33	90.00	91.00	90.11	8.92	10.87	13.44	11.07	20.94	22.87	23.00	22.27
2x6	89.67	90.33	91.33	90.44	10.92	10.89	12.67	11.49	23.55	24.11	24.50	24.05
2x7	89.00	90.33	91.33	90.22	7.28	11.73	13.83	10.95	23.00	25.00	25.17	24.39
2x8	86.67	86.33	87.33	86.78	6.47	6.78	6.60	6.61	23.00	24.22	24.64	23.95
3x4	95.67	96.67	97.33	96.56	10.17	13.00	20.22	14.46	23.80	23.78	24.42	24.00
3x5	91.00	93.33	94.67	93.00	9.73	14.52	18.12	14.12	22.20	21.87	23.27	22.44
3x6	93.33	94.67	96.33	94.78	9.62	18.89	17.80	15.43	22.60	23.66	24.57	23.61
3x7	92.33	94.33	96.33	94.33	9.14	13.11	19.10	13.78	23.00	24.11	26.44	24.52
3x8	92.67	94.33	96.00	94.33	9.32	12.22	11.58	11.04	23.43	24.55	24.33	24.11
4x5	92.33	95.33	96.67	94.78	7.68	18.22	13.00	12.97	21.13	23.00	22.20	22.11
4x6	94.33	97.33	98.33	96.67	10.28	14.67	17.50	14.15	23.00	25.00	26.44	24.81
4x7	90.33	92.00	93.33	91.89	6.94	17.55	15.33	13.28	23.78	26.11	25.70	25.19
4x8	89.33	90.33	91.33	90.33	10.83	12.72	12.55	12.04	24.23	24.55	24.83	24.54
5x6	95.33	96.67	98.00	96.67	6.08	17.08	16.33	13.17	20.00	22.39	23.17	21.85
5x7	90.33	91.33	92.33	91.33	7.39	13.44	22.44	14.42	22.00	25.89	25.00	24.29
5x8	93.33	95.33	96.67	95.11	6.55	12.61	11.40	10.19	22.47	24.16	23.67	23.43
6x7	93.00	95.00	96.33	94.78	9.94	13.11	16.17	13.07	23.55	26.55	25.44	25.18
6x8	90.33	92.00	93.33	91.89	10.57	12.55	12.89	12.00	23.40	25.44	25.49	24.78
7x8	84.33	86.00	87.00	85.78	8.53	10.55	9.25	9.45	23.40	23.77	24.61	23.93
LSD at 5%	0.99	1.09	0.79	0.95	1.69	2.40	2.58	2.22	1.16	1.27	1.01	1.13
LSD at1%	1.32	1.45	1.04	1.25	2.25	3.19	3.42	2.92	1.55	1.68	1.34	1.49

Table 3: Cont.

	Number of grains / spike (No.)				1000-grain weight (g)				Grain yield / plant (g)			
	Fer. 1	**Fer. 2**	**Fer.3**	**Comb.**	**Fer. 1**	**Fer. 2**	**Fer.3**	**Comb.**	**Fer. 1**	**Fer. 2**	**Fer.3**	**Comb.**
1x1	55.91	61.02	63.47	60.13	44.38	45.58	49.41	46.45	16.53	41.17	48.27	35.32
2x2	82.33	118.22	98.00	99.52	52.65	56.56	58.29	55.84	26.75	45.00	40.33	37.36
3x3	74.27	52.77	79.91	68.98	43.88	40.66	39.74	41.43	23.27	35.75	43.20	34.07
4x4	65.51	43.44	73.92	60.96	47.99	41.69	42.08	43.92	21.22	35.00	44.58	33.60
5x5	43.58	34.22	65.20	47.67	54.80	53.29	55.82	54.63	18.25	31.33	48.97	32.85
6x6	47.22	35.60	54.44	45.75	46.88	53.11	52.45	50.81	17.27	26.92	36.65	26.94
7x7	58.05	71.05	69.83	66.31	56.99	51.61	54.14	54.24	29.52	42.42	32.75	34.89
8x8	71.47	73.69	86.32	77.16	50.35	53.06	57.53	53.65	23.05	31.17	38.37	30.86
1x2	74.28	54.17	80.97	69.80	53.82	49.50	54.46	52.60	35.57	43.92	45.47	41.65
1x3	70.67	47.55	69.33	62.52	47.49	45.24	48.45	47.06	23.92	51.42	41.60	38.98
1x4	66.50	41.63	72.20	60.11	51.27	45.91	47.19	48.12	26.80	36.00	48.47	37.09
1x5	55.44	50.00	67.63	57.69	52.62	51.02	56.04	53.23	21.05	39.50	37.70	32.75
1x6	51.73	57.11	60.97	56.60	53.67	51.22	54.75	53.22	16.80	45.42	42.55	34.92
1x7	63.53	60.73	65.69	63.32	50.39	52.65	51.31	51.45	21.22	36.23	34.45	30.63
1x8	57.82	48.75	75.16	60.58	53.39	52.15	55.70	53.75	29.00	37.75	64.37	43.71
2x3	67.97	60.55	91.83	73.45	50.78	47.08	50.22	49.36	30.10	48.75	47.70	42.18
2x4	73.61	83.44	83.67	80.24	51.78	50.63	49.11	50.51	33.33	57.17	52.97	47.82
2x5	56.30	70.33	86.22	70.95	55.64	56.85	62.75	58.41	25.65	35.28	46.82	35.92
2x6	77.61	55.78	83.67	72.35	60.06	57.59	58.35	58.67	33.12	38.17	50.48	40.59
2x7	61.72	74.40	73.92	70.01	58.60	56.84	55.14	56.86	22.32	43.03	54.90	40.08
2x8	73.20	89.53	86.63	83.12	58.69	59.34	65.02	61.01	25.67	36.42	36.87	32.98
3x4	61.18	49.64	83.42	64.75	49.52	43.89	45.67	46.36	23.85	36.08	58.70	39.54
3x5	56.60	35.15	61.78	51.18	53.41	50.84	51.59	51.95	21.92	34.70	47.00	34.54
3x6	53.78	43.89	69.78	55.82	52.16	51.25	52.31	51.91	20.70	52.00	51.52	41.41
3x7	55.72	65.44	81.91	67.69	56.25	53.59	51.80	53.88	29.82	35.67	54.67	40.05
3x8	74.33	63.11	83.25	73.56	50.25	49.29	52.73	50.76	29.62	47.17	41.80	39.53
4x5	59.63	59.67	64.33	61.21	55.65	52.26	57.02	54.98	20.52	48.92	32.33	33.92
4x6	51.50	62.33	77.53	63.79	56.55	54.48	54.22	55.08	23.68	34.92	59.47	39.36
4x7	36.75	54.22	64.98	51.98	55.23	53.73	50.64	53.20	17.57	45.00	38.48	33.68
4x8	68.77	58.44	80.28	69.16	54.87	52.27	53.11	53.42	31.33	40.25	39.45	37.01
5x6	40.90	51.66	58.42	50.33	56.71	56.91	59.30	57.64	14.67	43.33	45.50	34.50
5x7	47.61	56.22	81.23	61.69	61.13	58.51	62.04	60.56	22.52	43.92	58.87	41.77
5x8	44.31	43.11	69.20	52.21	58.24	57.68	60.50	58.81	17.92	35.33	34.73	29.33
6x7	56.00	59.88	79.05	64.98	55.56	55.87	56.06	55.83	26.20	31.00	49.20	35.47
6x8	56.55	57.11	77.64	63.77	58.24	57.35	59.58	58.39	28.95	41.33	44.38	38.22
7x8	55.27	73.50	66.14	64.97	64.09	62.60	63.17	63.28	27.93	36.00	35.15	33.03
LSD at 5%	9.68	10.68	9.29	9.75	2.21	2.20	2.23	2.18	5.11	4.86	6.26	5.36
LSD at 1%	12.85	14.17	12.33	12.79	2.93	2.92	2.96	2.86	6.78	6.44	8.31	7.03

It is clear that Sids 12 and line 5 exhibited the highest mean values of grain yield/plant at zero and low nitrogen rates. Meanwhile, Sakha 94, Sids 12, line 1, line 2 and line 3 gave the highest mean values of this trait at normal nitrogen rate as well as the combined analysis. In the same trend, the crosses 1 x 2, 1 x 8, 2 x 3, 2 x 4, 3 x 6, and 5 x 7 showed the best mean values of grain yield/plant at zero, low and normal nitrogen rates. This result clear that, Sakha 94, Sids 12, line 1, line 2, line 3, and line 4could be considered the promising ones for high productivity. On this context, their parental combinations sakha 94 x sids 12, sids 12 x line 2, sakha 94 x line 5 and sids 12 x line 1 were superior for grain yield/plant.

Grain yield/plant tended to increase from 31.33, 52.00 to 64.37 gm with increasing nitrogen levels from zero, low and normal rates, respectively such increase may be due to the important role of N stimulating assimilation activities and hence vegetative growth as well as spike initiation and grain filling. Also, due to the favorable role of N in increasing spike length and number of grains/spike recorded herein. These results are confirmed with finding by Salem. (2000).

Analysis of variance for combining ability as outlined by Griffing's (1956) method 2 model 1 in each nitrogen rates and the combined data for all studied traits is presented in Table 2. Results indicated that mean squares associated with general (GCA) and specific (SCA) combining ability were significant for all studied traits. The variance of general combining ability includes the additive and additive X additive genetic portion. While, specific combining ability represents the non additive genetic portion of the total variance arising largely from dominance and epistatic deviations. If both general and specific combining ability mean squares are significant. One may ask which type and or types of gene action are important in determining the performance of single-cross progeny. To overcome such situation the size of mean squares can be used to assume the relative importance of both types of combining ability.

Both GCA and SCA mean squares were highly significant for all traits. Hence, GCA/SCA ratio was used as measure to reveal the nature of genetic involved. High ratios which largely exceeded the unity were obtained for all studied traits except grain yield/plant in low and normal nitrogen fertilization rates indicating that large part of the total genetic variability associated with these traits was additive and additive by additive gene action. For grain yield/ plant showed GCA/SCA ratios less than unity, therefore, it could be concluded that the large portion of the total genetic variability associated with these traits is due to non-additive gene action. The largest heterotic magnitude express by the previous traits. May strength ened the conclusion about the 9 importance of non-additive gene effects in their inheritance.

The importance of additive genetic variance in controlling yield and yield attributes in wheat was reported by several investigators, among those are: El-sayed *et al.* (2000) and Abdel-Wahed (2001) for number of spikes/plant; El-Sayed (1997), Hassan (1998) and Hendawy (1998) for number of grains/spike; Hassan (1998) and El-Sayed *et al.* (2000) for 1000-grain weight; Abdel-Shafi (1999), Mahmoud (1999) and El-sayed *et al.* (2000) for grains weight/plant. On the other hand, several investigators reported that non-additive gene action was responsible for the inheritance of wheat grain yield and its attributes Abdel-Shafi (1999), El-Sayed *et al.* (2000) and Abdel-Hameed (2002).

Also, results in Table 2 indicated that the interaction between GCA X nitrogen and SCA X nitrogen rates was significant for all studied traits indicating that the magnitude of additive and non-additive types of gene action varied from nitrogen rates to another.

It is fairly evident that the ratio for GCA x N /GCA was lower than ratio of SCA X D/SCA for all studied trait. This result indicated that non-additive effects were more influenced by nitrogen levels than additive genetic effects for these traits (Gelbert 1958).

General combining ability effects:

General combining ability effects were computed for the parents when the traits showing significant GCA mean squares. Estimates of GCA effects ($\hat{g}_i$) for individual parental genotype in each trait for each nitrogen rates i.e. zero, low, normal as well as the combined data are presented in Table 4.

Table 4: Estimating of general combining effects ($\hat{g}_i$) for all studied traits.

	Heading date				Number of spikes/ plant				Number of spikelets / spike			
	Fer. 1	Fer.2	Fer. 3	Comb.	Fer. 1	Fer.2	Fer. 3	Comb.	Fer. 1	Fer.2	Fer. 3	Comb.
P1	0.24*	0.23	0.25**	0.24*	-0.13	2.01**	2.46**	1.45**	-0.65**	-0.60**	-0.48**	-0.57**
P2	-1.83**	-2.64**	-2.85**	-2.44**	-0.08	-2.34**	-3.02**	-1.81**	0.27*	0.01	0.01	0.10
P3	1.71**	1.03**	1.22**	1.32**	0.53**	0.55*	1.62**	0.90**	0.46**	-0.33*	0.06	0.06
P4	-0.89**	2.23**	1.78**	1.04**	0.55**	2.08**	1.18**	1.27**	0.50**	0.29*	0.27*	0.35**
P5	0.44**	0.49**	0.25**	0.39**	-1.24**	0.81**	0.44	0.00	-1.67**	-1.27**	-1.31**	-1.41**
P6	1.94**	1.29**	2.48**	1.91**	0.35	0.41	0.61*	0.46	-0.55**	0.10	0.06	-0.13
P7	-0.73**	-0.91**	-1.05**	-0.89**	0.44*	-0.49	0.31	0.09	0.74**	1.28**	0.83**	0.95**
P8	-0.89**	-1.71**	-2.08**	-1.56**	-0.43*	-3.03**	-3.59**	-2.35**	0.90**	0.52**	0.55**	0.66**
LSD $\hat{g}_i$ at 5%	0.21	0.23	0.16	0.20	0.35	0.50	0.54	0.47	0.24	0.27	0.21	0.24
LSD $\hat{g}_i$ at 1%	0.28	0.30	0.22	0.27	0.47	0.67	0.72	0.62	0.32	0.35	0.28	0.32
LSD ($\hat{g}_i$ - $\hat{g}j$) at 5%	0.31	0.35	0.25	0.30	0.54	0.76	0.82	0.70	0.37	0.40	0.32	0.36
LSD ($\hat{g}_i$ - $\hat{g}j$) at 1%	0.42	0.46	0.33	0.40	0.71	1.01	1.08	0.93	0.49	0.53	0.42	0.48

Table (4): Cont.

	Number of grains/ spike				1000-kernal weight				Grain yield per plant			
	Fer. 1	Fer.2	Fer. 3	Comb.	Fer. 1	Fer.2	Fer. 3	Comb.	Fer. 1	Fer.2	Fer. 3	Comb.
P1	0.99	-4.74**	-5.31**	-3.02**	-3.21**	-3.17**	-2.02**	-2.80**	-1.20*	1.17*	0.40	0.12
P2	10.75**	19.53**	11.09**	13.79**	1.12**	2.04**	2.47**	1.88**	3.99**	3.19**	0.87	2.68**
P3	4.69**	-5.85**	2.92**	0.59	-3.59**	-4.80**	-5.47**	-4.62**	0.71	1.64**	2.22**	1.52**
P4	0.71	-3.31**	0.23	-0.79	-1.26**	-3.40**	-4.58**	-3.08**	0.01	0.75	1.19	0.65
P5	-9.39**	-9.48**	-5.28**	-8.05**	1.95**	2.01**	3.40**	2.45**	-3.87**	-1.72**	-0.63	-2.07**
P6	-5.94**	-7.04**	-5.60**	-6.19**	0.32	2.04**	1.26**	1.20**	-2.07**	-2.09**	0.92	-1.08
P7	-4.92**	5.72**	-1.94	-0.38	3.17**	2.65**	1.15**	2.32**	0.72	-0.52	-1.60*	-0.46
P8	3.13**	5.16**	3.90**	4.06**	1.50**	2.63**	3.79**	2.64**	1.71**	-2.43**	-3.37**	-1.36*
LSD $\hat{g}_i$ at 5%	2.03	2.23	1.94	2.07	0.46	0.46	0.47	0.46	1.07	1.02	1.31	1.13
LSD $\hat{g}_i$ at 1%	2.69	2.96	2.58	2.74	0.61	0.61	0.62	0.61	1.42	1.35	1.74	1.50
LSD ($\hat{g}_i$ - $\hat{g}j$) at 5%	3.06	3.38	2.94	3.13	0.70	0.70	0.71	0.70	1.62	1.54	1.98	1.71
LSD ($\hat{g}_i$ - $\hat{g}j$) at 1%	4.06	4.48	3.90	4.15	0.93	0.92	0.94	0.93	2.15	2.04	2.63	2.27

*** and ** significant at 0.05 and 0.01 levels of probability, respectively.**

The parent (P1) exhibited significant positive ($\hat{g}_i$) effects for grain yield/plant at low nitrogen rate, and number of spikes/plant at each of low, normal nitrogen rate and the combined analysis.

The parent 2 (Sids 12) gave highly significant negative ($\hat{g}_i$) effects for heading date in the three nitrogen rates as well as the combined analysis. Such results indicated that Sids 12 could be a good combiner for developing early heading and maturity genotypes. On the other hand, this parent P2 (sids 12) expressed highly significant positive ($\hat{g}_i$) for number of grains/spike and 1000-grain weight at the three nitrogen rates as well as the combined analysis, number of spikes /plant at low, normal N-rate and combined data, number of spikelets/spike at zero nitrogen rate and grain yield/plant at zero, low N rate and the combined analysis. Such results indicated that the parental new variety Sids 12 could be considered as excellent combiner for developing early maturity genotypes.

The parent No. 3 (line 1) showed that significant positive ($\hat{g}_i$) effects for number of spikes/plant at the three nitrogen rates as well as the combined analysis, number of spikes/ plant at zero nitrogen level, number of grains/spike at zero and normal level of nitrogen and grain yield/plant at low, normal and combined analysis. This parent could be considered as the second best combiner for grain yield/plant and some of its components.

The parent No. 4 (line 2) seemed to be good combiner for number of spikes/plant, number of spikelets/spike at the three nitrogen levels and the combined analysis. On the contrary, it expressed either undesirable significant or non appreciable ($\hat{g}_i$) values for the other traits.

The parent No. line 5 exhibited significant positive ($\hat{g}_i$) effects for 1000-grain weight at three nitrogen rates and the combined analysis, number of spikes/plant at low nitrogen rate. It was around the average for the other cases.

The parent No. 6 (line 4) behaved as the best combiner for number of spikes/plant at normal nitrogen levels, 1000-grain weight at low, height and the combined data. However, it gave undesirable ($\hat{g}_i$) effects for other traits.

The parent No. 7 (line 5) seemed to be good combiner for heading date, 1000-grain weight, number of spikelets/spike, number of spikes and number of grains/spike at low nitrogen rate. It is worth noting that earliness is required for developing early maturing season to escape stem rust. The parent which possessed high ($\hat{g}_i$) effects for total yield/plant showed the same effect for one or more of the traits contributing to grain yield. However, it exhibited either significant undesirable or insignificant ($\hat{g}_i$) effects for the other traits.

The parent No. 8 (line 6) showed that significant negative ($\hat{g}_i$) effect for heading date indicating that this parent could be considered as good combiner for developing early genotypes. Also, it gave significant ($\hat{g}_i$) effects for number of spikelets/spike, number of grains/spike, 1000-grain weight at the three nitrogen levels as well as the combined analysis and grain yield/plant at zero N-rate.

From the previous result, it could be concluded that the parental genotype P2 and P3 seemed to be the best general combiner for grain yield/plant and some of its components in the combined analysis of the three nitrogen rates. Also, P2 and P5 gave the best combiner for heading date.

In most traits, the values of ($\hat{g}_i$) effects mostly differed from nitrogen rate to another. This finding coincided with that reached above where significant GCA by nitrogen rates mean squares were detected in Table 2.

Specific combining ability:

Specific combining ability effects for 28 F_1 crosses were estimated for all studied traits at the three nitrogen rates as well as the combined analysis are presented in Table 5. For heading date, ten, nine, twelve and seven parental combinations exhibited significant negative ($\hat{S}_{ij}$) effects under zero, low, normal nitrogen rates and the combined analysis, respectively. Also, the crosses 1 x 3 under different nitrogen levels and the combined gave the best crosses for SCA. Thus, it could be considered stable cross and of great value in practical nitrogen rate breeding programs to produce early heading genotypes. For number of spikes/plant; seven, five, four and four crosses at zero, low normal and the combined analysis, respectively gave significant and positive ($\hat{S}_{ij}$) effects. However the best ($\hat{S}_{ij}$) effects were detected for the crosses P1 x P8 (3.43**), P2xP4 (3.37**) and P3xP6 (3.05**) for the respective cases. As fore number of spikelets per spike; five, three, three and two crosses exhibited significant and positive $\hat{S}_{ij}$ effects in zero, low, normal N-rate and the combined analysis, respectively. However the best $\hat{S}_{ij}$ effects were detected for the crosses P6xP7 (1.35**) and P1xP8 (0.85*) for the respective cases in the combined analysis.

For number of grains per spike; five, five, four and one crosses exhibited significant and positive ($\hat{S}_{ij}$) effects in zero, low, normal nitrogen rate and the combined analysis, respectively. However, the best ($\hat{S}_{ij}$) effects were detected by the cross 3 x 8 (7.46**) for the respective cases in the combined analysis. Regarding 1000-grain weight, eleven, seven, ten and ten crosses gave significant and positive ($\hat{S}_{ij}$) effects in zero, low, normal nitrogen rate and the combined analysis, respectively. Also, the crosses

P2xP8, P3xP6, P4xP8, P5xP6, P4xP6 and P6xP7 were exhibited the best ($\hat{S}_{ij}$) effects in the nitrogen rates as well as the combined analysis.

Table 5: Estimates of specific combining ability effects for crosses studies in each nitrogen levels as well as the combined data.

	Heading date				Number of spikes / plant				Number of spikelets / spike			
	Fer. 1	Fer.2	Fer. 3	Comb.	Fer. 1	Fer.2	Fer. 3	Comb.	Fer. 1	Fer.2	Fer. 3	Comb.
1x2	-1.70**	-0.63	-0.46	-0.93**	1.20*	2.42**	1.41	1.67**	1.23**	-0.72	-0.35	0.05
1x3	-3.57**	-4.30**	-3.86**	-3.91**	0.20	1.97*	-2.78**	-0.20	0.33	0.45	-0.12	0.22
1x4	3.36**	0.84*	0.24	1.48**	1.77**	-4.54**	0.91	-0.62	0.06	-0.18	0.43	0.10
1x5	-0.97**	-0.10	0.44	-0.21	0.97	1.02	-4.90**	-0.97	-0.50	0.34	0.05	-0.04
1x6	1.53**	1.10**	-0.46	0.73*	-1.88**	3.00**	-2.02*	-0.30	0.01	0.14	-0.52	-0.12
1x7	0.20	0.30	0.08	0.19	-1.09*	-3.25**	-2.45**	-2.26**	-0.02	-0.24	-0.44	-0.23
1x8	0.70*	0.44	0.44	0.53	1.59**	-0.03	8.73**	3.43**	1.00**	0.22	1.33**	0.85
2x3	-1.84**	-0.76*	0.58*	-0.67*	0.12	-2.53**	-0.62	-1.01	-0.49	0.38	0.00	-0.04
2x4	2.76**	-0.63	-0.66*	0.49	1.97**	5.51**	2.64**	3.37**	0.25	0.79	0.56	0.53
2x5	0.10	-0.56	-0.46	-0.31	1.17*	-1.73*	0.56	0.00	-0.25	0.10	-0.08	-0.08
2x6	-1.07**	-1.03**	-2.36**	-1.49**	1.58**	-1.32	-0.38	-0.04	1.24**	-0.03	0.06	0.42
2x7	0.93**	1.17**	1.18**	1.09**	-2.14**	0.44	1.08	-0.21	-0.60	-0.31	-0.04	-0.32
2x8	-1.24**	-2.03**	-1.79**	-1.69**	-2.09**	-1.98*	-2.25**	-2.11	-0.76*	-0.33	-0.29	-0.46
3x4	4.23**	0.70*	0.28	1.74**	0.02	-3.76**	1.97*	-0.59	0.25	-0.20	-0.29	-0.08
3x5	2.33**	-0.90*	1.21**	0.88**	-2.09**	-0.97	-0.17	-1.08*	-0.38	-0.56	0.05	-0.30
3x6	0.00	-0.36	-0.92**	-0.43	-0.88	3.80**	6.23**	3.05**	0.33	-0.13	1.11**	0.44
3x7	3.16**	-0.30	4.44**	2.44**	-0.84	1.05	-0.91	-0.23	0.64	0.80	0.05	0.49
3x8	1.16**	-4.10**	0.84**	-0.70*	0.09	-0.05	-0.21	-0.06	0.77*	-2.05**	0.18	-0.36
4x5	-1.34**	1.50**	-1.12**	-0.32	1.58**	-1.08	0.42	0.31	0.46	-0.87*	0.50	0.03
4x6	-4.67**	2.30**	-3.92**	-2.10**	-0.54	0.57	-2.93**	-0.96	-0.83*	0.34	-1.14**	-0.55
4x7	-1.77**	-0.10	-0.86**	-0.91**	1.38*	1.20	0.60	1.06*	0.81*	-0.04	0.14	0.30
4x8	-0.94**	1.10**	-1.42**	-0.42	-0.33	-1.96*	0.12	-0.72	0.10	0.59	0.07	0.26
5x6	0.73*	-2.03**	2.11**	0.27	-0.90	1.83*	1.71*	0.88	-0.79*	0.52	1.18**	0.30
5x7	1.23**	-2.90**	2.81**	0.38	0.15	-0.46	-1.90*	-0.74	-0.52	-0.28	-0.66*	-0.48
5x8	2.16**	2.17**	0.58*	1.64**	-0.69	1.73*	-4.07**	-1.01	-0.29	-0.47	-1.14**	-0.63
6x7	2.66**	-0.96**	0.01	0.57	0.31	-1.00	0.26	-0.14	0.46	1.85**	1.74**	1.35**
6x8	1.33**	3.84**	-1.46**	1.24**	-3.11**	0.70	-1.61	-1.34	-0.05	0.89*	0.23	0.35
7x8	0.50	1.90**	-2.42**	-0.01	1.65**	-0.94	-0.49	0.08	0.24	1.15**	-0.37	0.34
LSD at 5% Sij	0.64	0.70	0.50	0.61	1.09	1.54	1.65	1.43	0.75	0.81	0.65	0.74
LSD at 1% Sij	0.85	0.93	0.67	0.82	1.44	2.04	2.19	1.89	0.99	1.08	0.86	0.98
LSD at 5% Sij-Sik	0.94	1.04	0.75	0.91	1.61	2.28	2.45	2.11	1.11	1.20	0.96	1.09
LSD at 1% Sij-Sik	1.25	1.38	0.99	1.21	2.13	3.03	3.25	2.80	1.47	1.59	1.27	1.44
LSD at 5% Sij-Skl	0.89	0.98	0.70	0.86	1.51	2.15	2.31	1.99	1.04	1.13	0.90	1.03
LSD at 1% Sij-Sik	1.18	1.30	0.93	1.14	2.01	2.85	3.06	2.64	1.38	1.50	1.20	1.36

Table 5: Cont.

	Number of grains / spike				1000-grain weight				Grain yield / plant			
	Fer. 1	**Fer.2**	**Fer. 3**	**Comb.**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**
1x2	2.33	-19.44**	0.52	-5.53	2.19**	-1.65*	-0.09	0.15	8.40**	-0.54	-1.04	2.27
1x3	4.78	-0.68	-2.94	0.39	0.56	0.93	1.84*	1.11	0.03	8.51**	-6.26**	0.76
1x4	4.59	-9.14**	2.62	-0.64	2.02**	0.19	-0.31	0.63	3.61*	-6.01**	1.64	-0.25
1x5	3.63	5.40	3.55	4.19	0.16	-0.11	0.56	0.21	1.74	-0.05	-7.31**	-1.87
1x6	-3.53	10.06**	-2.79	1.25	2.84**	0.07	1.41	1.44*	-4.31*	6.24**	-4.01	-0.69
1x7	7.25*	0.94	-1.72	2.15	-3.30**	0.89	-1.92**	-1.44*	-2.68	-4.52**	-9.59**	-5.60**
1x8	-6.51*	-10.49**	1.91	-5.03	1.38	0.41	-0.18	0.54	4.11*	-1.09	22.10**	8.37**
2x3	-7.68*	-11.95**	3.16	-5.49	-0.47	-2.44**	-0.89	-1.27*	1.03	3.82*	-0.63	1.41
2x4	1.95	8.41*	-2.32	2.68	-1.80*	-0.30	-2.89**	-1.66*	4.96**	13.14**	5.67**	7.92**
2x5	-5.26	1.46	5.74	0.65	-1.15	0.52	2.78**	0.71	1.15	-6.28**	1.33	-1.26
2x6	12.59*	-15.53**	3.51	0.19	4.90**	1.23	0.52	2.22*	6.83**	-3.03	3.45	2.42
2x7	-4.32	-9.66**	-9.90**	-7.96*	0.59	-0.13	-2.58**	-0.71	-6.77**	0.27	10.39**	1.30
2x8	-0.88	6.02	-3.02	0.71	2.35**	2.39**	4.65**	3.13**	-4.41**	-4.44**	-5.87**	-4.91
3x4	-4.42	-0.02	5.61	0.39	0.65	-0.19	1.62*	0.69	-1.25	-6.40**	10.05**	0.80
3x5	-3.98	-8.34*	-5.37	-5.90	0.72	1.35	0.55	0.87	-3.77*	-5.32**	-0.03	-3.04
3x6	1.71	-2.04	13.78**	4.48	2.29**	1.74*	3.39**	2.47**	1.28	12.35**	15.85**	9.83**
3x7	-9.64**	0.17	-4.08	-4.52	1.07	0.40	-0.79	0.23	-4.31*	5.75**	-6.51**	-1.69
3x8	6.65*	3.81	11.93**	7.46*	-1.66*	5.04**	-0.45	0.98	3.18	-1.15	4.63*	2.22
4x5	-0.85	6.76	4.69	3.53	2.70**	3.46**	0.43	2.20*	4.93**	-5.55**	1.59	0.32
4x6	-3.15	4.98	-10.48**	-2.89	5.70**	-0.81	4.12**	3.00**	1.12	7.86**	-5.13*	1.28
4x7	1.09	13.64**	-10.52**	1.40	1.33	1.37	-0.44	0.75	0.70	9.79**	0.17	3.55*
4x8	-5.18	13.86**	-2.19	2.16	1.71*	3.56**	2.42**	2.56**	-2.31	-3.84*	3.13	-1.01
5x6	-4.26	-7.01*	6.27*	-1.66	2.94**	2.20**	2.01**	2.38**	4.01*	4.67**	8.80**	5.83**
5x7	6.31*	-2.22	1.77	1.95	-1.39	0.76	0.30	-0.11	2.82	1.83	-2.29	0.79
5x8	8.11*	9.36**	-5.28	4.06	1.24	0.58	4.10**	1.97*	-0.01	7.04**	-13.47**	-2.14
6x7	-3.48	1.16	8.24**	1.97	3.77**	1.57*	3.44**	2.93**	1.37	6.06**	12.12**	6.51**
6x8	-19.25**	-11.39**	-7.97**	-12.87**	-0.40	0.76	-0.03	0.11	-7.54**	-0.61	-6.35**	-4.84**
7x8	4.72	2.39	1.49	2.87	0.91	-1.10	-0.20	-0.13	5.23**	-6.49**	-3.61	-1.62
LSD at 5% Sij	6.21	6.85	5.96	6.34	1.42	1.41	1.43	1.42	3.28	3.11	4.01	3.47
LSD at 1% Sij	8.24	9.09	7.91	8.41	1.88	1.87	1.90	1.88	4.35	4.13	5.33	4.60
LSD at 5% Sij-Sik	9.19	10.14	8.82	9.38	2.10	2.09	2.12	2.10	4.85	4.61	5.94	5.13
LSD at 1% Sij-Sik	12.19	13.45	11.70	12.44	2.78	2.77	2.81	2.79	6.44	6.11	7.88	6.81
LSD at 5% Sij-Skl	8.66	9.56	8.31	8.84	1.98	1.97	2.00	1.98	4.57	4.34	5.60	4.84
LSD at 1% Sij-Sik	11.49	12.68	11.03	11.73	2.62	2.61	2.65	2.63	6.07	5.76	7.43	6.42

*** and ** significant at 0.05 and 0.01 levels of probability, respectively.**

For grain yield/plant; eight, ten, eight and six crosses expressed significant and positive ($\hat{S}_{ij}$) effects at zero, low, normal nitrogen rate and the combined analysis, respectively. However, the most desirable ($\hat{S}_{ij}$) effect were recorded by the crosses P3 x P6, P1 x P8, P2 x P4, P6 x P7 and P5 x P6 in the respective cases. Also, the cross 1 x 2 (8.40**) in zero nitrogen rate, P2 x P4 (13.14**) in low nitrogen rate and P1 x P8 (22.10**) in normal nitrogen rate ranked the first best ($\hat{S}_{ij}$) effects.

In these crosses showing high specific combining ability involving only one good combiner, such combinations would show desirable transgressive segregates, providing that the additive genetic system present in the good combiner as well as the complementary and epistatic effect in the cross, act in the same direction to reduce undesirable plant characteristics and maximize the character in view. Therefore, the previous crosses might be of prime importance in breeding program for traditional breeding procedures. In most traits, the values of SCA effects were mostly different from nitrogen rate to another. This finding coincided with that reached above where significant SCA by nitrogen rates mean squares were detected Table 2.

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وراثة المحصول ومكوناتة فى الجيل الاول للقمح بأستخدام التهجين النصف تبادلى تحت ثلاث مستويات من النيتروجين

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تم أجراء التحليل النصف تبادلى بين ثمانية اصناف وسلالات من قمح الخبز و تم تقييم الهجن تحت ثلاث مستويات من التسميد الازوتى فى تصميم قطاعات كاملة العشوائية بثلاثة مكررات و تم تقدير ٦ صفات و هى (طرد السنابل – عدد السنابل – عدد السنيبلات فى السنبلة – عدد الحبوب بالسنبلة – وزن ١٠٠٠ حبة – و محصول حبوب النبات).

كان تباين كل من التراكيب الوراثية, الاباء, الهجن, التراكيب الوراثية x النيتروجين و الهجن X النيتروجين فى جميع الصفات تحت الدراسة و كان تباين القدرة العامة و الخاصة على التآلف معنويا فى جميع الصفات تحت الدراسة. و كانت النسبة (القدرة العامة على التآلف/ القدرة الخاصة على التآلف) تزيد عن الوحدة فى جميع الصفات تحت الدراسة عدا صفة محصول الحبوب/ نبات فى المستوى المنخفض للنيتروجين وهذا يرجع الى ان التباين الوراثى يكون راجع الى التأثير المضيف و المضيف x المضيف. و بالنسبة لمحصول الحبوب/ نبات فأن النسبة اقل من الوحدة و هذا يدل على ان التباين الوراثى راجع الى التأثير الغير مضيف.

اظهر الاب رقم ٢ (سدس ١٢) افضل الآباء فى القدرة على التآلف لصفة التبكير فى طرد السنابل و محصول الحبوب/نبات. اما بالنسبة لصفة محصول الحبوب/ نبات اظهر ثمانية , عشرة, ثمانية و ستة هجن معنوية موجبة و معنوية فى المستوى النيتروجينى صفر, المنخفض , العادى و التحليل التجميعى على الترتيب.

و كانت افضل الهجن فى قدرتها الخاصة على التآلف لصفة محصول الحبوب/ نبات ٣x٦ , ١X٨ , ٢x٤ , ٦x٧ و ٥x٦. و كان افضل الهجن فى قدرتها الخاصة على التآلف لصفة محصول الحبوب/ نبات هو الهجين ١X٢ (٨,٤٠**) فى المستوى التسميدى صفر, الهجين ٢x٤ (١٣,١٤**) فى المستوى التسميدى المنخفض و ١X٨ (٢٢,١٠**) فى المستوى التسميدى العادى.

وتوصى الدراسة الى احلال الصنف سدس ١٢ محل الأصناف المنزرعة لما يتميز به من انتاجيه عالية و يمكن ان يدخل فى برامج التربية لما لديه من قدره عامه على التآلف. و من الواضح ان الهجن ٣x٦ , ١X٨ , ٢x٤ , ٦x٧ و ٥x٦. و كان افضل الهجن فى قدرتها الخاصة على التآلف لصفة محصول الحبوب/ نبات. و يمكن استخدام تلك الهجن فى انتاج سلالات جديده لها انتاجيه عاليه عن طريق طرق التربية المختلفة.

قام بتحكيم البحث

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Table 2: Observed mean squares from analysis of variance for studied traits in each nitrogen level and combined data.

	df		Heading date				Number of spikes / plant				Number of spikelets/ spike			
Sources of variance	**S**	**C**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**
Nitrogen (N)		2				323.68**				1230.40**				95.95**
Rep.x N	2	6	1.56*	1.12	2.11**	1.60**	8.53**	6.79	0.56	5.29*	1.75*	0.39	0.52	0.89
Genotypes	35	35	28.57**	25.72**	30.37**	65.76**	8.86**	34.37**	46.84**	48.22**	5.77**	4.95**	3.80**	12.15**
Parents	7	7	54.90**	25.31**	45.88**	49.97**	16.53**	48.46**	72.39**	86.84**	13.51**	9.63**	5.19**	25.97**
Crosses	27	27	21.04**	26.45**	26.63**	72.28**	7.19**	31.99**	41.93**	39.97**	3.85**	3.84**	3.49**	8.73**
Pxf1	1	1	47.86**	8.90**	22.88**	0.24	0.33	0.06	0.52	0.79	3.44*	2.18	2.44*	7.98**
entrx N		70				9.45**				20.93**				1.18**
parenxlN		14				38.06**				25.27**				1.18**
crosx N		54				0.92**				20.57**				1.23**
P1vsF1xN		2				39.70**				0.06				0.04
Error	70	210	0.37	0.45	0.23	0.35	1.09	2.19	2.52	1.93	0.51	0.61	0.39	0.50
GCA	7	7	17.70**	26.69**	35.03**	67.89**	3.77**	34.88**	46.71**	58.00**	7.70**	5.80**	4.31**	16.35**
SCA	28	28	7.48**	4.04**	3.90**	10.42**	2.75**	5.60**	7.84**	5.59**	0.48**	0.61**	0.50**	0.98**
Ent.xN		70				9.45**				20.93**				1.18**
GCAxN		14				5.76**				13.68**				0.73**
SCAxN		56				2.50**				5.30**				0.31**
Error	70	210	0.12	0.15	0.08	0.12	0.36	0.73	0.84	0.64	0.17	0.20	0.13	0.17
GCA/SCA			2.37	6.60	8.98	6.51	1.37	6.22	5.96	10.37	16.01	9.48	8.54	16.76
GCAxN/GCA						0.08				0.24				0.04
SCAxN/SCA						0.24				0.95				0.32

Table 2:Cont

			Number of grains/ spike				1000-grain weight				Grain yield/ plant			
Sources of variance	**S**	**C**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**	**Fer. 1**	**Fer.2**	**Fer. 3**	**Comb.**
Nitrogen (N)		2				8316.56**				99.71**				12759.96**
Rep.x N	2	6	98.25	65.39	36.41	66.68	12.60**	5.86*	0.95	6.47**	127.36**	112.06**	1.55	80.32**
Genotypes	35	35	369.59**	803.70**	304.50**	1017.54**	61.69**	76.20**	95.29**	208.31**	84.52**	134.03**	200.99**	173.60**
Parents	7	7	546.67**	2260.31**	578.93**	2651.86**	69.11**	106.68**	145.59**	270.56**	63.74**	118.93**	96.45**	90.42**
Crosses	27	27	332.43**	449.04**	243.94**	626.19**	43.93**	61.93**	76.02**	163.75**	86.48**	124.61**	220.71**	163.51**
Pxf1	1	1	133.63	183.33*	18.74	143.81	489.27**	248.21**	263.35**	975.68**	177.09**	494.00**	400.37**	1028.33**
entrx N		70				230.13**				12.44**				122.97**
parenxlN		14				367.02**				25.41**				94.35**
crosx N		54				199.61**				9.07**				134.14**
P1vsF1xN		2				95.95				12.57**				21.56
Error	70	210	35.51	43.23	32.71	37.15	1.85	1.84	1.89	1.86	9.90	8.94	14.85	11.23
GCA	7	7	423.49**	925.12**	339.93**	1371.46**	60.32**	101.33**	128.42**	265.80**	57.88**	40.37**	31.99**	74.87**
SCA	28	28	48.13**	103.60**	41.89**	81.11**	10.62**	6.42**	7.60**	20.34**	20.75**	45.75**	75.75**	53.62**
Ent.xN		70				230.13**				12.44**				122.97**
GCAxN		14				158.54**				12.13**				27.69**
SCAxN		56				56.25**				2.15**				44.31**
Error	70	210	11.84	14.41	10.90	12.38	0.62	0.61	0.63	0.62	3.30	2.98	4.95	3.74
GCA/SCA			8.80	8.93	8.11	16.91	5.68	15.79	16.90	13.07	2.79	0.88	0.42	1.40
GCAxN/GCA						0.12				0.05				0.37
SCAxN/SCA						0.69				0.11				0.83

*** and ** significant at 0.05 and 0.01 levels of probability, respectively.**