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GENERATION MEAN ANALYSIS OF SOME AGRONOMIC TRAITS, BLAST DESEASE AND STEM BORER RESISTANCE IN TWO RICE CROSSES UNDER TWO N-LEVELS

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Abstract

Two rice crosses (HR2824-B-3-2-3 × Sakha 101) and (GZ 5310-20-3-3 × Sakha 101) and their six population (P_1, P_2, F_1, F_2, BC_1 and BC_2) were evaluated for some agronomic characters, blast reaction and stem borer under two nitrogen fertilizer levels; 40 and 80 units/ feddan L_1 and L_2. Highly significant positive values of heterosis were found for grain yield/plant, panicle length and primary branches in cross I at L_1 and L_2 and high negative heterotic effects were detected for blast reaction at both nitrogen levels, stem borer % at L_1 in cross I. Highly significant negative values for inbreeding depression were obtained for stem borer % and blast reaction in both crosses at L_1 and L_2. Highly significant positive values (Id) were found for grain yield/plant, panicle length and primary branches at the two nitrogen levels and both crosses. Overdominance, over the higher parent, was found for grain yield/plant, panicle length and primary branches in cross I at both nitrogen levels, spikelets/ panicle and primary branches in cross II at L_1 and L_2, grain yield/plant and panicle length in cross II at L_2, and harvest index % for the same cross at L_1. Overdominance, over the lower parent, was recorded for plant height in cross I at L_1 and L_2, plant height and days to heading at L_1 in cross II. Partial dominance, towards the better parent, was found for spikelets/panicle and panicle length in cross I at L_1 and L_2, harvest index % at L_2 in the same cross. Absence of dominance was found for stem borer % in cross I at L_1. The additive gene effects (a) were found to be highly significant for all traits in both crosses and both nitrogen levels except for blast reaction and primary branches in the cross I at L_1, stem borer % and harvest index % in cross II at L_2 and spikelets/ panicle in the same cross at L_1. Dominance gene effects (d) were detected to be highly significant for most of the studied characters except for plant height in cross I at L_2, panicle length in cross II at L_1 and L_2, days to heading and grain yield/plant at L_2 in cross II and spikelets/ panicle in the same cross at L_1. Significant additive × additive (aa) epistatic types were exhibited for all studied traits except for spikelets/ panicle in cross I at L_2 and primary branches at L_1 in the same cross but, blast reaction in cross II at L_1 and L_2, plant height and stem borer % at L_2 in the same cross. High heritability estimates in broad sense were detected for all traits studied in both crosses at L_1 and L_2. High estimates of narrow sense hertability were found for days to heading at L_1 and L_2 in both crosses, primary branches in cross I at L_1 and L_2 and panicle length and fertility % at L_1 and L_2 in cross II, grain yield/plant, harvest index % and panicle length in cross I at L_1, blast reaction in crosses I and II. Genetic advance under selection Δg % was found to be high in magnitude for stem borer % and blast reaction in the two crosses at L_1 and L_2, spikelets/ panicle in cross II at L_1 and L_2, panicle length in crosses I and II at L_1. Relatively, moderate genetic gain was observed for harvest index % and primary branches in cross I at L_1. Low genetic gain was detected for the rest of the studied characters under L_1 and L_2 in both crosses. Grain yield/plant was significant positively correlated with fertility %, panicle length, no. of primary branches, harvest index % and no. of spikelets/ panicle in cross I at both nitrogen levels. Stem borer

% the significant negatively correlated with grain yield/plant in both crosses for both nitrogen levels, but blast reaction was variable under the two crosses at both nitrogen levels.

Key words: ***Rice, Six population analysis, Heterosis, Inbreeding depression, Heritability, Genetic advance, Phenotypic correlation coefficient.***

INTRODUCTION

High yielding rice (*Oryza sativa* L.) cultivars resistant to biotic stresses could be achieved by introducing well adapted genes, or through hybridization and selection for one or more of its major yield components with resistance to biotic stresses such as stem borer and blast, (Hammoud 2004). Information about the type and magnitude of genetic variation and the relative importance of additive and non-additive gene action types and correlation coefficient for rice characters would assist rice breeders in carrying out the most suitable breeding program for rice improvement of yield and resistance to biotic stresses. Accordingly, the maximum progress in character improvement would be expected in a selection program when the additive gene action was the main component of genetic variance. Whereas, the presence of non-additive gene action might suggest the use of hybridization program (El-Hosary *et al* 2001). The performance of local and introduced rice cultivars with respect to yield potential and other important traits can help rice breeders to select the most genotypes to biotic stresses. These elite genotypes could be used either as new varieties or donors for one or more of the related yield traits for incorporation into the local adapted cultivars (Aly and Shaalan 1984, El-Hity and El-Keredy 1992 and Hammoud 2005). Therefore, breeders need information about nature of gene action and correlation coefficient for these traits i.e, heterosis, inbreeding depression, potence ratio, heritability and predicted genetic gain from selection for resistance to stem borrer and blast reaction, also, earliness, dwarfiness, yield and yield components Hammoud (2004), (2005) and Sprague (1963) listed three major factors to be considered that may limit the progress in the analysis of quantitative genetic variation; the number of genes involved, type of gene action and genotype-environment interaction (G × E).

In the current study, six populations, i.e. P_1, P_2, F_1, F_2, Bc_1 and Bc_2 were used for partitioning the genetic components, using the methods of Mather (1949), Gamble (1962), Hayman and Mather (1955) and Mather and Jinks (1971). The main objective was to study heterosis, inbreeding depression, potence ratio, nature of gene action, heritability, genetic advance and correlation coefficient to select the best elites for yield component, early maturity and resistance to stem borer and blast disease.

MATERIALS AND METHODS

The local cultivar Sakha 101 has high yield potential (12 T/h) and resistance to stem borer (*Chilo agamemnon* Bles), but recently, it has become susceptible to blast (*Pyricularia grisea*) (race IG-1). However, the local line (GZ 5310-20-3-3) and foreign one (HR5824-B-3-2-3) are resistant to race IG-1 but susceptible to race IB-45 under field condition (El-Wahsh and Hammoud 2007). The experiments reported herein were carried out during three successive growing seasons; 2004, 2005 and 2006 at the experimental farm of Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt, using two nitrogen fertilizer levels; 40 and 80 N/fed. The nitrogen fertilizer levels urea were added in two equal splits 14 and 28 days after transplanting. The six rice populations i.e. P_1, P_2, F_1, F_2, BC_1 and BC_2 were derived from two crosses, i.e. cross I (HR5824-B-3-2-3 × Sakha 101) and cross II (GZ5310-20-3-3 × Sakha 101). These parental rice cultivars represent a wide range of genetic diversity in the studied traits. A brief description of these cultivars is presented in Table (1).

Table 1. The names, pedigree and origin of parental cultivars

No.	Entry	Pedigree	Origin
1	Sakha 101	Giza 176/Milyang 79	Egypt
2	GZ5310-20-3-3	GZ3707-4-2-2/GZ4069-71-1	Egypt
3	HR5824-B-3-2-3	Akiyudaka/Suweon 310	IRRI

* IRRI = International Rice Research Institute (Philippines)

In 2004, rice growing season, cross I (HR5824-B-3-2-3 × Sakha 101) and cross II (GZ5310-20-3-3 × Sakha 101) were carried out to produce hybrid seeds. In 2005, 30-day old seedlings of the three parents as well as F_1s were individually transplanted in the field. At heading, some of resultant F_1 plants were backcrossed with each parent to produce Bc_1 and Bc_2 while the rest were maintained (selfed) to produce F_2 seeds. In 2006 season, two experiments, arranged in a randomized complete block design (RCBD) with three replications, were conducted. Each experiment included P_1, P_2, F_1, Bc_1 and Bc_2 of each cross. Each plot consisted of seven rows, 3-meters long and 20 × 20 cm between plants 10 rows for F_1, Bc_1 and Bc_2 and 30 rows for F_2 population.

Biotic stresses

Blast reaction

Leaf blast reaction, were scored under condition at the vegetative stage according to scale of standard evaluation system for rice (IRRI. 1996).

Stem borer %

Stem borer, was observed and recorded at maturity stage by counting the number of white head per plant according to the method which adopted by standard evaluation system of (IRRI 1996).

Statistical and genetic analysis

The t-test was used to examine the existence of genetic variance between parental means, A one tail "F" ratio was used to examine the existence of genetic variance within the F_2 population as follows:

$$T = \frac{\overline{P}_1 - \overline{P}_2}{\sqrt{VP_1} - \sqrt{VP_2}} \qquad F = \frac{VF_2}{VE} \text{ where } VE = \frac{VP_1 + VP_2 + VF_1}{3}$$

Where = $\overline{P}_1$ = Mean of first parent, $\overline{P}_2$ = Mean of second parent,
VP_1 = Variance of first parent, VP_2 = Variance of second parent.
VF_1 = Variance of F_1, seeds

Heterosis (H): was expressed as percent increase of the F_1 mean performance above the respective better parent according to Wynne *et al* (1970) as follows : Heterosis = $\overline{F}_1 - \overline{BP}/\overline{BP} \times 100$

Inbreeding depression (Id): was measured as the average percent decrease of the F_2 from the F_1

$Id = (F_1 - F_2)/F_1 \times 100$

Potence ratio (PR): which can be defined as the average dominance of the whole gene set of one parent or the other (Peter and Frey 1966) as follows.

$$PR = \frac{\overline{F}_1 - \overline{MP}}{HP - \overline{MP}}$$

where: HP refers to the mean value of the higher parent

Type of gene effects: were estimated according to Gamble (1962). S.E.: The standard error of a (additive), d (dominance), aa (additive × additive), ad (additive × dominance) and dd (dominance × dominance) was calculated by taking the square root of respective variance. T: values were calculated by dividing the effects of a, d, aa, ad and dd by their respective standard error.

The genetic parameters indicating heterosis over the better parent, inbreeding depression and heritability in broad and narrow sense were estimated according to Mather (1949), predicted genetic gain from selection (Δg) was calculated according to Johanson *et al* (1955). Phenotypic correlation was done according to Mather (1949), Johansen *et al* (1955) and Mather and Jinks (1971).

RESULTS AND DISCUSSION

The validity of the variety differences and the genetic variance within F_2 population of each cross for some agronomic traits, stem borer % and blast reaction were evaluated under different nitrogen fertilizer levels. T. test for the differences between parents and F-test of significance of the genetic variance in the F_2 population for all studied characters were found to be highly significant in the two crosses at the two nitrogen fertilizer levels; (Tables 2 and 3). Mean performance and variance of the six populations, i.e. P_1, P_2, F_1, F_2, Bc_1 and Bc_2 for all traits studied in the cross I and cross II under the (L_1 and L_2) are presented in Tables (4 and 5). High the significant

Table 2. Differences between parents and genetic variance in F_2 population for agronomic, blast reaction and stem borer percentage characters in the cross (HR 5824 × Sakha 101) at the two nitrogen fertilizer levels.

Character	T-Test		F-Test	
	40 unit/fed.	80 unit/fed.	40 unit/fed.	80 unit/fed.
Plant height (cm)	24.64**	242.75**	3.14**	3.79*
Days to heading (day)	423.44**	116.67**	9.35**	43.55**
Grain yield/plant (g)	75.62**	-28.88**	13.00**	4.29**
Stem borer %	-64.55**	104.33**	9.57**	4.72**
Blast reaction	145.00**	38.75**	7.67**	19.64**
Spikelets/panicle	-14.45**	-24.56**	2.84*	149.51**
Harvest index (%)	20.41**	18.17**	6.39**	4.03**
Panicle length (cm)	504.50**	240.00**	6.19**	2.29
Primary branches	9.66**	9.07**	7.67**	6.02**
Fertility %	245.80**	248.80**	4.78**	6.88**

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

Table 3. Differences between parents and genetic variance in F_2 population for agronomic characters, blast reaction and stem borer percentage in the cross (GZ 5310 × Sakha 101) at the two nitrogen fertilizer levels.

Character	T-Test		F-Test	
	40 unit/fed.	80 unit/fed.	40 unit/fed.	80 unit/fed.
Plant height (cm)	-25.97**	-54.33**	2.45	6.0
Days to heading (day)	-96.4**	33.5**	6.41	32.42
Grain yield/plant (g)	112.52**	50.1**	2.93	3.74
Stem borer %	25.04**	111.16**	3.19	3.13
Blast reaction	-17.31**	-11.96**	5.99*	9.11
Spikelets/panicle	-15.25**	63.95**	4.82	3.16
Harvest index (%)	250.00**	8.21**	8.09	7.41
Panicle length (cm)	-5.47**	16.05**	4.32	9.62
Primary branches	-74.50**	254.0*	6.32	3.15
Fertility %	-132.5**	40.54**	37.66	36.3

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

Table 4. Mean (X) and variances (V) of the agronomic characters for P_1, P_2, F_1, F_2, BC_1, BC_2 populations of cross (HR5824 × Sakha 101) at the two, nitrogen fertilizer levels.

Character	Mean	P_1 (HR5824)		P_2 (Sakha 101)		F_1		F_2		BC_1		BC_2	
	Variance	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	X	77.91	85.65	89.00	95.36	110.47	105.89	98.08	93.65	80.41	89.67	99.71	90.47
	V	6.09	1.23	8.46	1.33	9.76	1.03	25.44	4.55	17.51	3.08	20.71	[illegible]
Days to heading (day)	X	72.33	75.65	110.44	115.32	81.51	108.98	81.14	95.65	75.36	100.21	94.51	99.13
	V	1.02	1.28	0.85	2.17	0.87	2.13	8.51	8.47	6.17	6.04	5.93	[illegible]
Grain yield/plant (g)	X	25.33	23.65	59.36	45.89	61.23	54.32	45.35	45.65	36.68	33.54	26.99	35.64
	V	3.17	7.65	5.01	3.98	3.17	6.91	49.15	26.51	33.77	21.35	35.17	20.36
Stem diameter (mm)	X	25.76	33.21	1.23	1.91	14.33	0.46	15.18	12.33	4.36	7.68	9.36	1.54
	V	5.46	6.81	7.36	5.32	5.71	3.45	59.12	24.50	43.56	20.16	49.36	20.16
Blast rection	X	4.40	5.22	7.30	8.32	2.10	1.30	6.71	7.74	0.71	3.51	5.15	3.16
	V	0.81	0.29	0.85	0.39	0.35	0.40	5.14	7.07	4.56	4.98	4.02	4.01
Spikelets/panicle	X	73.40	75.87	141.60	154.24	113.33	125.64	22.40	132.58	135.14	147.25	117.87	122.38
	V	229.83	302.25	109.11	201.58	700.38	215.47	510.40	532.24	372.00	412.54	363.35	402.35
Harvest index %	X	36.55	35.21	46.35	41.57	40.94	38.99	40.96	39.87	38.01	37.38	40.31	39.78
	V	2.76	3.22	4.65	4.55	5.13	2.45	26.71	14.33	17.16	11.22	19.36	12.54
Panicle length (cm)	X	13.56	14.57	23.65	24.17	25.13	25.78	20.61	19.78	22.17	15.68	23.36	16.90
	V	1.13	0.28	1.17	0.33	2.24	0.41	9.35	3.55	6.55	2.88	5.99	2.95
Primary branches	X	7.17	8.51	11.23	12.23	12.36	12.58	11.23	11.20	10.25	9.22	11.54	9.42
	V	0.23	0.34	0.80	0.99	0.51	0.46	3.91	3.61	2.56	2.45	3.25	1.92
Fertility %	X	81.36	77.89	93.65	90.33	88.99	87.32	86.35	82.36	84.33	83.34	90.36	88.77
	V	0.08	0.18	0.11	0.14	0.09	0.19	0.43	1.17	0.31	0.84	0.36	[illegible]
Harvest index %	X	36.55	35.21	46.55	41.57	40.94	38.99	40.96	39.87	38.01	37.38	40.31	39.78
	V	2.76	3.22	4.65	4.55	5.13	2.45	26.71	14.33	17.16	11.22	19.36	12.54

* and ** significant at 0.05 and 0.01 probability levels, respectively according to T-test.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N/ feddan

Table 5. Mean (X) and variances (V) of the agronomic characters for P_1, P_2, F_1, F_2, BC_1, BC_2 populations of cross (GZ 5310 × Sakha 104) at the two, nitrogen fertilizer levels.

Character	Mean	P_1 (GZ 5310)		P_2 (Sakha 101)		F_1		F_2		BC_1		BC_2	
	Variance	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	X	104.32	107.32	89.00	92.65	109.87	112.35	99.87	98.74	90.32	102.35	94.25	95.87
	V	5.36	3.26	8.46	4.35	4.04	5.24	14.58	25.68	10.21	22.36	13.25	23.58
Days to heading (day)	X	105.62	109.87	110.44	115.23	117.32	108.36	104.32	110.35	104.51	112.47	109.54	111.25
	V	0.95	0.36	0.85	0.58	0.64	0.47	5.64	15.24	3.54	9.48	4.25	13.12
Grain yield/plant (g)	X	40.25	38.98	59.38	48.98	55.32	65.32	42.35	55.47	42.88	44.47	50.20	51.59
	V	4.25	23.56	5.01	25.47	6.35	35.32	15.24	142.58	10.25	122.35	14.21	132.54
Stem borer %	X	13.25	15.69	1.23	2.35	1.96	2.55	3.27	4.51	6.35	3.25	9.54	3.96
	V	10.23	11.23	7.36	10.44	3.58	10.53	22.54	33.58	19.21	21.66	17.84	30.21
Blast reaction	X	4.01	5.22	7.30	8.21	1.02	2.01	4.54	4.88	3.58	4.32	5.24	6.21
	V	1.25	0.98	0.85	0.54	1.54	0.35	7.25	5.65	5.35	3.25	6.87	3.22
Spikelets/panicle	X	120.40	133.21	141.60	145.36	165.40	169.54	144.10	145.23	130.50	156.32	136.71	148.24
	V	140.16	155.21	109.11	159.87	131.10	201.34	611.60	544.36	411.35	399.65	455.50	401.23
Harvest index %	X	36.55	36.55	40.55	45.54	46.62	38.04	47.78	42.08	36.73	39.71	40.15	40.15
	V	1.25	2.01	1.33	4.65	1.59	3.99	11.25	26.31	7.65	20.55	8.65	19.31
Panicle length (cm)	X	20.53	21.93	23.65	24.98	22.49	25.65	22.17	23.54	20.14	22.35	22.88	23.54
	V	2.71	0.19	1.17	0.39	3.17	0.29	10.15	2.79	7.55	1.77	6.04	[illegible]
Primary branches	X	9.74	10.23	11.23	12.77	12.19	13.24	10.19	10.88	10.41	11.65	12.12	10.87
	V	0.82	0.55	0.80	0.57	1.22	1.13	5.94	2.36	3.61	2.02	4.13	[illegible]
Fertility %	X	88.35	25.68	93.65	88.25	85.35	71.46	84.65	87.25	85.65	77.21	90.23	74.89
	V	0.14	0.32	0.11	0.77	0.21	0.42	5.65	18.15	3.19	10.25	3.52	12.54

* and ** significant at 0.05 and 0.01 probability levels, respectively according to T-test.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N /feddan

positive values of heterosis were obtaned in all studied characters except plant height, days to heading, stem borer % and blast reaction that had negative values were obtained these negative value would be useful from the rice breeders point of view (Tables 6 and 7). High significant positive values of heterosis were obtained for grain yield/plant, panicle length and primary branches in cross I at (L_1 and L_2) and highly significant negative values were detected for blast reaction at (L_1 and L_2), stem borer % at L_2 in the cross I. Concerning cross II, highly significant positive useful heterosis was shown for spikelets/panicle and primary branches at both nitrogen levels, harvest index % and fertility % at the first nitrogen level, grain yield and panicle length at L_2. On the other hand, highly significant negative heterosis was found for blast reaction at the two nitrogen fertilizer levels and days to heading in L_2 only. These results are in general agreement with those obtained by Vivekamandan and Giridharan (1995), Singh and Choudhary (1996), Hammoud (1996 and 2004).

As for inbreeding depression (Id), highly significant negative values were obtained for stem borer % and blast reaction in the two crosses at the two nitrogen levels and days to heading in the second cross at the second nitrogen level Tables (6 and 7). Highly significant positive (Id) values were found for grain yield/plant, panicle length and primary branches at the two nitrogen levels in the two crosses, fertility % in the cross I, spikelets/ panicle in cross II at the two nitrogen fertilizer levels and fertility % in cross II at the first nitrogen level. The present results were found to be in agreement with these obtained by Aly (1979), Reddy and Kumar (1996), El-Hity and El-Keredy (1992) and Hammoud (2004 and 2005). Contradictions between heterosis and inbreeding depression were found in fertility % in the first cross and stem borer % in the second cross at both L_1 and L_2. The contradiction between heterosis and inbreeding depression may be due to the presence of linkage between genes in these materials (Van der Veen 1959). Concerning potence ratio (PR) (Tables 6 and 7) overdominance the higher parent was found for grain yield/plant, panicle length and primary branches in cross I at both L_1 and L_2, spikelets/panicle and primary branches in the cross II at both nitrogen levels, grain yield/plant and panicle length in the cross II at L_2 and harvest index % in the same cross at L_1. Overdominance with values lower than the lower parent, was recorded for plant height in the first cross at both nitrogen levels, plant height and days to heading at L_1 in cross II. Partial dominance, towards the better parent, was found for spikelets/ panicle and panicle length in cross I at L_1 and L_2, harvest index % at L_2 in the same cross, grain yield/plant and panicle length in the second cross at L_1. Partial dominance, towards the lower parent, was detected for days to heading at the second nitrogen level. Similar results were previously reported by Reddy and Nekar (1991), Singh and Choudhary (1996), Hammoud (2004 and 2005). Absence of dominance was found for

Table 6. Heterosis, inbreeding depression, potence ratio and the type of gene action parameters in the cross (HR 5824 × Sakha 101) for agronomic characters, blast reaction and stem borer % at the two nitrogen levels (L_1 and L_2)

Character	N level	Heterosis	Inbreeding depression	Potence ratio	Gene action parameters					
					m	a	d	aa	ad	dd
Plant height (cm)	L_1	41.79**	11.22**	-4.86	98.08**	-19.30**	-5.07**	-32.08**	-13.76**	59.69**
	L_2	23.63**	11.55**	-3.16	93.65**	-0.80**	1.06NS	-14.32**	4.06**	46.83**
Days to heading (day)	L_1	12.69**	0.45	0.52	81.14**	-14.15**	5.31**	15.18**	-0.10NS	-9.13**
	L_2	44.06**	12.23**	-0.67	95.65**	1.08**	29.58**	16.08**	20.92**	-5.83**
Grain yield/plant (g)	L_1	3.15**	25.93**	1.11	45.35**	9.69**	-35.18**	-54.06**	26.71**	133.87**
	L_2	18.37**	15.96**	1.75	45.65**	-2.10**	-24.69**	-44.24**	9.02**	84.06**
Stem borer %	L_1	1065.04**	-5.93**	-0.067	15.18**	-5.00**	-32.45**	-33.28**	-17.27**	61.49**
	L_2	-75.92**	-2580.43**	-1.09	12.33**	6.14**	-47.98**	-30.88**	-9.51**	48.48**
Blast reaction	L_1	-52.27**	-219.52**	1.18	6.71**	-4.44**	-18.87**	-15.12**	-2.99**	19.30**
	L_2	-75.09**	-495.38**	3.53	7.74**	0.35NS	-23.09**	-17.62**	1.90**	20.42**
Spikelets/panicle	L_1	-19.96**	-8.00**	0.17	122.40**	17.27**	22.25**	16.42*	51.37**	-80.78**
	L_2	-18.54**	-5.52**	0.27	132.58**	24.87**	19.53*	8.94NS	64.06**	-66.81**
Harvest index %	L_1	-12.05**	-0.05	-0.122	40.96**	-2.30**	-7.81**	-7.20**	2.70**	15.54**
	L_2	-6.21**	-2.26	0.18	39.87**	-2.40**	-4.56**	-5.16**	0.78NS	5.60*
Panicle length (cm)	L_1	6.26**	17.98**	1.29	20.61**	-1.19**	15.15**	8.62**	3.86**	-12.21**
	L_2	6.66**	23.27**	1.34	19.78**	-1.22**	-7.55**	-13.96**	3.58**	39.10**
Primary branches	L_1	10.06**	9.14**	1.55	11.23**	-1.29**	1.82*	-1.34NS	0.74**	0.88NS
	L_2	2.86**	10.97**	1.18	11.20**	-0.20NS	-5.31**	-7.52**	1.66**	16.14**
Fertility %	L_1	-4.98**	2.97**	0.24	86.35**	-6.03**	5.47**	3.98**	0.11NS	-0.37NS
	L_2	-3.33**	5.68**	0.92	82.36**	-5.43**	17.99**	14.78**	0.79**	-16.14**

* and ** significant at 0.05 and 0.01 probability levels, respectively according to T-test.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N/feddan

Table 7. Heterosis, inbreeding depression, potence ratio and the type of gene action parameters in the cross (GZ 5310 × Sakha 101) for agronomic characters, blast reaction and stem borer % at the two nitrogen levels (L_1 and L_2)

Character	N level	Heterosis	Inbreeding depression	Potence ratio	Gene action parameters					
					m	a	d	aa	ad	dd
Plant height (cm)	L_1	23.45**	9.10**	-1.72	99.87**	-3.93**	-17.13**	-30.34	-11.59**	74.26**
	L_2	21.26**	12.11**	1.68	98.74**	6.48**	13.85**	1.48NS	-0.86NS	26.75**
Days to heading (day)	L_1	11.08**	11.08**	-3.85	104.32**	-5.03**	20.11**	10.82**	-2.62**	11.78**
	L_2	-1.37	-1.84	1.56	110.35**	1.22*	1.85NS	6.04**	3.90**	-11.66**
Grain yield/plant (g)	L_1	-6.84**	23.45**	0.57	42.35**	-7.32**	22.27**	16.76**	2.25**	7.35**
	L_2	33.36**	15.08**	4.26	55.47**	-7.12**	-8.42NS	-29.76**	-2.12NS	56.24**
Stem borer %	L_1	59.35**	-66.84**	0.87	3.27**	-3.19**	13.42**	18.70**	-9.20**	-32.08**
	L_2	8.51**	-76.86**	0.97	4.51**	-0.71NS	-10.09**	-3.62NS	-7.38**	12.34**
Blast reaction	L_1	-75.56**	-345.10**	2.81	4.54**	-1.66**	-5.16**	-0.52NS	-0.02NS	-3.77*
	L_2	-61.49**	-142.79**	3.14	4.88**	-1.89**	-3.17**	1.54NS	-0.39NS	-5.15**
Spikelets/panicle	L_1	16.81**	12.88**	3.24	144.10**	-6.21NS	-7.58NS	-41.98**	4.39NS	100.36**
	L_2	16.63**	14.34**	22.02	145.23**	8.08*	58.46**	28.20**	14.16**	-19.67NS
Harvest index %	L_1	0.15	-2.49*	1.01	47.78**	-3.42**	-32.29**	-37.36**	1.58**	59.94**
	L_2	-10.58**	-10.62**	-0.50	42.08**	-0.44NS	-10.11**	-8.60**	2.56**	4.05NS
Panicle length (cm)	L_1	-4.90**	1.42	0.25	22.17**	-2.74**	-2.24NS	-2.64**	-1.18*	5.76**
	L_2	2.68**	8.23**	1.42	23.54**	-1.19**	-0.19NS	-2.38**	0.34NS	8.81**
Primary branches	L_1	8.55**	16.41**	2.29	10.19**	-1.71**	6.01**	4.30**	-0.96**	-4.01**
	L_2	3.68**	17.82**	1.37	10.88**	0.78**	3.26**	1.52**	2.05**	2.92**
Fertility %	L_1	16.81**	0.52	-2.13	84.65**	-4.58**	7.51**	13.16**	-1.93**	-12.22**
	L_2	-19.03**	-22.10**	-1.67	87.25**	2.32**	-55.31**	-44.80**	8.60**	47.45**

* and ** significant at 0.05 and 0.01 probability levels, respectively according to T-test.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N/feddan

stem borer % in cross I at L_1. It is of interest to mention that the signs of heterosis and potence ratio were found to be different under nitrogen fertilizer levels (40 & 80 unit/fed.). For instance, grain yield/plant in cross II exhibited highly significant positive heterosis at L_2 (23.45**), while at the first level L_1, the estimated heterotic effect was -6.84**. Also, the potence ratio value for some traits in the same cross at L_1 was found to be overdominance but at L_2, it exhibited partial dominance. Therefore, it could be concluded that the average degree of dominance could be increased or decreased according to the growing environmental conditions. Also, the test of potential of parents for the expression of heterosis would be necessarily conducted over an umber of environmental conditions. Genetic diversity alone would not guarantee the expression of heterosis, but the suitability of the environmental condition would be required. The similar results were reached by Sarawgi and Shrivastav (1988), Hammoud (1996), Salem (1997), Hammoud (2004 and 2005).

Nature of gene action

Genetic analysis of generation means, for estimation of additive (a), dominance (d) and the three epistatic effects additive × additive (aa), additive × dominance (ad) and dominance × dominance (dd) variances, were performed according to relationship explained by Gamble (1962). The estimated values of the various types of gene effects are presented in Tables (6 and 7). The estimated mean effect (m) parameter, which reflects the contribution due to the over-all mean plus the locus effects and interaction of the fixed loci, were found to be highly significant for all traits in the two crosses at L_1 and L_2 fertilizer levels. The additive gene effects (a) were found to be highly significant for all traits in the two crosses at both nitrogen levels, except for blast reaction and primary branches in the cross I at L_1, stem borer % and harvest index % in cross II at L_2 and spikelets/panicle in the same cross at L_1. It could be concluded that the traits which exhibited highly significant estimates of the additive gene effect (a) would give the potential for obtaining further improvement. Dominance gene effects (d) were detected to be highly significant for most of studied characters except for plant height in the cross I at L_2, panicle length in the cross II at both nitrogen levels, days to heading and grain yield/plant at L_2 in cross II and spikelets/panicle in the same cross at L_1. Significant (aa) epistatic types were exhibited for all studied traits except for spikelets/panicle in the cross I at L_2 and primary branches at L_1 in the same cross, blast reaction in the cross II at both levels, plant height and stem borer % at L_2 in the same cross. The estimated values of (ad) types of epistasis were found to be significant for most of the studied traits except days to heading and fertility % in the cross I at L_1 and harvest index % in the same cross at L_2, blast reaction in the cross II at both levels, plant height, grain yield/plant and panicle length at L_2 and spikelets/ panicle at L_1 at the same cross. Dominance × dominance (dd) type of gene action was found to be significant for all traits, except for primary branches and fertility % at L_1 in the cross I, spikelets/ panicle and harvest index % in cross II at L_2. The similar results were previously reported by Tripathi *et al* (1999), Hammoud (2004 and 2005). It is of interest to mention that the estimation of the different types of gene action parameters, i.e. a, d, aa, ad and dd were found to be only significant at a certain level of nitrogen fertilizer, but not significant at the other nitrogen level for the same characters in the same cross (Tables 6 and 7). These observations would indicate that the test of the different gene action parameters should be conducted over a number of environmental conditions, due to of the fluctuation in estimation of the different gene action parameters from one nitrogen fertilizer level to another.

Heritability and genetic advance

Heritability in both broad (h^2b) and narrow sense (h^2n) and genetic advance under selection (Δg) were compared, and the obtained results are presented in Tables (8 and 9). High (h^2b) estimates were detected for all traits studied in the two crosses at both nitrogen levels. High estimates of (h^2n) were found for days to heading at L_1 and L_2 in the two crosses, primary branches in cross I at both nitrogen levels and panicle length and fertility % at both nitrogen levels in cross II, grain yield/plant, harvest index % and panicle length in cross I at L_1, spikelets/ panicle, harvest index % and primary branches in the cross II at L_1, blast reaction in both crosses at L_2. Similar results were previously reported by Tripathi *et al* (1999), Abd El-Aty *et al* (2002) and Hammoud (2004 and 2005). The differences in magnitudes of both broad and narrow sense heritability estimates were found in most of the traits studied under investigation and this would ascertain the presence of both additive and non-additive genetic variances in the inheritance of most of traits at the two nitrogen fertilizer levels as previously obtained from gene action parameters studied. Similar conclusion was previously reached by Aly *et al* (1979), Lokaprakash *et al* (1991), Reddy and Choudhary (1991), Marwat *et al* (1994), Sawant and Patil (1995), Singh *et al* (1998), Tripathi *et al* (1999) and Hammoud (2004 and 2005).

Genetic advance under selection given in Tables (8 and 9) showed possible gain from selection as percent increase in the F_3 over the F_2 mean when the most desirable 5% F_2 plants are selected. Genetic advance under

Table 8. Heritability estimates, genetic advance (Δg) and genetic advance expressed as a percentage of the F_2 mean (Δg %) in the cross (HR5824 × Sakha 101) studied for agronomic characters, blast reaction and stem borer %.

Character	Heritabeilty				Genetic advance			
	Broad Sense		Narrow sense		Δ g		Δ g %	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	68.15	73.70	49.76	47.03	5.17	2.07	5.27	2.21
Days to heading (day)	89.27	78.04	57.81	59.27	3.47	3.55	4.26	3.71
Grain yield/plant (g)	92.30	76.69	59.74	42.66	8.63	4.53	19.03	9.92
Stem borer %	89.55	78.80	42.83	35.43	6.78	3.61	44.66	29.28
Blast reaction	86.96	94.91	33.07	72.84	1.54	3.99	22.95	51.55
Spikelets/panicle	64.78	99.33	55.93	46.89	26.03	11.06	21.27	8.34
Harvest index (%)	84.35	75.16	63.27	34.19	6.74	2.67	16.46	6.70
Panicle length (cm.)	83.81	56.34	65.88	35.77	4.15	1.39	20.14	7.03
Primary branches	86.87	83.47	51.41	78.95	2.09	3.09	18.61	27.59
Fertility %	78.29	85.47	44.19	52.99	0.60	1.18	0.69	0.84

* and ** significant at 0.05 and 0.01 probability levels, respectively.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N/feddan

Table 9. Heritability estimates, genetic advance (Δg) and genetic advance expressed as a percentage of the F_2 mean (Δg %) in the cross (GZ 5310 × Sakha 101) studied for agronomic characters, blast reaction and stem borer %.

Character	Heritabeilty				Genetic advance			
	Broad Sense		Narrow sense		Δ g		Δ g %	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	59.17	83.32	39.09	21.18	3.08	2.20	3.08	2.23
Days to heading (day)	84.40	96.92	4.88	51.71	3.03	4.16	2.90	3.77
Grain yield/plant (g)	65.86	80.28	39.50	21.23	3.18	5.22	7.51	9.41
Stem borer %	68.69	68.04	32.63	45.53	3.48	5.44	106.42	120.62
Blast reaction	83.26	88.97	31.45	85.49	1.74	4.19	38.33	85.86
Spikelets/panicle	79.27	68.38	58.27	52.88	29.68	25.41	20.60	17.50
Harvest index (%)	87.64	86.51	55.11	50.59	3.81	5.35	7.97	12.71
Panicle length (cm.)	76.85	89.61	66.11	69.89	4.34	2.49	19.58	10.20
Primary branches	84.06	68.22	69.70	26.27	3.50	0.83	34.35	7.63
Fertility %	97.29	97.23	81.24	74.44	3.98	6.53	4.70	7.48

* and ** significant at 0.05 and 0.01 probability levels, respectively.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N/feddan

selection was found to be high in magnitude for stem boror % and blast reaction in the two crosses at both nitrogen levels, spikelets/ panicle in cross II at both nitrogen levels, panicle length in the two crosses at L_1, primary branches in cross I at L_2 and primary branches in cross II at L_1. Relatively, moderate genetic gain was observed for harvest index % and primary branches in the cross I at L_1 and panicle length in cross II at L_2. Low genetic gains were detected for the rest of studied characters under different fertilizer levels in the two crosses. Johanson *et al* (1955) reported that hertability estimates along with genetic gain upon selection were more valuable than the former alone, in predicting the effect of selection. On the other hand, Dixit *et al* (1970) pointed out that high heritability is not always associated with high genetic gain, but in order to make effective selection, high hertability should be associated with high genetic gain. In this investigation, high genetic gain was found to be associated with high narrow sense heritability estimates for primary branches in the cross I at L_1 and L_2 fertilizer levels, spikelets/ panicle in cross II at L_1 and L_2 fertilizer levels, primary branches in cross I at L_2 and blast reaction in cross II at L_2. Consequently, selection for these traits should be effective and satisfactory for successful breeding purpose. Moderate estimates of both narrow sense heritability and genetic advance were observed for grain yield/plant, spikelets/ panicle, harvest index and panicle length in cross I at L_1, harvest index % in cross II at L_2. Therefore, selection for these traits in this population will be effective, but probably of less success than in the former characters. Low genetic gain was associated with low and high narrow sense heritability values for the rest of the characters studied. Hence, selection of these traits would be of less effect. Similar results were previously obtained by Veillet *et al* (1995), Abdallah *et al* (2002) and Hammoud (2004 and Hammoud 2005).

Phenotypic correlation coefficient

The phenotypic correlation coefficients between eight agronomic traits, blast reaction and stem borer % at the two nitrogen levels for two crosses (HR5824-B-3-2-3 × Sakha 101) and (GZ5310-20-3-3 × Sakha 101) in F_2 populations are presented in Tables (10 and 11). Grain yield/plant was significantly and positively correlated with fertility %, panicle length, no. of primary branches, harvest index % and no. of spikelets/ panicle in cross I at both nitrogen levels, panicle length, no. of primary branches and no. of spikelets/ panicle in cross II at both nitrogen levels. In the mean time, stem borer % was significantly negatively correlated with grain yield/plant in both crosses for both nitrogen levels, but blast reaction was variable under the two crosses at both nitrogen levels. This shows that the test of potential yield for blast reaction should be conducted over a wide range of environmental conditions. This also means that genetic diversity alone would not guarantee the expression of yield potentiality for this trait. These results confirmed those obtained by Aly and Shaalan (1984) and Samonte *et al* (1998).

Table 10. Estimates of phenotypic correlation coefficients among ten agronomic traits, blast reaction and stem borer-in the F_2 population for cross I (HR5824 × Sakha 101) at the two N levels.

character	N. level	PH	HD	GY	F%	SB %	BR	PL	PB	HI	S/P
Plant height (PH)	L_1		0.220	0.516*	0.535*	-0.560*	0.074	0.670*	0.826**	0.352	0.201
	L_2		0.702**	0.932**	0.547*	-0.646*	-0.311	0.917**	0.894**	0.494	0.386
Days to heading (HD)	L_1			0.431	0.929**	-0.672*	0.631*	0.541*	0.474	0.911**	0.588*
	L_2			0.797**	0.896**	-0.921**	0.007	0.790**	0.706**	0.832**	0.868**
Grain yield/plant (GY)	L_1				0.603*	-0.413	0.108	0.634*	0.649*	0.735**	0.531*
	L_2				0.626*	-0.729**	-0.026	0.930**	0.959**	0.728**	0.391*
Fertility (F)%	L					-0.691*	0.458	0.784**	0.751**	0.910**	0.663*
	L_2					-0.914**	-0.061	0.649*	0.607*	0.849**	0.686*
Stem borer (SB) %	L_1						-0.280	-0.759**	-0.594*	-0.645*	-0.946**
	L_2						0.221	-0.625*	-0.620*	-0.796**	-0.808**
Blast reaction (BR)	L_1							-0.950**	-0.350	0.608*	0.084
	L_2							0.038	0.140	0.362	0.205
Panicle length (PL)	L_1								0.953**	0.611*	0.798**
	L_2								0.984**	0.678*	0.479
Primary branches (PB)	L_1									0.598*	0.713**
	L_2									0.724**	0.541*
Harvest index (HI) %	L_1										0.610*
	L_2										0.754
Spikelets/panicle S/P	L_1										
	L_2										

*, ** Significant at 0.05 and 0.01 levels, respectively.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N/feddan

Table 11. Estimates of phenotypic correlation coefficients among ten agronomic traits, blast reaction and stem borer-in the F_2 population for cross I (GZ5310 × Sakha 101) at the two N levels.

character	N. level	PH	HD	GY	F%	SB %	BR	PL	PB	HI	S/P
Plant height (PH)	L_1		0.432	-0.132	-0.534*	0.105	-0.774**	-0.123	0.078	0.177	0.413
	L_2		-0.601*	0.097	-0.840**	0.322	-0.714**	0.030	0.215	-0.901**	0.417
Days to heading (HD)	L_1			0.797**	0.139	-0.443	-0.378	0.562*	0.836**	0.460	0.797**
	L_2			-0.410	0.646	-0.328	0.832*	0.824	0.198	0.668	-0.271
Grain yield/plant (GY)	L_1				0.572	-0.647	0.207	0.825**	0.771	0.578	0.635
	L_2				-0.123	-0.643	-0.498	0.826**	0.617	0.180	0.764
Fertility (F) %	L_1					-0.020	0.796	0.553*	0.219	0.013	-0.242
	L_2					-0.219	0.657	0.090	0.016	0.837*	-0.416
Stem borer (SB) %	L_1						-0.015	-0.580*	-0.387	-0.843*	-0.777
	L_2						0.014	-0.666*	-0.702	-0.658	-0.705
Blast reaction (BR)	L_1							0.424	-0.150	0.062	-0.439
	L_2							-0.099	-0.173	0.581	-0.655
Panicle length (PL)	L_1								0.668	0.763	0.570
	L_2								0.862*	0.315	0.629
Primary branches (PL)	L_1									0.375	0.700
	L_2									0.217	0.755
Harvest index (HI) %	L_1										0.787
	L_2										-0.043
spikelets/panicle (S/P)	L_1										
	L_2										

*, ** Significant at 0.05 and 0.01 levels, respectively.
L_1 = nitrogen level 40 kg N/feddan
L_2 = nitrogen level 80 kg N /feddan

Furthermore, plant height was significantly and positively correlated with each of grain yield/plant, fertility %, panicle length and no. of primary branches in cross I under both nitrogen levels. Moreover, stem borer % in cross I at L_1 and L_2 was negatively correlated with plant height but highly significant negative correlation was obtained for blast reaction with plant height at both nitrogen levels in cross II. On the other hand, significant and positive correlations were detected between days to heading and fertility %, panicle length, harvest index % and no. of spikelets/ panicle in cross I at L_1 and L_2 but, the reaction differed under different nitrogen levels in cross II at both nitrogen levels, which may be due to different growing condition. Fertility % showed negative and significant correlations with stem borer in cross I at both L_1 and L_2 and insignificant negative correlation in cross II under L_1 and L_2. Similar results were obtained by Rao *et al* (1973).

Finally, stem borer was found to correlate significantly and negatively with panicle length, no. of primary branches, harvest index and no. of spikelets/panicle in cross II at L_1 and L_2. In the mean time, stem borer correlated with significant negative values with panicle length, harvest index % and no. of spikelets/panicle in cross II at L_1 and L_2, no. of primary branches at L_2. The current results are in agreement with those of Aly *et al* (1984), Yolanda and Das (1995) and Sawant and Jadhar (1996).

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تحليل متوسطات الأجيال لبعض الصفات المحصولية ومقاومة مرض اللفحة والثاقبات لهجينين فى الأرز تحت مستويين من التسميد الأزوتى

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أجرى هذا البحث بمركز البحوث والتدريب فى الأرز بسخا – كفرالشيخ – مصر خلال مواسم 2004، 2005، 2006 بهدف دراسة تأثير الفعل الجينى وقوة الهجين والإنخفاض الناشئ عن التربية الداخلية ودرجة التوريث بمعناها الضيق والواسع ومعامل الإرتباط بين الصفات المدروسة فى هجينين من الأرز (أتش أر 5824-B-3-2-3 × سخا 101) ، (جى زد 5310-20-3-3 × سخا 101) تحت مستويين من التسميد الأزوتى (40-80 وحدة أزوت للفدان). وشملت الدراسة ستة عشائر هما الأبوين والجيلين الأول والثانى وجيلا الهجينين الرجعيين الأول والثانى لصفات طول النبات، التزهير، محصول النبات الفردى، نسبة الثاقبات، المقاومة لمرض اللفحة، عدد السنيبلات بالسنبلة، دليل الحصاد، طول السنبلة، عدد الأفرع الأولية بالسنبلة ونسبة الخصوبة.

وأظهرت النتائج ما يلى :

كانت قوة الهجين معنوية وموجبة لكل من محصول النبات الفردى وطول السنبلة وعدد الأفرع الأولية بالسنبلة فى الهجين الأول تحت مستويا التسميد النتروجينى بينما كانت قوة الهجين سالبة وعالية المعنوية لمقاومة مرض اللفحة تحت مستويا التسميد النتروجينى ونسبة الثاقبات فى الهجين الأول فى مستوى النتروجين الأول.

أظهر معامل التربية الداخلية زيادة معنوية فى محصول النبات الفردى وطول السنبلة وعدد الأفرع الأولية بالسنبلة تحت مستويا النتروجين للهجينين الأول والثانى.

كانت السيادة الفائقة بقيم تزيد عن الأب الأعلى لصفة محصول النبات الفردى وطول السنبلة وعدد الأفرع الأولية بالسنبلة تحت مستويا التسميد النتروجين وعدد السنيبلات بالسنبلة وعدد الأفرع الأولية فى الهجين الثانى تحت مستويا التسميد النتروجينى الأول والثانى. وكانت السيادة الفائقة بقيم تقل عن الأب الأقل لصفة طول النبات فى الهجين الأول تحت مستويا التسميد الأزوتى الأول والثانى. وكانت السيادة الجزئية فى اتجاه الأب الأفضل لعدد السنيبلات فى السنبلة وطول السنبلة فى الهجين الأول تحت مستويا التسميد النتروجينى الأول والثانى وكانت السيادة غائبة فى النسبة المئوية للثاقبات فى الهجين الأول تحت مستوى التسميد النتروجينى الأول.

كان الفعل الجينى المضيف معنوياً لكل الصفات المدروسة فى الهجينين تحت مستويا التسميد النتروجينى الأول والثانى عدا صفة المقاومة لمرض اللفحة وعدد الأفرع الأولية فى السنبلة فى الهجين الأول للمستوى النتروجينى الأول وكذلك نسبة الثاقبات ودليل الحصاد فى الهجين الثانى فى المستوى الأعلى للتسميد النيتروجينى.

كان الفعل الجينى السائد معنوياً لمعظم الصفات المدروسة عدا صفة طول النبات فى الهجين الأول للمستوى النتروجينى الثانى وطول السنبلة فى الهجين الثانى لمستويا التسميد النتروجينى الأول والثانى وصفة التزهير ومحصول النبات الفردى فى المستوى التسميد النتروجينى الثانى للهجين الثانى وعدد السنيبلات بالسنبلة فى نفس الهجين فى المستوى التسميد النتروجينى الأول.

كان الفعل الجينى التفوقى (المضيف × المضيف) معنوياً لكل الصفات المدروسة عدا صفة عدد السنيبلات بالسنبلة فى الهجين الأول وعدد الأفرع الأولية بالسنبلة فى المستوى التسميدى المنخفض الأول. كانت قيم معاملة التوريث بمعناها الواسع عالية فى جميع الصفات المدروسة تحت مستويا التسميد النتروجينى الأول والثانى بينما كانت قيم معامل التوريث بمعناها الضيق المعنوية لصفة التزهير فى المستوى التسميد النتروجينى الأول والثانى للهجينين وعدد الأفرع الأولية بالسنبلة فى الهجين الأول لمستويا التسميد النتروجينى وطول السنبلة ونسبة الخصوبة فى الهجين الثانى تحت مستويا التسميد النتروجينى.

كانت النسبة المئوية للتحسين الوراثى المتوقع بالإنتخاب لأفضل 5% من النباتات فى الإتجاه المرغوب عالية لصفة النسبة المئوية للثاقبات – المقاومة لمرض اللفحة فى الهجينين تحت مستويا التسميد النتروجينى وعدد السنيبلات بالسنبلة فى الهجين الثانى تحت مستويا التسميد النتروجينى الأول والثانى وطول السنبلة فى الهجينين تحت مستويا التسميد النتروجينى الأول.

كانت نسبة التحسين الوراثى المتوقع عالية لصفة دليل الحصاد %، عدد الأفرع الأولية بالسنبلة فى الهجين الأول تحت مستوى التسميد النتروجينى الأول وكانت أقل نسبة تحسين وراثى متوقع فى بقية الصفات المدروسة.

كان معامل الإرتباط عالى المعنوية وموجب بين صفة محصول النبات الفردى ونسبة الخصوبة وطول السنبلة وعدد الأفرع الأولية بالسنبلة ودليل الحصاد وعدد السنيبلات بالسنبلة فى الهجين الأول تحت مستويا التسميد النتروجين وطول السنبلة وعدد الأفرع الأولية بالسنبلة وعدد السنيبلات بالسنبلة فى الهجين الثانى تحت مستويا التسميد النتروجين. بينما كانت النسبة المئوية للثاقبات معنوية وسالبة الإرتباط مع محصول النبات الفردى فى الهجينين تحت مستويا التسميد النتروجينى، بينما المقاومة لمرض اللفحة كانت متغيرة تحت مستويا التسميد النتروجين للهجينين.

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