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891GENETIC STUDIES ON GRAIN DIMENSION, YIELD AND ITS RELATED TRAITS IN RICE UNDER SALINE SOIL CONDITIONS (*Orayza sativa* L.)

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ABSTRACT

The present investigation was carried out at the Lysimeter of the Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2009, 2010 and 2011 summer seasons. The aim of this investigation estimate heterosis, heterobeltiosis, heritability in broad and narrow senses, expected genetic advance, inbreeding depression, phenotypic and genotypic coefficient of variability and nature of gene action for grain dimensions, yield and its related traits in rice using six populations technique, viz., P1, P2, F1, BC1, BC2 and F2 generation of (Nabatat Asmar x Sakha 105) rice cross under both saline soil irrigated with 10.6 dSm^{-1} of sodium chloride (NaCL2) and calcium chloride (CaCL2) at the ratio of 1: 2, respectively, and normal soil conditions irrigated with tap water (EC, 0.77 dSm^{-1}). The main finds could be summarized as follows:

The results indicated that highly significant and positive heterosis and heterobeltiosis were obtained for all the studied traits under saline soil conditions, except 100-grain weight, grain width and grain shape traits, which, showed highly significant and negative estimates of heterosis when it were measured as a deviation from better-parent under normal soil conditions for the first two traits. Highly significant and negative estimates of heterosis when it was measured as a deviation from mid-parent for the third trait. Phenotypic coefficient of variability (P.C.V) was higher than genotypic coefficient of variability (G.C.V) for all the studied traits, indicating that they all affected by environment conditions. High estimates of broad sense heritability coupled with high genetic advance was observed for days to 50 heading, plant height, 100-grain weight, panicle weight, grain length, grain width and grain shape under two conditions. Therefore, direct selection for these characters is recommended in early generations. In addition, incomplete dominance to over-dominance was operative for most the studied traits under two conditions.

The estimates of nature of gene action showed that mid-parent values were positively and highly significant for all the studied traits under two conditions except days to 50 % heading, plant height and sterility % under two conditions. Additive gene action was important for all the studied traits except plant height, grain length and grain shape under saline soil conditions. Whereas, dominance gene action was played an important role in the inheritance of 100- grain weight and grain yield/ plant. Moreover, additive x additive type of gene interaction were important for plant height, 100- grain weight and sterility % under normal conditions. On the other hand, grain yield/ plant followed by number of filled grains/ panicle, panicle length, grain length and panicle weight were affected by dominance x dominance gene interaction.

The results in general, revealed that days to 50 % heading, plant height, panicle length, grain length, grain width, and grain shape were controlled by almost one pairs of effective genes suggesting that these traits were inherited as simple traits under two conditions. Moreover, number of panicles/ plant and number of filled grains/ panicle under saline soil conditions were probably controlled by two to sixty nine pairs of genes indicating that these traits were inherited as a complicated or quantitative

traits, so, selection late generation was important and play an remarkable role in important such traits.

Keywords: Rice, yield and grain dimension traits, saline soil conditions, GCV, heritability, heterosis, inbreeding depression and genetic advance.

INTRODUCTION

Rice is one of the most important cereal crops, which is a very popular staple food in many developing countries such as Egypt. Grain yield is one of the most breeding objectives. Considerable efforts have been made by breeders to study the genetic expression for yield components characters contributing to yield potential including Days to 50% heading, plant height, number of panicles/ plant, panicle length, panicle weight, 100-grain weight, number of filled grains/ panicle and sterility % and grain dimensions traits, viz, grain length, grain width and grain shape.

Rice is considered a salt-sensitive crop species it has a salinity threshold of 3 dS/m, with a 12% reduction in yield per dSm^{-1}, beyond this threshold. Therefore, rice yields can be reduced by up to50% when grown under moderate (6 dSm^{-1}) salinity conditions (Zeng *et al.* 2002). In general, rice plants are very sensitive to salinity stress at young seedling stages, relatively tolerant at the later vegetative stages, and sensitive again during reproduction (Flowers and Yeo 1981 and Lutts *et al.* 1995).

The decreasing of rice productivity in salt-affected areas can be addressed through an integrated approach involving both reclamation and management strategies, as well as enhanced genetic tolerance. However, management practices are not always feasible in the long run, as in coastal areas where salt stress is seasonal or in inlands when reclamation costs are prohibitive. In both cases, developing salt-tolerant varieties seems more feasible to enhance the productivity of these marginal lands. Rice is recommended as a crop best suited for salt affected soils because it can grow well under flooded conditions that can help in leaching harmful salts (Ismail *et al.* 2008; Ismail and Tuong, 2009).

Although rice is a normally self-pollinated crop, strong heterosis is observed in their F1 hybrids. Heterosis or hybrid vigor is manifested as improved performance for F1 hybrids generated by crossing two inbred parents. Heterosis can be defined quantitatively as an upward deviation of the mid-parent, based on the mean values of the two parents (Johnson and Hutchinson 1993). Heterosis may be positive or negative. Depending upon breeding objectives, both positive and negative heterosis is useful for crop improvement. In general, positive heterosis is desired for yield, and negative heterosis for early maturity. Heterosis is expressed in three ways, depending on the criteria used to compare the performance of a hybrid. The three ways are: mid-parent, standard variety and better parent heterosis. However, from the plant breeder's viewpoint, better parent and/or standard variety is more effective. The former is designated as heterobeltiosis (Fanseco and Peterson 1968) and the latter as standard heterosis (Virmani, 1994). Good hybrids have the potential for yielding 15%- 20% more than the best inbred variety grown under similar condition (Virmani *et al.* 1997). All these reports led to the conclusion that there was significant occurrence of heterosis, which could be exploited commercially by developing F1 rice hybrids (Virmani, 1994). Hybrid rice technology could offer great opportunity for increasing food production of rice growing countries. Inbreeding depression (ID) is usually defined as the lowered fitness or vigor of inbred individuals compared with their non-inbred counterparts. Its converse is heterosis, the 'hybrid vigor' manifested as increased size, growth rate or other parameters resulting from the increase in heterozygosity in F1 generation crosses between inbred lines.

Inbreeding depression, the depressive effect, is the expression of traits arising from increasing homozygosity (Allard, 1960). In quantitative genetics theory, inbreeding depression and heterosis are due to nonadditive gene action, and are considered to be two aspects of the same phenomenon (Mather and Jinks 1982 and Li *et al.* 1997) suggested that hybrid breakdown in rice was part of ID largely related to additive epistasis. In this work, heterosis and inbreeding depression were studied for selecting good materials for developing superior hybrid rice variety. Experiments were conducted to estimate the effect of heterosis on different yield contributing characters for developing high yielding F1 hybrid rice variety.

Assessment and standardizing the genetic parameters in rice were found out by many investigators. Roy and Panwar (1997) reported that dominance gene action was important for plant height, number of panicles/ plant, and panicle weight. Dominance x dominance type of gene interaction was more important than additive x dominance and additive x additive in most of the studied traits. Rice grain yield and yield attributes such as productive panicles per unit area, fertility, and spikelets per panicle, are sensitive to salinity (Zeng and Shannon, 2000). Khatun *et al*. (1995) observed that salt stress at panicle initiation reduces the number of fertile florets, grain weight, panicle length, and grain yield. Salinity also adversely affects pollen viability and panicle fertility in rice. Even a small increase in sodium concentration can severely affect developing reproductive organs that determine yield components and ultimately reduce grain yield.

This study was conducted to analyze the genetic aspects of the traits through the analysis of P_1, P_2, F_1, BC_1, BC_2 and F_2 generation to investigate the contribution of various gene effects by generation mean analysis; and to estimate the heterosis, heterobeltiosis, heritability, genetic advance, degree of dominance, inbreeding depression, minimum number of effective factors controlling traits, Phenotypic (PCV) and Genotypic (G.C.V) coefficient of variability were calculated also for the studied traits in the studied rice cross.

MATERIALS AND METHODS

The present investigation was carried out at the Lysimeter of the Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2009, 2010 and 2011 summer seasons, the objective of this investigation was aimed to study the genetic parameters that control some yield and its related traits i.e., days to 50% heading, plant height (cm), number of panicles/ plant, panicle length (cm), panicle weight (g), 100-grain weight (g), number of filled grains/ panicle, sterility % and grain yield/ plant (g) as well as grain dimensions traits viz, grain length (mm), grain width (mm) and grain shape.

Two rice varieties, Nabatat Asmar (tolerant to salinity) and Sakha 105 (sensitive to salinity) possess characteristics of wide range of genetic diversity for studied traits were used in this study as female and male parents, respectively.

In 2009 season, parents were grown and crossed following the technique proposed by Jodon, 1938, to produce F_1 hybrid seeds of (Nabatat Asmar X Sakha 105) rice cross.

In 2010 season, parents and F_1 hybrid seeds were planted. F_1 generation was crossed back to its respective parents to produce first backcross BC_1 (F_1 x P_1) and second backcross BC_2 (F_1 x P_2). Simultaneously, crossing between the two parents were made to produce a new F_1 hybrid seeds. On the other hand, the F_1 plants were selfed to produce F_2 seeds.

In 2011 season, seeds of the six populations (P_1, P_2, F_1, F_2, BC_1 and BC_2) were sown in dry seedbed. After thirty days from sowing seedlings of each (P_1, P_2, F_1, F_2, BC_1 and BC_2) were transplanted under normal and saline soil conditions in Lysimeter at randomized complete block design experiment with four replications. Each replicate comprised 5 rows for each P_1, P_2, F_1, BC_1 and BC_2 and thirty rows for F_2 seeds. Each row was 1 m long and 15 x 15 cm apart was maintained between rows and seedlings. All agricultural practices such as sowing date, fertilizer application and weed control were applied as recommended. The Lysimeter plot is concrete beds (1m width x 2m length) filled with soil to 100 cm depth in three layers, i.e., 60 cm clay at surface layer, 20 cm sand at the middle layer and 20 cm gravel at bottom layer.

Salinity, irrigation and drainage cycle were accurately controlled. The saline soil conditions were adjusted to 10.6 dSm^{-1} in addition, the normal soil conditions were irrigated by tap water. The mean value of electrical conductivity (EC) of irrigation water is 0.77 dSm^{-1} for normal otherwise 10.6 dSm^{-1} at 25 °C for the saline soil conditions. The water was artificially salinized by applying sodium chloride (NaCL) and calcium chloride (CaCL2) at the ratio of 1: 2, respectively.

Data were collected purposelessly at maturity on 30 plants from each P_1, P_2, F_1, BC_1 and BC_2 and 150 plants from F_2 generation per replicate. The following genetic parameters were estimated for the studied characters; heterosis and degree of dominance followed Mather and Jinks, 1971, the minimum number of effective factors according to Burton, 1951, scaling test for adequacy of additive and dominance model and genetic components followed Mather, 1949, phenotypic (P.C.V) and Genotypic (G.C.V) coefficients of variability pursuant to Burton, 1952, broad and narrow senses heritabilites according to Powers *et al.* 1950 and Werner, 1952 respectively, and expected genetic advance (Gs %) in according to Johnson *et al*. 1955.

RESULTS AND DISCUSSION

1- Means of the parents and their generation:

The best source of information about the question of base on these estimates is that derived by fitting a model to the mean of the basic generation, i.e., P_1, P_2, F_1, F_2, BC_1 and BC_2, which are presented in Table (1). The results revealed that wide range of means was recorded among the two parents in most of the studied traits under normal and saline soil conditions. The different mean values of parental genotypes recorded were for days to 50 % heading (115.04, 96.21 and 75.03, 82.21 day), plant height (170.08, 112.03 and 73.07,54.02 cm), number of panicles/plant (22.78, 26.51 and 4.78, 3.51), number of filled grains/panicle (112.17, 173.97 and 57.17, 43.97), grain yield/ plant (26.29, 38.49 and 2.29, 0.99 g), grain length (5.89, 5.44 and 5.49, 6.17 mm) and grain shape (2.27,1.47 and 2.11, 2.30 mm) for Nabatat Asmar and Sakha 105 under normal and saline soil conditions, respectively, indicating a wide range of genetic variation between the parents used under two conditions.

The mean value of F_1 generation was higher than the highest parent for days to 50 % heading, plant height, panicle length, number of panicles/ plant, number of filled grains/ panicle, panicle weight, sterility (%) and grain yield/ plant under two conditions, while it was higher than the highest parent for 100-grain weight, grain width and grain shape under saline soil conditions. On the other hand, the F_2 mean values were intermediate between the two parents for number of panicles/ plant and panicle weight under two conditions and for 100-grain weight and grain yield/plant under saline soil conditions indicating that desirable transgressive segregation in successive generation, provided that desirable complementary genes and epistatic effects were coupled in the same direction to maximize such traits under consideration. Moreover, both BC_1 and BC_2 mean values were varied according to the traits itself; it was tended toward the mean of recurrent parent for all the studied traits under two conditions except grain length under normal soil conditions.

Table 1: Mean performance of six populations and their standard error for the studied rice cross under two conditions for all the studied traits.

Character	Soil conditions	Mean performance ± standard error					
		P1	P2	F1	F2	BC1	BC2
Days to 50 % heading	N	115.04 ± 0.50	96.21 ± 0.47	139.90 ± 1.14	127.28 ± 3.03	124.66 ± 2.02	122.38 ± 1.81
	S	75.03 ± 0.05	82.21 ± 0.47	129.90 ± 1.14	104.30 ± 3.03	89.72 ± 2.04	106.45 ± 1.82
Plant height (cm)	N	170.08 ± 0.45	112.03 ± 0.96	138.75 ± 1.26	137.57 ± 2.03	151.87 ± 0.92	105.18 ± 0.92
	S	73.07 ± 0.45	54.02 ± 0.0.96	110.75 ± 1.26	84.57 ± 2.03	94.87 ± 0.92	75.21 ± 0.94
Panicle length (cm)	N	17.43 ± 0.19	24.42 ± 0.21	26.74 ± 0.22	23.56 ± 0.33	20.94 ± 0.14	21.82 ± 0.16
	S	14.79 ± 0.19	12.32 ± 0.21	16.94 ± 0.22	14.76 ± 0.33	15.64 ± 0.14	12.06 ± 0.14
No. of panicles/ plant	N	22.78 ± 0.14	26.51 ± 0.12	28.91 ± 0.39	29.05 ± 0.49	27.81 ± 0.23	28.51 ± 0.23
	S	4.78 ± 0.14	3.51 ± 0.12	13.91 ± 0.39	12.37 ± 0.46	8.81 ± 0.23	7.50 ± 0.20
No. of filled grains/ panicle	N	112.17 ± 0.11	173.97 ± 0.10	190.10 ± 0.02	155.18 ± 1.55	135.52 ± 0.12	179.58 ± 0.65
	S	57.17 ± 0.11	43.97 ± 0.11	80.10 ± 0.02	52.37 ± 0.23	70.52 ± 0.12	54.75 ± 0.11
100- grain weight (g)	N	2.35 ± 0.11	2.67 ± 0.01	2.55 ± 0.01	2.50 ± 0.02	2.66 ± 0.01	2.72 ± 0.01
	S	1.95 ± 0.11	1.57 ± 0.01	2.45 ± 0.01	2.01 ± 0.02	2.16 ± 0.01	1.92 ± 0.01
Panicle weight (g)	N	3.09 ± 0.02	4.04 ± 0.02	4.88 ± 0.03	4.50 ± 0.12	3.63 ± 0.02	4.35 ± 0.09
	S	0.89 ± 0.02	0.34 ± 0.02	1.15 ± 0.05	1.10 ± 0.06	1.03 ± 0.02	0.69 ± 0.01
Sterility (%)	N	9.08 ± 0.13	4.25 ± 0.11	15.40 ± 0.11	16.50 ± 0.27	10.22 ± 0.14	7.22 ± 0.09
	S	44.08 ± 0.13	59.25 ± 0.11	60.41 ± 0.11	51.27 ± 0.26	51.68 ± 0.11	56.79 ± 0.11
Grain yield/ plant	N	26.29 ± 0.02	38.49 ± 0.02	49.12 ± 0.12	37.30 ± 0.12	30.09 ± 0.05	39.09 ± 0.05
	S	2.29 ± 0.02	0.99 ± 0.02	11.12 ± 0.12	5.22 ± 0.10	6.09 ± 0.05	3.12 ± 0.03
Grain length (mm)	N	5.89 ± 0.05	5.44 ± 0.10	6.36 ± 0.10	5.90 ± 0.25	5.14 ± 0.12	5.60 ± 0.10
	S	5.49 ± 0.05	6.17 ± 0.10	6.01 ± 0.10	5.35 ± 0.25	5.34 ± 0.12	5.70 ± 0.11
Grain width (mm)	N	2.63 ± 0.05	3.68 ± 0.04	3.46 ± 0.03	3.50 ± 0.12	2.94 ± 0.03	3.84 ± 0.02
	S	2.35 ± 0.05	2.68 ± 0.04	2.87 ± 0.03	2.62 ± 0.12	2.52 ± 0.03	2.74 ± 0.03
Grain shape (mm)	N	2.27 ± 0.04	1.47 ± 0.01	1.83 ± 0.01	1.76 ± 0.11	1.74 ± 0.03	1.46 ± 0.03
	S	2.11 ± 0.03	2.30 ± 0.02	2.39 ± 0.03	2.21 ± 0.17	2.06 ± 0.03	2.08 ± 0.05

P_1 = female parent (Nabatat Asmar) **P_2 = Male parent (Sakha 105)**
F_1 = P_1 x P_2 (Nabata Asmar x Sakha 105) **F_2 = F_1 Selfed seeds (second generation)**
BC_1 = F_1 backcrossed to female parent **BC_2 = F_2 baccrossed to male parent**
N = normal soil conditions (0.77 dSm^{-1}) **S = saline soil conditions (10.6 dSm^{-1})**

2- Estimates of heterosis, inbreeding depression, degree of dominance and the minimum number of effective factors controlling traits:

It is clear from Table (2) that significant and highly significant and positive estimates of heterosis and heterobeltiosis were obtained for all the studied traits under two conditions except days to 50 % heading, plant height and sterility % which exhibited highly significant positive heterosis and heterobeltiosis in undesirable direction as well as 100- grain weight and grain width which exhibited significant negative heterobeltiosis. Insignificant negative heterosis was estimated for plant height under normal condition. The highest estimated values of heterosis were recorded for grain yield (51.63 %) followed by panicle weight (36.86 %) and number of filled grains/ panicle (32.86 %) under normal soil conditions. Moreover, highly significant and positive estimates of heterobeltiosis were reported for grain yield/ plant (384.32 %) followed by number of panicle/ plant (190.60 %) and number of filled grains/ panicle (40.09 %) under saline soil conditions. Similar results were reported earlier by Panwar *et al*. (1998), Sitaramaiah *et al.* (1998), Singh and Haque (1999), Vishwakarma *et al.* (1999), El-Abd and Abdallah (2002), Hammoud (2005), Sedeek *et al*. (2007), Shehata *et al.* (2009), Sultan *et al.* (2010) and El-Rewainy *et al.* (2011).

Inbreeding depression is largely due to the increased homozygosity of rare recessive alleles. Results in Table (2) indicated that highly significant positive inbreeding depression values were obtained for all the studied traits under saline soil conditions, while panicle length, 100- grain weight, panicle weight, grain yield/ plant, grain length and grain shape were affected by highly significant positive inbreeding depression under normal soil conditions. On the contrary, insignificant or significant negative estimates of inbreeding depression when it measured under normal soil conditions was illustrated for days to 50 % heading, plant height, number of panicles/ plant, number of filled grains/ panicle, sterility % and grain width traits. 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), El-Abd and Abdallah (2002), Hammoud (2005) and Sedeek *et al* (2007).

As shown in Table (2), the degree of dominance was greater than unity (±1.0) suggesting the important of over dominance in controlling all the studied traits under both conditions except plant height, number of filled grains/ panicle, grain width and grain shape under normal soil conditions and grain length under saline soil conditions. These results can be summarized in modern terminology by saying that the alleles determining lateness, shortness, long panicle, high number of panicles/ plant, high number of filled grains/ panicle, heavy grains, heavy panicle, low sterility % and high yielding/ plant are dominant to the alleles determining earliness, long plants, short panicle, low number of panicles/ plant, low number of filled grains/ panicle, light grains, light panicles, high sterility % and low yielding/ plant under saline soil conditions. Conversely, the results also showed that the alleles for lateness, long panicles, high number of panicles/ plant, light grains, heavy panicles, high sterility % and high yielding/ plant are recessive to that for earliness, short panicles, low number of panicles/ plant, heavy grains, light panicles, low sterility % and low yielding/ plant under normal conditions. The point is that the hybrid, which receive a different allele from each parental strain, express only the trait corresponding to the dominant allele and fail to express the trait corresponding to the recessive alleles. However, the degree of dominance were lower than unity (0.08, -0.23, -0.58 and -0.09) for plant height, number of filled grains/ panicle, grain width and grain shape, respectively under normal soil conditions and grain length (-0.54) under saline soil conditions. The ratio which was between zero and unity, suggesting partial or incomplete dominance might be played a remarkable role in the inheritance of such traits. Similar results were previously reported by Reedy and Nekar (1991), Singh and Choudhary (1996), El-Abd and Abdallah (2002), Hammoud (2005), Sedeek *et al*. (2007), Shehata *et al.* (2009) and El-Rewainy *et al.* (2011).

Table 2: Estimates of heterosis (M.P), heterobeltiosis (B.P), inbreeding depression, Degree of dominance and the minimum number of effective factors controlling traits.

Character	Soil conditions	Heterosis %		Inbreeding depression	Degree of dominance	Minimum number of effective genes
		M.P	B.P			
Days to 50 % heading	N	32.44**	45.40**	9.01	-3.64	0.07
	S	66.21**	73.11**	19.70**	14.29	0.37
Plant height (cm)	N	-1.68	23.85**	0.84	0.08	0.08
	S	74.27**	104.99**	23.63**	-4.95	0.34
Panicle length (cm)	N	27.78**	9.49**	11.89**	-7.65	0.87
	S	24.26**	14.54**	12.86**	2.74	0.61
No. of panicles/ plant	N	17.29**	9.05**	-0.50	-2.28	0.40
	S	235.24**	190.60**	8.44**	15.31	5.52
No. of filled grains/ panicle	N	32.86**	9.26**	1.81	-0.23	0.23
	S	58.37**	40.09**	34.61**	4.47	13.67
100- grain weight (g)	N	1.51**	-4.58**	18.20**	3.63	2.32
	S	39.03**	25.54**	18.20**	3.63	20.23
Panicle weight (g)	N	36.86**	20.87**	7.75**	-2.78	1.40
	S	86.94**	28.83**	4.54**	1.93	3.46
Sterility (%)	N	131.12**	262.34**	-7.12**	3.62	2.75
	S	16.91**	37.04**	15.11**	-1.15	1.78
Grain yield/ plant	N	51.63**	27.60**	24.05**	-2.74	34.03
	S	575.29**	384.32**	53.02**	14.58	68.18
Grain length (mm)	N	12.32**	16.94**	7.31**	3.12	0.19
	S	3.16**	9.54**	11.06**	-0.54	0.06
Grain width (mm)	N	9.82**	-5.87**	-1.04**	-0.58	0.35
	S	13.90**	6.89**	8.55**	-2.11	0.31
Grain shape (mm)	N	-1.96**	24.39**	3.96**	-0.09	0.25
	S	8.52**	13.30**	7.78**	-2.02	0.07

N = normal soil conditions (0.77 dSm^{-1}) **S = saline soil conditions (10.6 dSm^{-1})**

***, **: Significant and highly significant at 0.05 and 0.01conditions of probability, respectively.**

The estimates of minimum number of effective factor were ranged between 0.06 and 68.18 pairs of gene for grain length and grain yield, respectively in the studied cross under saline soil conditions. On the other hand, the estimates of minimum number of effective factor were ranged between 0.07 and 34.03 pairs of gene for days to 50 % heading and grain yield, respectively in the studied cross under normal soil conditions. The results in general, revealed

that days to 50 % heading, plant height, panicle length, grain length, grain width, and grain shape were controlled by almost one pairs of effective genes suggesting that these traits were inherited as a simple traits under two conditions. Moreover, number of panicles/ plant and number of filled grains/ panicle were controlled also by one pairs of gene under normal soil conditions. On the other hand, the other remaining traits, viz, 100- grain weight, panicle weight, sterility (%) and grain yield/ plant under two conditions, as well as, number of panicles/ plant and number of filled grains/ panicle under saline soil conditions were probably controlled by two to sixty nine pairs of genes indicating that these traits were inherited as a complicated or quantitative traits, so, selection late generations was important and play an remarkable role in the inheritance such traits.

3- Estimates of genetic components of generation mean:

Obviously, the results in Table (3) show that scaling test for adequacy of additive and dominance model and genetic components of generation mean. The data showed that one at least of computed parameters (A, B and C) of scaling test were significant for all the studied traits. This result indicates the genetic control of these characters depends on allelic interaction.

The estimates of mid-parental values were positive and significant or highly significant for all the studied traits under two conditions except, number of panicles/ plant under saline soil conditions. Additive gene action appear to be positive and significant for all the studied traits under two conditions, except days to 50 % heading (2.28) under normal soil conditions and grain shape (-0.02) under saline soil conditions. The highest estimated value was recorded for plant height (46.69) followed by number of filled grain/ panicle ((-44.06), which were in undesirable direction under normal soil conditions. On the other hand, it was ranged between (0.16 and 19.66) for grain width and plant height, respectively, under saline soil conditions.

Moreover, dominance gene action was played an important role in the inheritance of plant height (-38.47), number of filled grains/ panicle (56.52), 100- grain weight (0.80), sterility % (-22.39) and grain yield/ plant (5.87) under normal soil condition. These results further emphasized that the dominance gene action was greater than additive gene action in the inheritance of the last mentioned traits. Furthermore, additive x additive type of gene interaction was significant in desirable direction for plant height (-36.17), 100- grain weight (0.76) and sterility % (-31.13) under normal conditions, while it was significant positive for number of filled grains/ panicle (41.05) under saline soil condition. In addition, it was exhibited significant and insignificant either positive or negative in undesirable direction for other remaining traits.

In addition, additive x dominance type of gene interaction showed significant in desirable direction for days to 50 % heading, panicle length, number of panicle/ plant and 100- grain weight under two conditions. Moreover, it was played an important role in the inheritance of number of filled grains/ panicle (9.17), number of panicles/ plant (0.67) and grain yield/ plant (2.32) under saline soil conditions. Otherwise, significant in either positive or negative estimates of additive x dominance type of gene interaction in undesirable direction were found for other remaining traits. On the other hand, highly significant and positive estimates of dominance x dominance type of gene interaction were detected for panicle length (18.53), number of filled grains/ panicle (26.63), panicle weight (2.97), grain yield/ plant (35.51), grain length (4.69) and grain shape (1.64) under normal soil conditions, while it was significant or highly significant and positive under saline conditions for panicle length, number of panicles/ plant, panicle weight and grain yield/ plant, their estimated values were 9.24, 21.82, 1.03 and 9.57 respectively. On the contrary, highly significant in desirable negative direction of dominance x dominance type of gene action was exhibited for sterility (%) (-4.64) under saline soil conditions and 100- grain weight (-1.42) under normal conditions. The other remaining traits showed insignificant with either negative or positive values of dominance type of gene interaction.

Table 3: Scaling test for adequacy of additive and dominance model and genetic components of generation mean for yield and its related characters in the studied cross.

Character	Soil conditions	Scaling test			Genetic components					
		A	B	C	m	a	d	aa	ad	dd
Days to 50% heading	N	-5.61	8.63	18.08**	127.28**	2.28	19.21	-15.06	-7.12**	12.03
	S	-25.48**	0.78	0.15	104.30**	-16.72**	26.42*	-24.85	-13.13**	49.55**
Plant height (cm)	N	-5.07*	-40.40**	-9.30	137.57**	46.69**	-38.47**	-36.17**	17.66**	81.65
	S	5.92*	-14.35**	-10.30	84.57**	19.66**	49.08**	1.87	10.13**	6.55
Panicle length (cm)	N	-2.29**	-7.52**	-1.09	23.56**	-0.88**	-2.90*	-8.72**	2.61**	18.53**
	S	-0.44**	-5.14**	-1.95	14.76**	3.58**	-0.26	-3.64**	2.35**	9.24**
No. of panicles/ plant	N	3.92**	1.60**	9.10**	29.06**	-0.70*	0.68	-3.58	1.16**	-1.94
	S	-1.07**	-2.42**	14.82**	12.73	1.31**	-8.56**	-18.32**	0.67*	21.82**
No. of filled grains/ panicle	N	-31.22**	-4.90**	-45.61*	155.18**	-44.06**	56.52	9.49	-13.16**	26.63**
	S	3.77**	-14.57**	-51.85**	52.37**	15.77**	70.57**	41.05**	9.17**	-30.25**
100- grain weight (g)	N	0.42**	0.22**	-0.10**	2.50**	-0.06**	0.80**	0.76**	0.10**	-1.42**
	S	-0.07**	-0.17**	-0.40**	2.00**	0.24**	0.84**	0.15	0.05*	0.09
Panicle weight (g)	N	-0.78**	-0.21**	1.11**	4.50**	-0.72**	-0.73	-2.05**	-0.25*	2.97**
	S	0.02**	-0.10**	0.86**	1.10**	0.34**	-0.41	-0.94**	0.06	1.03**
Sterility (%)	N	-4.04**	-5.21**	21.87**	16.51**	2.99**	-22.39**	-31.13**	0.58**	40.39**
	S	-1.11**	-6.08**	-19.05**	51.27**	-5.10**	20.59**	11.84**	2.48**	-4.64**
Grain yield/ plant	N	-15.22**	-9.43**	-13.80**	37.30**	-8.99**	5.87**	-10.85**	-2.89**	35.51**
	S	-1.23**	-5.87**	-4.63**	5.22**	2.97**	7.01**	-2.46**	2.32**	9.57**
Grain length (mm)	N	-1.97**	-0.60**	-0.46	5.90**	-0.46**	-1.41	-2.11*	-0.68**	4.69**
	S	-0.82**	-0.79**	-2.29**	5.35**	-0.36*	0.86	0.67	0.01	0.94
Grain width (mm)	N	-0.21**	0.53**	0.76**	3.50**	0.90**	-0.13	-0.45	-0.37**	0.13
	S	-0.04**	-0.06**	-0.28*	2.62**	0.16**	0.53	0.18	0.01	-0.08
Grain shape (mm)	N	-0.61**	-0.39**	-0.36**	1.76**	0.29**	-0.67	-0.63	-0.11*	1.64**
	S	-0.38**	-0.52**	-0.36	2.21**	-0.02	-0.35	0.54	0.07	1.44*

N = normal soil conditions (0.77 dSm^{-1}) S = saline soil conditions (10.6 dSm^{-1})

m: mid-parent value. A and d: pooled additive and dominance effects, respectively.

aa, ad and dd: pooled additive x additive, additive x dominance and dominance x dominance gene interaction, respectively.

***, **: Significant and highly significant at 0.05 and 0.01conditions of probability, respectively.**

In contrast, dominance gene action; additive x dominance and dominance x dominance type of gene interaction showed highly significant values, indicating that these factors are significant contributors to the variation of generation means and played an important role in the inheritance of such characters. These findings were agreement with those of Roy and Panwar (1997), Roy (1999), El-Abd and Abdallah (2002), Sedeek *et al* (2007) and Shehata *et al.* (2009).

4- Estimates of genetic variance, genetic variability, heritability and genetic advance:

The genetic parameters of the studied traits were computed in Tables (4 and 5).

Table 4: Estimates of generation mean (X), phenotypic (V ph), genotypic (V g) and environmental (V e) variance and phenotypic (P.C.V.) and genotypic (G.C.V.) coefficient of variation for the studied traits.

Character	Soil conditions	X	V ph	V g	V e	P.C.V	G.C.V
Days to 50 % heading	N	120.91	9.18	8.58	0.59	7.59	7.10
	S	97.93	9.20	8.60	0.59	9.39	8.78
Plant height (cm)	N	135.91	4.15	3.24	0.91	3.05	2.38
	S	82.08	4.16	3.25	0.91	5.06	3.95
Panicle length (cm)	N	22.48	0.11	0.06	0.04	0.49	0.29
	S	14.42	0.11	0.07	0.04	0.77	0.47
No. of panicles/ plant	N	27.26	0.24	0.17	0.06	0.89	0.65
	S	8.54	0.21	0.15	0.06	2.57	1.81
No. of filled grains/ panicle	N	157.75	1.42	2.41	0.01	1.54	1.53
	S	59.81	0.05	0.04	0.01	0.09	0.07
100- grain weight (g)	N	2.58	0.0007	0.0005	0.0001	0.029	0.022
	S	2.01	0.0007	0.0005	0.0001	0.038	0.028
Panicle weight (g)	N	4.08	0.014	0.013	0.001	0.35	0.33
	S	0.87	0.003	0.002	0.001	0.40	0.27
Sterility (%)	N	10.44	0.07	0.06	0.010	0.73	0.58
	S	53.91	0.06	0.053	0.014	0.12	0.09
Grain yield/ plant	N	36.73	0.016	0.011	0.005	0.045	0.031
	S	4.80	0.011	0.006	0.005	0.240	0.130
Grain length (mm)	N	5.72	0.064	0.056	0.008	1.13	0.98
	S	5.67	0.064	0.056	0.008	1.14	0.99
Grain width (mm)	N	3.34	0.015	0.013	0.002	0.46	0.39
	S	2.64	0.015	0.012	0.003	0.58	0.46
Grain shape (mm)	N	1.75	0.013	0.012	0.0008	0.75	0.70
	S	2.19	0.031	0.030	0.0008	1.42	1.38

N = normal soil conditions (0.77 dSm^{-1}) **S = saline soil conditions (10.6 dSm^{-1})**

The results demonstrated high values of genotypic variance (VG) comparing with the environmental variance (VE) for all the studied traits, the highest estimated values were found for days to 50 % heading (8.58 and 8.60) and plant height (3.24 and 3.25) under normal and saline soil conditions, respectively. Furthermore, phenotypic coefficient of variability (P.C.V) was higher than genotypic coefficient of variability (G.C.V) for all the studied traits, indicating that they all interacted with the environment condition. The lowest values of (G.C.V) were recorded for 100- grain weight (0.022 and 0.028), grain yield/ plant (0.031 and 0.130) and sterility % (0.58 and 0.09) with some exception under normal and saline soil conditions, respectively, indicating lack of inherent variability and limited scope for improvement through selection for such traits.

Table 5: Estimates of additive genetic variance (1/2 D), dominance genetic variance (1/4 H), broad and narrow-sense heritability and genetic advance (G.S %) for the studied traits.

Characters	Soil conditions	Genetic variance		Heritability		Genetic advance (G.S %)
		½ D	¼ H	Broad sense	Narrow sense	
Heading Date	N	10.95	-2.37	93.49	80.64	395.53
	S	10.93	-2.32	53.50	81.23	486.72
Plant Height (cm)	N	6.60	-3.36	78.07	40.99	125.15
	S	6.56	-3.31	78.07	42.07	208.92
Panicle Length (cm)	N	0.17	-0.11	60.00	40.82	119.63
	S	0.18	-0.11	60.07	35.78	167.36
No. of Panicles/ plant	N	0.37	-0.19	73.53	46.10	161.43
	S	0.34	-0.18	70.59	43.81	332.11
No. of Filled Grains/ Panicle	N	4.40	-01.99	99.49	18.36	37.96
	S	0.08	-0.04	76.66	50.97	46.04
100- Grain Weight (g)	N	0.001	-0.001	74.90	65.87	149.63
	S	0.001	-0.001	74.90	59.90	189.99
Panicle weight (g)	N	0.018	-0.005	95.12	70.34	387.81
	S	0.006	-0.003	68.96	35.56	393.39
Sterility (%)	N	0.12	-0.06	80.73	39.29	135.45
	S	0.11	-0.05	78.39	36.92	38.68
Grain Yield/ plant	N	0.03	-0.01	68.57	36.94	26.46
	S	0.02	-0.01	55.26	37.58	161.52
Grain Length (mm)	N	0.10	-0.05	86.99	40.91	363.82
	S	0.10	-0.04	86.98	45.39	445.13
Grain Width (mm)	N	0.03	-0.01	85.71	10.97	80.14
	S	0.03	-0.02	79.86	12.67	123.60
Grain Shape (mm)	N	0.02	-0.01	93.51	15.18	204.68
	S	0.06	-0.03	97.35	12.91	213.08

N = normal soil conditions (0.77 dSm^{-1}) **S = saline soil conditions (10.6 dSm^{-1})**

In addition, data summarized in Table (5) revealed that additive genetic variance (½ D) was higher than dominance genetic variance (¼ H) for all studied traits, indicating that additive component of genetic variance were predominant in the expression for all the studied traits under two conditions.

High heritability estimates in broad sense were observed for all the studied traits, while low to high estimates of heritability in narrow sense were detected under two conditions. The highest estimates of narrow sense heritability were recorded for days to 50 % heading (80.64 and 81.23) followed by 100- grain weight (65.87 and 59.90), number of panicles/ plant (46.10 and 43.81), grain length (40.91 and 45.39), plant height (40.99 and 42.07) and sterility % (39.29 and 36.92) under normal and saline soil conditions, respectively.

Acknowledge of genetic advance produced by applying selection pressure to a population is useful in designing an effective breeding program. High estimates of expected genetic advance (Gs %) expressed as percentages of mean were found for all the studied traits under two conditions, except number of filled grains/ panicle and sterility % under saline soil conditions (Table 5). In addition, most of the studied traits had high heritability estimates in broad sense coupled with high genetic advance and high genotypic coefficient of variability, suggesting that these traits are either simply inherited or governed by a few major genes or the additive gene effects play an important role in the inheritance of these traits, so, selection in early generation was played an important role in the improving such traits. These results are in harmony with those of Manonmani *et al*. (1996), Reddy and Kumar (1996), Singh and Choudhary (1996), Choudhary and Das (1997), Narendra and Reddy (1997), Saravanan and Senthil (1997), Kumar *et al*. (1998), Singh *et al*. (1998),Tripathi *et al*. (1999), El-Abd and Abdallah (2002), Hammoud (2005), Sedeek *et al* (2007) and Shehata *et al.* (2009).

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دراسات وراثيه على صفات أبعاد الحبة والمحصول والصفات المرتبطة به فى الأرز تحت ظروف الاراضى الملحية

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أجريت هذه الدراسة بمزرعة مركز البحوث والتدريب فى الأرز بسخا – كفر الشيخ خلال المواسم الزراعية الصيفية 2009، 2010 و 2011 بهدف دراسة تأثير قوة الهجين عند قياسها كأنحراف عن قيم متوسط الابوين وقيم أحسن الابوين. و قدرت النسبة المئوية لدرجة التوريث بمعناها الواسع والضيق والتربية الداخلية، كما تم دراسة طبيعة الفعل الجينى لصفات ابعاد الحبة والمحصول والصفات المرتبطة به. وقد استخدمت الأجيال الستة (الابوين، الجيل الأول، الجيل الثانى والجيلين الرجعيين الأول والثانى) لهجين أرز نباتات أسمر (المتحمل للملوحة) x سخا 105 (الحساس للملوحة) تحت ظروف كل من الرى بالمياه الملحية بكلوريد الصوديوم و كلوريد الكالسيوم بنسبة 1 : 2 على الترتيب (10.6 ملليموز سم $^{-1}$) والاراضى العادية (0.77 ملليموز سم $^{-1}$).

وأشارت النتائج الى أن قوة الهجين كانت معنوية جدا وموجبة عند قياسها كانحراف عن قيم متوسط الابوين وقيم الاب الافضل لجميع الصفات المدروسة تحت المستويين ماعدا صفتى وزن المئة حبة ومحصول النبات الفردى تحت ظروف الاراضى العادية. كما لوحظ أن تقديرات معامل الأختلاف الوراثى ودرجة التوريث بمعناها الواسع والتحسين المتوقع من الانتخاب كانت عالية لصفات عدد الايام ل 50% من التزهير، طول النبات، وزن المئة حبة، وزن الدالية وطول وعرض وشكل الحبة تحت كلا الظرفين، وبناء عليه فأنه يوصى بالأنتخاب المباشر لتحسين هذه الصفات. كما كان معامل التباين المظهرى (PCV) أعلى من معامل التباين الوراثي (GCV) لجميع الصفات المدروسة، مما يشير إلى تأثرها بالظروف البيئة. بالأضافة الى ذلك فقد أوضحت النتائج أهمية كل من السيادة الجزئية والسيادة الفائقة فى وراثة معظم الصفات المدروسة تحت كلا الظرفين.

أوضحت نتائج تقديرات طبيعة الفعل الجينى أن قيم متوسط الأبوين كانت عالية المعنوية وموجبة لجميع الصفات المدروسة تحت كلا الظرفين ماعدا عدد الداليات/ نبات تحت الظروف الملحية. كما أظهرت النتائج اهمية التاثير الاضافى للجين فى وراثة صفات أرتفاع النبات وعدد السنيبلات الممتلئة/ دالية وذلك تحت كلا الظرفين. بينما لعب التاثير السيادى للجين دورا هاما فى وراثة صفات طول النبات، عدد السنيبلات الممتلئة/ دالية والنسبة المئوية للعقم وكذا اظهرت النتائج اهمية التفاعل بين الجينات الغير الأليلية (المضيف x المضيف) فى وراثة صفات عدد السنيبلات الممتلئة/ دالية والنسبة المئوية للعقم تحت كلا الظرفين، ووزن المئة حبة تحت ظروف الاراضى العادية.

كما اوضحت النتائج أن صفات عدد الايام ل 50% من التزهير، طول النبات، طول الدالية وطول وعرض وشكل الحبة كانت صفات بسيطة حيث تحكم فيها زوج واحد من العوامل الوراثية. بينما كانت صفات عدد الداليات/ نبات وعدد السنيبلات الممتلئة/ دالية صفات معقده أو كمية حيث تحكم فيها من زوجين الى العديد من أزواج العوامل الوراثية وذلك تحت كلا الظرفين وعليه فأن الإنتخاب فى الأجيال المتأخرة يلعب دورا هاما فى توريث هاتين الصفتين.

قام بتحكيم البحث

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