Original Article

Genetic Studies on Agro-Morphological Traits in Rice (*Oryza sativa* L.) under Water Stress Conditions

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ABSTRACT:

The present investigation was carried out at the farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2014, 2015 and 2016 seasons. The evaluation were done based on estimation of heterosis, gene action, heritability, genetic advance and phenotypic correlation coefficient, some root and grain quality traits in rice using six populations technique, viz., P_1, P_2, F_1, BC_1, BC_2 and F_2 generation of three rice crosses namely Sakha 105 x WAB 450-T-B-P 3811-B (cross I); Sakha 104 x IR 66946-3R-178-1-1 (cross II) and Sakha 106 x Sakha 178 (cross III) were raised in a randomized complete block design. Flashing water irrigation was added after 10 days intervals. The current study aimed to determine the heterosis, gene action, heritability, genetic advance and phenotypic correlation response to selection and prediction by the new lines for the traits of days to 50 % heading, plant height, panicle length, number of panicles / plant, number of filled grains/ panicle, 100-grain weight, sterility % and grain yield/ plant. The results obtained from the mean of parents, F_1 and F_2 generations showed wide range in mean values between the parents and the presence of partial and over-dominance were found for all studied characters. Significant and highly significant positive estimates as a deviation from mid and better parents in all crosses for panicle length, number of panicles/plant and grain yield/plant, also highly significant positive estimates as a deviation from mid and better parents in the first two crosses for plant height. Scaling test provide evidence of non-allelic interaction in controlling all the characters studied in most crosses, the additive gene effect (d) was more important in the genetic system for all studied characters, dominance gene effects (h) and additive x additive gene effects (i) were played an important role in the inheritance of plant height, panicle length, number of filled grains/panicle, 100-grain weight, sterility percentage and grain yield/ plant. The additive x dominance (j) were significant and involved in the inheritance of days to 50% heading, plant height, number of panicles/plant, number of filled grains/panicle, 100-grain weight, sterility percentage and grain yield/plant. However, the dominance x dominance (l) were involved in the genetic control of all characters. Heritability estimates in broad sense were high. Meanwhile, heritability estimates in narrow sense were mostly low. The maximum genetic advance of the mean values was found to be high for number of panicles/plant, plant height and days to 50% heading characters. Highly significant and positive correlation was found for grain yield/plant with panicle length, number of panicles/plant, number of filled grains/panicle and 100-grain weight in all studied crosses. From the foregoing results, Sakha 105 x WAB 450-T-B-P 3811-B (cross I) and Sakha 104 x IR 66946-3R-178-1-1(cross II) could be recommended for growing under water deficit condition to achieve the highest rice grain yield and the highest values of saving water at the same time.

KEY WORDS Rice, water stress, six parameters, heterosis, heritability and correlation.

INTRODUCTION

Rice (*Oryza sativa* L.) plays a significant role which supply nutrition as a staple food to more than three billion people and comprising 50-80% of their daily calorie intake (Khush, 2005). Rice is one of the most important crops in Egypt after wheat and ranks the second export crop after cotton. It covered about 22% of the cultivated area in Egypt. The area under rice cultivation tremendously increased during the last five years due to its better net return comparing to other summer crops. Water shortage is a major problem for rice grown under lowland conditions. The water of Nile River is not sufficient for irrigation of both old and new reclaiming lands. Irrigated areas are scarce or unreliable in Egypt.

Drought is one of the major environmental stress factor that effects on the growth of plants and it is also the main challenge to researchers and plant breeders in agriculture section (Al-Ashkar *et al.,* 2016). The slow progress of inbreeding in rice for drought tolerance is the complexity of the drought environment, which often results in the lack of clear identification of the target environment. Developing of drought tolerant rice varieties are needed to overcome the shortage of irrigation water Fukai *et al*. (1996). Mady (2004) reported that increasing irrigation intervals decreased plant height, panicle length, number of panicles/m2, number of filled grains/panicle, 1000-grain weight and grain yield/plant. Upland rice crop is grown in non-puddle aerobic soil without standing water Mujataba *et al.* (2007).

Establishment and breeding genotypes and lines of rice with high degree of tolerance to drought stress for using in breeding and gene discovery as donors is one of the main challenges for rice research interest (Serraj & Atlin, 2008). Less water requirement is a set of characteristics that should be incorporated into future rice cultivars to meet the needs of various environmental and water regimes. Breeding for drought tolerance varieties is become of high priority in the Egyptian rice breeding program in order to reduce the water requirements in one hand, and also to tolerate the drought conditions which occurred in some rice growing areas due to the shortage of irrigate water. On the other hand, the success of developing and releasing new rice varieties suitable for drought conditions will increase the rice production in Egypt and also increase the farmer's welfare. Consideration of yield and yield traits are very important to increase yield under water stress. Therefore, the objectives of the present study to determine the heterosis, degree of dominance, genetic variance, heritability, genetic advance and phenotypic correlation coefficient, yield and yield traits under water deficiency conditions.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm of the Rice Research and Training Center (RRTC), Sakha, Kafer EL-Sheikh, Egypt, during the three successive rice growing seasons of 2014, 2015 and 2016 to study the inheritance of grain yield and yield traits in rice under water deficiency conditions. Regarding those issues, six genotypes were crossed to produce F_1 hybrid seeds of three crosses namely: i) Sakha 105 (sensitive) x WAB 450-T-B-P 3811-B (tolerant), ii) Sakha 104 (moderate) x IR 66946-3R-178-1-1 (tolerant) and iii) Sakha 106 (sensitive) x Giza 178 (moderate). Six populations viz. P_1, P_2, F_1, F_2, BC_1 and BC_2 for each cross were utilized in this study.

In 2014 season, the six cultivars were grown at RRTC farm in three successive planting dates with ten days interval in order to overcome the differences in flowering time between parents. Thirty days old seedlings of each parent were individually transplanted in the permanent field in seven rows. Each row was 5m long and contained 25 hills. At flowering time, hybridization between parents was carried out following the technique proposed by Jodon (1938) and modified by Butany (1961), and the aforementioned three crosses were done.

In 2015 season, parents and F1 hybrid seeds of the three crosses were planted together under normal conditions. At heading, parents were crossed again to produce the F_1 hybrid seeds of three crosses following the same technique. Moreover, some of F_1 plants were left to self pollinated in order to produce F_2 seeds, while some other F_1 plants were crossed with their own parents to produce BC_1 and BC_2 seeds. At harvest, seeds of different generations were individually harvested to be grown in the next season. Subsequently, in the summer season 2016, seeds of P_1, P_2, F_1, BC_1, BC_2 and F_2 of each cross were sown under drought conditions. Eighteen entries belongs to different generations (6 parents, 3 $F_{1'S}$, 3 $F_{2'S}$, 3 BC_1, 3 BC_2) were arranged in a randomized complete block design experiment with three replications. Each replication contained 10 rows of each P_1, P_2 and 5 rows of each F_1, BC_1 and BC_2 and 20 rows of F_2. Rows were 5 m long and 20 x 20 cm spacing apart. In all growing seasons of the study, all cultural practices such as field preparations, sowing, transplanting and fertilization were followed as per recommendation. The six populations in 2016 season were planted under water deficit conditions (water deficiency was imposed by using flush irrigation every 10 days without standing water after irrigation). Hand weeding was done as necessary. Sixty plants from each P_1, P_2 and F_1, 90 plants from each BC1 and BC2, and 200 plants from each F_2 populations were taken randomly. These plants were individually harvested and threshed separately to determine the grain yield/plant and yield components.

Heterosis was estimated according to Falconer and Mackay (1996). Furthermore, appropriate LSD values were calculated to test the significance of heterotic effects according to the formula suggested by Wynne *et al.* (1970). The relative of potence ratio (P) was used to determine the degree of dominance and its directions according to the formula given by Mather and Jinks (1971). Estimation of gene effects was suggested by Mather (1949) and Hayman (1958). Expected genetic variance of VBC1, VBC2 and VF2 in terms of additive (1/2 D) and dominance (1/4 H) are derived by Mather (1949). Heritability in both broad (Powers *et al.,* 1950) and narrow sense (Warner, 1952) was determined. Expected and predicted values of genetic advance (GS and GS %) were calculated according to Johnson et al. (1955). The phenotypic correlation coefficient was performed according to the procedure of Dewey and Lu (1959).

RESULTS AND DISCUSSION

MEAN PERFORMANCE

The mean values of the studied characters for three studied crosses are presented in (Table 1). The results indicated that the parents differed significantly in all the studied characters. The F1 mean values were higher than the highest parent for panicle length, number of panicles/plant, sterility percentage and grain yield/plant in all crosses, number of filled grains/panicles for crosses I and II; plant height and 100-grain weight for cross III and days to 50% heading for cross III. While, the F1 mean values were intermediated between the two parents in plant height and 100-grain weight in crosses I and II, and days to 50% heading in crosses III and II. However, it was lower than the lowest parent for number of filled grains/panicle in cross III. The results indicated that over-dominance was important in the inheritance of these traits. While, partial dominance was recorded for plant height and 100-grain weight in crosses I and II, and days to 50% heading in crosses III and I. Moreover, the F_2 mean values approximately nearer to the mid-parents with few exceptions. On the other hand, the transgressive segregation was recorded for plant height in the cross II. The performance of backcross populations tended towards the means of recurrent parent varied somewhat among yield and its major components. These results were in agreement with those reported by Abd-Allah (2000), Abd Ellateef and Mady (2009), Ravikumar *et al.* (2014) and Guimaraes *et al.* (2016).

Table 1. Means and standard error of yield and yield traits in six populations in the three studied crosses under water deficit conditions.

Characters	Cr	Mean performance and standard error					
		P_1	P_2	F_1	BC_1	BC_2	F_2
Number of days to 50% heading	I	92.53±0.33	102.00±0.30	93.77±0.35	91.87±0.62	94.76±0.58	94.57±1.21
	II	102.07±0.33	101.23±0.47	104.9±0.42	98.38±0.44	97.63±0.53	97.13±1.19
	III	93.53±0.34	99.02±0.28	97.63±0.46	93.96±0.56	95.91±0.58	96.12±1.22
Plant height (cm)	I	72.51±0.46	85.97±0.43	83.32±0.46	75.60±0.54	80.25±0.54	81.47±1.55
	II	73.11±0.39	79.36±0.45	75.97±0.89	74.00±0.55	77.00±0.53	82.08±1.77
	III	75.60±0.24	77.67±0.36	80.13±0.33	76.21±0.54	79.22±0.58	78.80±1.17
Panicle length (cm)	I	18.90±0.12	21.10±0.11	22.56±0.11	19.93±0.05	20.90±0.04	21.34±0.28
	II	19.15±0.12	21.32±0.12	22.12±0.12	20.67±0.05	21.80±0.06	20.92±0.33
	III	17.56±0.12	20.67±0.11	22.23±0.10	20.45±0.11	21.87±0.12	20.80±0.34
Number of panicles/plant	I	9.57±0.18	6.65±0.14	13.51±0.26	11.46±0.16	10.91±0.22	12.39±0.78
	II	10.38±0.28	16.08±0.26	19.11±0.33	13.15±0.22	16.61±0.20	16.09±0.77
	III	8.38±0.21	15.07±0.35	18.10±0.29	10.75±0.36	13.80±0.27	13.39±0.78
Number of filled grains/panicle	I	81.98±0.92	100.63±0.60	103.0±0.75	92.25±0.54	102.52±0.55	82.95±1.74
	II	107.48±0.66	123.81±0.56	125.46±0.94	99.75±0.54	118.88±0.70	108.74±1.66
	III	88.82±0.59	132.00±1.25	80.88±0.92	72.66±0.53	108.26±0.54	62.57±2.42
100-grain weight (g)	I	2.10±0.011	3.12±0.011	2.63±0.01	2.58±0.012	2.62±0.011	2.19±0.03
	II	2.58±0.010	1.82±0.01	2.27±0.01	2.12±0.01	1.95±0.01	2.22±0.03
	III	2.50±0.013	1.82±0.012	2.52±0.013	2.27±0.019	2.11±0.013	2.15±0.03
Sterility (%)	I	20.72±0.16	12.88±0.14	34.53±0.13	17.51±0.32	12.47±0.16	31.78±0.61
	II	15.01±0.17	17.54±0.38	35.58±0.35	24.06±0.38	26.77±0.33	17.70±0.78
	III	13.23±0.24	6.5±0.18	47.71±0.51	32.62±0.50	36.36±0.50	41.65±1.12
Grain yield/plant (g)	I	24.08±0.13	22.96±0.12	27.96±0.12	24.63±0.10	23.88±0.14	23.37±0.41
	II	26.08±0.10	33.35±0.17	36.76±0.12	29.80±0.13	32.15±0.15	28.60±0.52
	III	20.70±0.11	28.71±0.13	29.56±0.11	21.90±0.11	26.97±0.13	24.32±0.39

GENETIC PARAMETERS

The percentages of heterosis as a deviation from mid- and better- parent and degree of dominance were showed in (Table 2). Significant positive values were recorded in most of all the crosses for grain yield and its components. On the contrary, the non significant heterosis as a deviation from mid- parents was recorded for days to 50% heading in the cross III and for plant height in the cross II. While, the not significant heterosis as deviations from better- parents were recorded for days to 50% heading in the cross I and for number of filled grains/panicle in the crosses I and II. Degree of dominance was greater than unity in all studied crosses for most of the studied characters indicating over-dominance for these characters. While, partial dominance was recorded for days to 50% heading in the crosses III and I, and for plant height and 100-grain weight in the crosses I and II. These results were in agreement with those of Charngpei et al. (1997), El-Abd et al. (2003), Ravikumar et al. (2014) and Guimaraes et al. (2016).

Table 2. Estimates of heterosis as a deviation from mid-parents (MP) and better-parents (BP) and degree of dominance of yield and yield traits under water deficit conditions.

Characters	Cr	Heterosis %		Degree of dominance
		MP	BP	
Number of days to 50% heading	I	-3.59*	1.33	0.73
	II	3.26*	3.69*	7.92
	III	1.4	4.38*	-0.49
Plant height (cm)	I	5.15**	14.91**	-0.6
	II	-0.34	3.91*	0.08
	III	4.56**	6.00**	-3.37
Panicle length (cm)	I	12.81**	6.93**	-2.32
	II	9.32**	3.75**	-1.73
	III	16.31**	7.55**	-2
Number of panicles/plant	I	66.56**	41.12**	3.69
	II	44.38**	18.80**	-2.06
	III	54.28**	20.06**	-1.9
Number of filled grains/panicle	I	12.79**	2.34	-1.25
	II	8.48**	1.33	-1.2
	III	26.74**	-38.72**	1.36
100-grain weight (g)	I	1.00**	-15.47**	-0.05
	II	3.20**	-11.94**	0.18
	III	16.29**	0.49**	1.03
Sterility (%)	I	150.50**	167.99**	4.52
	II	118.60**	137.05**	-15.24
	III	383.47**	634.03**	11.23
Grain yield/plant (g)	I	18.86**	16.08**	7.88
	II	23.70**	10.23**	-1.93
	III	19.65**	2.96**	-1.21

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

The scaling test parameters (A, B and C) estimated for yield and yield parameters in the three studied crosses illustrated in the (Table 3). Most of the computed permeates of scaling test were statistically significant. Thus it revealed the presence of non- allelic interaction. These results appeared that the genotype x environment type of gene interaction were important in the inheritance of yield and most its components. The mean of the parameter effects (m) was highly significant for all the studied traits, suggesting that these traits were expressional as yield and its inherited traits (Table 4). Additive gene action (d) played an important role in the inheritance of all crosses for all the studied characters, except days to 50% heading in the cross II and sterility percentage in the cross I. Moreover, dominance gene action (h) played a greater role in all crosses for all studied characters, except days to 50% heading and number of panicles/plant in all the crosses, and plant height in crosses III and II, panicle length in the cross I, number of filled grains/panicle in the cross II and sterility percentage in the cross III.

Table 3. Scaling test for adequacy of additive and dominance model of rice yield and yield traits for the three studied crosses under water deficit conditions.

Characters	Cr	A	B	C
Number of days to 50% heading (day)	I	-2.56±0.90**	-6.25±0.79**	-3.78±12.23
	II	-10.27±0.53**	-10.93±0.77**	-24.72±11.89*
	III	-3.25±0.80**	-4.83±0.83**	-3.33±12.45
Plant height (cm)	I	-4.63±0.80**	-8.80±0.79**	0.76±20.06
	II	-1.08±1.10	-1.33±1.07	23.90±27.02*
	III	-3.31±0.68**	0.63±0.80	1.68±11.35
Panicle length (cm)	I	-1.58±0.02**	-1.86±0.015**	0.24±0.68
	II	0.07±0.02**	0.15±0.024**	-1.02±0.94*
	III	1.10±0.03**	0.83±0.045**	0.48±0.96
No. of panicles/plant	I	-0.16±0.10	1.66±0.14	6.31±5.13*
	II	-3.20±0.20**	-1.97±0.17**	-0.33±5.09
	III	-4.98±0.32**	-5.57±0.25**	-6.09±5.22
Number of filled grains/panicle	I	-0.48±1.30	1.41±1.08	-56.79±26.21*
	II	-33.45±1.25**	-11.50±1.58**	-47.25±24.25
	III	-24.38±1.18**	3.63±1.80*	-132.30±49.90**
100-grain weight (g)	I	0.42±0.0004**	-0.51±0.0004**	-1.70±0.01**
	II	-0.60±0.0004**	-0.19±0.0004**	-0.05±0.0004**
	III	-0.48±0.0009**	-0.11±0.0005**	-0.74±0.01**
Sterility (%)	I	-20.23±0.23**	-22.47±0.07**	24.44±3.04**
	II	-2.47±0.38**	0.41±0.35	-32.90±5.30**
	III	4.30±0.67**	18.51±0.66**	51.47±10.76**
Grain yield/plant (g)	I	-2.77±0.03**	-3.15±0.05**	-9.47±1.43**
	II	-3.25±0.04**	-5.81±0.05**	-18.52±1.27**
	III	-6.46±0.04**	-4.32±0.07**	-11.23±2.22**

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

Additive x additive type of gene interaction (i) played an effective role in sterility percentage for all the crosses, plant height, 100-grain weight and grain yield/plant for crosses I and II, and panicle length in the cross I and number of filled grains/panicle in crosses III, II. 100-grain weight and sterility percentage in all the studied crosses, number of filled grains/panicle and grain yield/plant in crosses III and II, days to 50% heading and number of panicles/plant in the cross I and plant height in crosses III and I were affected by additive x dominance type of gene interaction (j). Dominance x dominance type of gene interaction (l) was played an important role in the inheritance of all the studied crosses for all the studied characters, except plant height and sterility percentage in the cross III, panicle length in the cross II, number of panicles/plant in the cross I and grain yield/plant in crosses I and II. These findings suggest that additive gene effects made a significant contribution to the inheritance of the studied characters in these crosses. The three types of gene interactions were important in the inheritance of the studied traits under drought conditions. These results were in agreement with those obtained previously by El-Hissewy and Bastawisi (1998), Acharya *et al.* (1999), El-Abd *et al.* (2007), Ravikumar *et al.* (2014), and Guimaraes *et al.* (2016).

Table 4. Genetic components of generation mean in rice yield and yield characters for the three studied crosses under water deficit conditions.

Characters	Cr	Genetic components of generation mean					
		m	d	h	i	j	L
Number of days to 50% heading	I	94.57**	-2.88**	-8.51	-5.02	1.84*	13.83*
	II	97.13**	0.75	6.83	3.51	0.33	17.69**
	III	96.12**	-1.95*	-3.39	-4.75	0.79	12.83*
Plant height (cm)	I	81.47**	-4.65**	-10.11	-14.20*	2.08*	27.63**
	II	82.08**	-3.00**	-26.59**	-26.33**	0.12	28.75**
	III	78.80**	-3.01**	-0.85	-4.35	-1.97*	7.03
Panicle length (cm)	I	21.34**	-0.96**	-1.12	-3.69**	0.13	7.14**
	II	20.92**	-1.12**	3.13*	1.25	-0.03	-1.47

	III	20.80**	-1.42**	4.56**	1.45	0.13	-3.38*
Number of panicles/plant	I	12.39**	0.55*	0.58	-4.81	-0.91**	3.31
	II	16.09**	-3.46**	1.03	-4.84	-0.61	10.01**
	III	13.39**	-3.05**	1.9	-4.46	0.29	15.02**
Number of filled grains/panicle	I	82.95**	-10.27**	69.40**	57.71**	-0.95	-58.64**
	II	108.74**	-19.13**	12.12	2.3	-10.97**	42.64**
	III	62.57**	-35.60**	82.02**	111.55**	-14.01**	-90.80**
100-grain weight (g)	I	2.19**	-0.04**	1.64**	1.61**	0.46**	-1.53**
	II	2.22**	0.17**	-0.67**	-0.74**	-0.20**	1.54**
	III	2.15**	0.15**	0.50**	0.15	-0.18**	0.44*
Sterility (%)	I	31.78**	5.03	-49.42**	-67.15**	1.11**	109.87**
	II	17.70**	-2.71**	50.14**	30.84**	-1.44**	-28.78**
	III	41.65**	-3.73**	9.18	-28.65**	-7.10**	5.84
Grain yield/plant (g)	I	23.37**	0.75**	7.98**	3.55*	0.18	2.37
	II	28.60**	-2.35**	16.51**	9.46**	1.28**	-0.4
	III	24.32**	-5.07**	5.30**	0.45	-1.06**	10.33**

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

It is clear from Table 5, that additive genetic variance was higher than that of dominance genetic variance for days to 50 % heading, plant height, panicle length, number of panicles/ plant, number of filled grains/ panicle, 100-grain weight, sterility % and grain yield/ plant in all studied crosses. Heritability in broad sense estimates were larger than their corresponding ones of narrow sense heritability for all the studied traits for all the studied crosses. High broad sense heritability and high genetic advance were estimated for the attendant yield and its component characters. Narrow sense heritability ranged from low to moderate in the three studied crosses. Similar results were reported by Abd-Allah (2000) and Abd Ellateef, Mady (2009), Ravikumar *et al.* (2014) and Guimaraes *et al.* (2016).

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 rice yield and yield characters for the three studied crosses under water deficit conditions.

Characters	Cr	Genetic variance		Heritability		G.S	G.S %
		$^1/_2$ D	$^1/_4$ H	Broad-sense	Narrow-sense		
Number of days to 50% heading	I	2.23	-0.85	92.62	49.6	124.56	131.7
	II	2.36	-1.11	87.77	33.74	82.83	85.28
	III	2.31	-0.96	90.6	44.54	112.02	116.54
Plant height (cm)	I	4.26	-2.04	91.41	24.43	78.44	96.28
	II	5.71	-2.94	87.66	18.99	69.48	84.65
	III	2.11	-0.83	92.71	46.54	112.07	142.69
Panicle length (cm)	I	0.15	-0.08	83.34	6.12	3.57	16.75
	II	0.21	-0.12	85.1	5.78	3.97	19.01
	III	0.2	-0.1	88.63	24.78	17.4	83.69
Number of panicles/plant	I	1.16	-0.58	93.24	12.39	20.12	162.38
	II	1.1	-0.59	85.41	15.46	24.66	153.29
	III	1.03	-0.5	86.25	32.91	53.42	398.91
Number of filled grains/panicle	I	5.51	-3.05	80.47	19.66	70.84	85.39
	II	4.73	-2.51	80.18	28.62	98.01	90.13
	III	11.21	-6.24	84.29	9.91	49.63	79.31
100-grain weight (g)	I	0.002	-0.001	89.15	24.71	1.76	80.41
	II	0.002	-0.001	90.56	18.89	1.54	69.54
	III	0.002	-0.0009	87.79	40.83	3.09	143.52
Sterility (%)	I	0.61	-0.26	94.1	36.17	45.54	143.3
	II	0.97	-0.45	83.75	42.32	68.73	388.16
	III	2.03	-0.88	90.52	39.9	92.77	222.69
Grain yield/plant (g)	I	0.31	-0.15	90.72	18.99	16.28	69.68
	II	0.49	-0.24	93.04	16.04	17.2	60.15
	III	0.27	-0.13	89.88	20.37	16.44	67.59

ESTIMATES OF PHENOTYPIC CORRELATION COEFFICIENTS:

The phenotypic correlation coefficients among all the possible pairs of grain yield component traits are presented in (Table 6). Grain yield was positively and strongly correlated with each of panicle length, number of panicles/plant, number of filled grains/panicle and 100-grain weight in all the studied crosses. These results indicated that these traits were found to be the principle yield components. Therefore, any selection based on these traits will bring the desired improvement in grain yield. Sterility percentage showed highly significant negative correlation with grain yield/plant in the cross II. Sterility percentage was highly significant and negative associated with each of panicle length, number of panicles/plant, number of filled grains/panicle and 100-grain weight in the third cross.

Table 6. Phenotypic correlation coefficient among all possible pairs of yield and its component characters in the F_2 generation of the crosses I, II and III under water deficit conditions.

Characters	Cr	1	2	3	4	5	6	7
Number of days to 50% heading	I							
	II							
	III							
Plant height (cm)	I	-0.108						
	II	-0.023						
	III	0.040						
Panicle length (cm)	I	0.007	0.117					
	II	0.232	-0.024					
	III	-0.202	0.029					
Number of panicles/plant	I	0.066	0.202	0.267				
	II	0.047	0.075	0.653**				
	III	-0.180	0.159	0.600**				
Number of filled grains/plant	I	0.063	0.200	0.279*	0.985**			
	II	0.056	0.093	0.636**	0.979**			
	III	-0.177	0.151	0.584**	0.990**			
100-grain weight (g)	I	0.082	0.183	0.268	0.975**	0.965**		
	II	0.054	0.092	0.671**	0.956**	0.960**		
	III	-0.179	0.130	0.587**	0.982**	0.981**		
Sterility (%)	I	-0.206	0.023	0.017	-0.227	-0.216	-0.211	
	II	-0.206	0.229	0.048	0.231	0.210	0.228	
	III	0.108	0.063	-0.428**	-0.479**	-0.480**	-0.489**	
Grain yield/plant (g)	I	0.099	0.200	0.314*	0.956**	0.962**	0.958**	-0.219
	II	0.053	0.092	0.643**	0.963**	0.970**	0.952**	0.205
	III	-0.105	0.158	0.575**	0.982**	0.977**	0.974**	-0.477**

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

However, a highly significant and positive estimate of phenotypic correlation coefficient was recorded between panicle length and number of filled grains/panicle in all the crosses, number of panicles/plant and 100-grain weight in crosses I and II. Highly significant positive estimates of phenotypic correlation coefficients were recorded between number of panicles/plant with number of filled grains/panicles and 100-grain weight. Present findings coincide with the results of Deng, HuiMing *et al.* (2005), Patil and Sarawgi (2005), Satyanarayana *et al*. (2005), El Abd *et al*. (2008) and Anis *et al. (*2016). However, the current results do not coincide with the findings of Islam *et al*. (2002), who reported that grain yield per plant was positively correlated with plant height. The difference in results may be attributed to the difference in genetic material and environmental condition of the experiment.

CONCLUSION

Considering the results of the current study, the additive gene effect was more important in the genetic system for all studied characters, dominance gene effects and additive x additive gene effects were played an important role in the inheritance of plant height, panicle length, number of filled grains/ panicle, 100-grain weight, sterility % and grain yield/ plant. Dominance gene action; additive x dominance and dominance x dominance type of gene interaction showed highly significant values for other remaining traits, indicating that these factors are significant contributors to the variation of generation means and played an important role in the inheritance of such characters. From the foregoing results, Sakha 105 x WAB 450-T-B-P 3811-B and Sakha 104 x IR 66946-3R-178-1-1 could be recommended for breeding program and growing under water deficiency to obtain the highest rice grain yield and the highest values of saving water at the same time.

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دراسات وراثية على المحصول والصفات

المرتبطة به فى الأرز تحت ظروف الاجهاد المائي

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أجريت هذة التجربة بالمزرعة البحثية لمركز البحوث والتدريب فى الأرز – سخا – كفرالشيخ – مصـــر وذلك خلال مواسم زراعة الأرز 2014, 2015 و2016 وذلك بهدف دراسة وراثة المحصول ومكوناته فى الأرز تحت ظروف ندرة المياه وذلك باستخدام العشائر الستة (الأب الأول, الأب الثانى, الجيل الأول, الجيل الثانى, الهجين الرجعى الأول والهجين الرجعى الثانى) لثلاثة هجن من الأرز هى سخا 105 Xواب 450-تي-ب-بي3811-ب (الهجين الأول), سخا 104 X جيزة 178 (الهجين الثانى) سخا 106 X أى أر 66946-3 ار- 178-1-1 (الهجين الثالث). وتم تصميم قطاعات كاملة العشوائية فى ثلاثة مكررات وأقيمت التجربة تحت ظروف ندرة المياه وذلك باستخدام الرى السطحى كل 10 أيام, وتم تقدير كل من قوة الهجين كإنحراف عن متوسط وأفضل الأبوين, الفعل الجينى المضيف والسيادى, درجة التوريث بالمعنى العريض والضيق, التحسين المتوقع من الإنتخاب وكذلك معامل الإرتباط المظهرى بين جميع الأزواج الممكنة لصفات المحصول ومكوناته (عدد الأيام حتى 50 % تزهير, طول النبات, طول الدالية, عدد الداليات/ نبات, عدد الحبوب الممتلئة/ دالية, وزن 100 حبة, النسبة المئوية للعقم ومحصول النبات الفردى).وأشارت النتائج المتحصل عليها من الأباء والجيل الأول والأجيال الإنعزالية إلى وجود مدى واسع بين متوسطات القيم وبعضها, وكذلك وجد تأثير كل من السيادة الجزئية والسيادة الفائقة لهذة الصفات. كذلك أوضحت النتائج أن النسبة المئوية لقيم قوة الهجين عند قياسها كإنحراف عن قيم متوسط وأفضل الأبوين كانت عالية المعنوية موجبة فى كل الهجن لصفات طول الدالية, عدد الداليات/ نبات ومحصول النبات الفردي , كذلك كانت قوة الهجين عالية المعنوية موجبة كإنحراف عن قيم متوسط وأفضل الأبوين لصفة طول النبات فى الهجين الأول والثاني. أوضحت النتائج أن إختبار إسكالينج أظهر تأثير التفاعل بين الجينات الغير أليلية فى معظم الهجن للصفات المدروسة. كذلك أظهرت النتائج أن التأثير المضيف للجين لعب دورًا هامًا فى وراثة معظم الصفات المدروسة لجميع الهجن, كذلك لعب كل من التأثير السيادى والتأثير المضيف X المضيف للجين دورًا هامًا فى وراثة كل من صفة طول النبات , طول الدالية , عدد الحبوب الممتلئة/ دالية , وزن 100 حبة , النسبة المئوية للعقم ومحصول النبات الفردى , بينما لعب الفعل الجينى المضيف X السيادى دورًا أساسيًا فى وراثة كل من صفة عدد الأيام حتى 50 % تزهير, طول النبات, عدد الداليات/ نبات, عدد الحبوب الممتلئة/ دالية, وزن 100 حبة, النسبة المئوية للعقم ومحصول النبات الفردى, كذلك لعب الفعل الجينى السيادى X السيادي دورًا هامًا فى وراثة كل الصفات المدروسة. أوضحت النتائج أن درجة التوريث بالمعنى العريض كانت عالية لكل الهجن فى كل الصفات المدروسة, بينما كانت درجة التوريث بالمعنى الضيق معظمها منخفض إلى متوسطة ، أما التحسين الوراثى المتوقع كما سجلت النتائج أن فقد تم الحصول على أعلى القيم لصفة عدد الداليات/ نبات متبوعا بصفات طول النبات وعدد الأيام حتى 50 % تزهير. محصول الحبوب قد تلازم تلازمًا قويًا وموجبًا مع كل من طول الدالية ، عدد الداليات/ نبات ، عدد الحبوب الممتلئة/ دالية ووزن 100 حبة فى كل الهجن المدروسة.توصى الدراسة بأن الهجين الاول (سخا 105 X واب 450-تي-ب-بي3811-ب) والهجين الثانى (سخا 104 X أى أر 66946-3 ار- 178-1-1) هما أفضل الهجن التي نستطيع أن نوصى بهما للنمو تحت ندرة المياه وذلك للحصول على أعلى محصول وأعلى القيم لتوفير المياه في نفس الوقت.