INHERITANCE OF EARLINESS, GRAIN YIELD AND SOME GRAIN QUALITY TRAITS IN RICE (*Oryza sativa* L.) UNDER WATER DEFICIENCY CONDITIONS

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ABSTRACT

The inheritance of earliness, grain yield and some grain quality traits for five populations P_1, P_2, F_1, F_2, and F_3) of three crosses, Milyang 54 x Sakha 101, Pi No. 4 x Sakha 103 and Dular x Sakha 104. were evaluated under water deficiency conditions. The present investigation was performed at Sakha Agricultural Research Station, Sakha, Kafr El-Sheikh, Egypt, during 2006, 2007 and 2008 summer seasons. The results indicated that highly significant and positive or negative estimates of heterosis were recorded for all studied traits in all crosses, except for days to 50% heading in all crosses; and plant height, panicle length, grain yield /plant and milling %, in (cross I). Moreover, significant or highly significant and positive or negative heterobeltiosis were detected for all studied traits in all crosses, with some exceptions. In addition, significant and highly significant positive or negative estimates of inbreeding depression were recorded for most of studied traits in all crosses, except for number of filled grains / panicle and amylose content % (cross I); head rice % and amylose content % (cross II); and hulling % and milling % (cross III). On the other hand, the magnitudes of inbreeding depression values were observed in F_2 and F_3 generations. Five parameters model indicated the important of additive, dominance gene action and epistatic gene interaction in the inheritance of the studied traits, in all crosses. Dominance gene effect was important in the inheritance of most studied traits in all crosses, except for days to

50% heading, number of filled grains / panicle, grain yield / plant, hulling % in (cross I); for panicle length, and head rice % in (cross II) and for number of panicles / plant, and hulling % in (cross III), which were controlled by additive gene effect. Additive x additive gene interactions was shared in the allotment of gene pond for number of filled grains / panicle in (cross I); and for days to 50 % heading and plant height in (crosses II and III). While, additive x dominance was shared a major role in the inheritance of days to 50 % heading in (cross I). Narrow sense heritability estimates in F_2 generation ranged from 15.63 % for head rice % to 50.23% for sterility % (cross II). Concerning F_3 generation, the lowest value of narrow sense heritability was 14.26 % for number of panicles / plant (cross II), while, the highest estimate was 55.63 % for hulling % in cross I. Expected genetic advance as a percentage of the population was high for most of studied characters. Highly significant and positive estimates of phenotypic correlation coefficient was found among grain yield and each of number of panicle / plant, 100-grain weight and head rice %, in the three cross, while, it was significantly and positively associated with milling %, in crosses I and II, and negatively correlated with hulling %, in the three crosses. The amount of total water applied to rice crosses were ranged between 3360.42 to 4357.5 m^3. The highest crop water use efficiency (0.64 kg / m^3) was recorded from (one m^3) water irrigation in (cross I). Milyang 54 x Sakha 101 could be recommended to be grown under drought condition to obtain the highest rice grain yield (kg/m^3) and the highest value of saving water at the same time.

Key words: Rice, Five populations, Genetic variance, Heritability, Genetic advance, Grain yield and grain quality traits, Water use efficiency, Evapotranspiration

INTRODUCTION

Rice is one of the most important cereal crops in Egypt. Its impact on economy lies within the fact that it occupies about 22% of the planted area in Egypt during the summer season. Moreover, rice is an important export crop. The amount in tons exported was 500.000. The rice area is increased during the last five years to about one and half million feddans. The success of development and releasing new rice varieties suitable for drought conditions will increase the rice production in Egypt, and also, increase the farmer's welfare. Recently, in Egypt, water of the river Nile is not sufficient for irrigation of both old and reclaimed new lands. So, saving of water is a necessity demand to face this problem through either increasing irrigation intervals without any drastic effect on the grain yield, or growing drought tolerant varieties which have a capability to grow under shortage of water (Nour, 1989). Therefore, efforts are needed to develop improved rice cultivars with early maturity and higher grain yield potential. The lower 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. For example, the reducing growth duration of rice varieties from 130 to 100 days can save between 200 and 350 mm of water (Wiekham 1977). Mady, (2004) reported that, increasing irrigation intervals decreased plant height, panicle length, number of panicles / m^2, number of field grains / panicle, 1000- grain weight and grain yield. But, the opposite was true for sterility % and WUE. Also, rice quality was not significantly affected by irrigation intervals.

The importance of earliness, grain yield and some grain quality characters, especially days to 50% heading, plant height, panicle length, number of panicles / plant, number of filled grains / panicle, 100 grain weight, sterility %, grain yield / plant, hulling %, milling%, head rice % and amylose content. in ensuring water capture under drought, its establishment in drought tolerance rice. To improve the efficiency of the earliness, grain yield and some grain quality characters, its needed to understand further genetic and environmental effects on morphological characteristics.

The present investigation aimed to estimate heterosis, degree of dominance, inbreeding depression, gene effects, genetic variance, heritability, genetic advance, and phenotypic correlation coefficient between all possible pars of the studied traits and to study the possibility of saving water in rice culture by means of prolonging irrigation intervals.

MATERIALS AND METHODS

The present investigation was carried out at Sakha Agricultural Research Station, Sakha, Kafr El-Sheikh, Egypt. during the three successive rice summer seasons, 2006. 2007 and 2008, to study the inheritance of earliness, grain yield and some grain quality characters related to drought tolerance in rice.

Six rice cultivars namely, Milyang 54 (early 86.34 days to heading and drought tolerant). Sakha 101 (late 112.84 days to heading and susceptible to drought), Pi No. 4 (early 88.64 days to heading and drought tolerant). Sakha 103 (moderate late 102.63 days to heading and moderately tolerant to drought), Dular (moderate early 90.72 days to heading and moderately tolerant to drought), and Sakha 104 (late 107.26 days to heading and susceptible to drought) were used in this study. These rice cultivars were taken from the pure genetic stock of Rice Research and Training Center.

A. Experimental field procedures

In 2006, the seeds of six rice cultivars were planted on three dates of planting with ten days interval in order to overcome the differences in flowering time among parents. Thirty day old seedlings of each parent were individually transplanted in the permanent field in ten rows. Each row was 5 m long and contained 25 hills. At flowering, hybridization among parents was carried out following the technique proposed by Jodon (1938) and modified by Butany (1961). To produce three rice crosses, namely, Milyang 54 x Sakha 101, Pi No. 4 x Sakha 103 and Dular x Sakha 104, which exhibited different types of drought tolerance. (tolerant x susceptible), (tolerant x moderately tolerant) and (moderately tolerant x susceptible). respectively.

In 2007, parents and F_1 hybrid seeds of their three crosses were planted to F_2. part of them were uses to produce F3 next year. Crossing between parents were done to further reproduce F_1 hybrid seeds of the three crosses.

In summer season of 2008, seeds of the five population of each cross, P_1, P_2, F_1, F_2, and F_3 were sown in dry seedbed. Thirty day old seedlings were transplanted in the field plots. Fifteen entries belong to different generations (six parents, three F_1, three F_2, and three F_3) were transplanted in a randomized complete block design, with three replications. Each replicate contained 10 rows of each P1and P2, and 5 rows of F_1, and 20 rows of each F_2 and F_3 generations. Each row was 5 m long and 20 cm apart was maintained between rows and seedlings. In all growing seasons of study, all cultural practices were applied as recommended. Flush water irrigation was used every twelve days. The amount of water irrigated was approximately to 5cm above the soil surface,. Weeds were chemically controlled by adding a maintained dose of 2 liters/fed. of Saturn, four days after transplanting.

Sixty plants from each P1, P2 and F_1's, 200 plants from F_2's and F_3's populations were taken at random. These plants were individually harvested and separately threshed to determine the grain yield, its components and grain quality traits. Data were collected for plant height (cm), days to 50% heading, panicle length (cm), number of panicles / plant, number of filled grains / panicle, 100 grain weight (g), sterility % and grain yield / plant (g), and for Four grain quality characters; namely, hulling %, milling%, head rice % and amylose content %. Heterosis, degree of dominance, inbreeding depression, gene effects, genetic variance, heritability and genetic advance and phenotypic correlation coefficients were estimated, according to Mather and Jinks (1971), Burton (1952) and Mather (1949).

B. Soil physical properties

Physical properties of the experimental field were determined, according to FAO (1976) and Black (1965) as shown in (Table 1).

Table (1). Soil physical properties of the experimental site.

Soil depth (cm)	Particle size distribution			Bulk density (g/cm^3)	Soil texture
	Sand (%)	Silt (%)	Clay (%)		
0-20	15.16	22.20	62.00	0.97	Clay
20-40	18.30	25.20	56.50	1.03	Clay
40-60	22.35	26.20	51.45	1.34	Clay

C. Monitoring soil moisture

Soil samples were collected before two days after each irrigation from three successive layers (20 cm each) to determine soil moisture content (Table 2).

Table (2). Soil moisture contents of the experimental site.

Soil depth, (cm)	Field capacity (F.C) %	Permanent wilting point (PWP) %	Available water (AW) (cm)	Bulk density, (g/cm^3)
0-20	45.00	24.30	20.70	1.08
20-40	37.20	21.20	16.00	1.20
40-60	34.10	18.50	15.00	1.31

D. Climatologic elements

Values of the climatological elements were obtained from The Meteorological Station at El Karada, Kafr El-Sheikh, governorate (Table 3), situated at 30 to 47 N latitude and 31 longitude and 15 m altitude. It represent the circumstances and conditions of the North Delta. Average values of temperature, air relative humidity (RH%) and wind speed were recorded daily during three studying seasons.

Table (3). Average meteorological data for three seasons (2006, 2007 and 2008).

Month	Temperature (%)	RH (%)	wind velocity, (Km/day)
June	24.30	65.30	119.00
July	25.80	67.00	103.00
August	26.70	67.70	86.00
Sept.	25.10	96.49	99.00

E. Estimation of the potential evapotranspiration (ETp)

ETp was estimated for four months from June until September in three seasons as follows:

Modified penman:

$$ET_0 = C\ \{(W.\ R_n + (1 - w).\ f(u)\ (ea - ed)\}\ \text{(FAO, 1990)}.$$

Where

ET_o = Potential crop evapotranspiration in (mm/day), **C** = Adjustment factor to compensate for the effect of day and night weather conditions, **W** = Temperature – related weighting factor, **R_n** = Net radiation in equivalent evaporation in (mm/day), **f (u)** = Wind – related function and **(ea – ed)** = Difference between the saturation vapor pressure at mean air temperature and the mean actual vapor pressure of the air, both in mbar.

F. Estimation of crop coefficient (KC)

Crop coefficient was estimated, according to FAO (1990) as follows:

ETc = Actual evapotranspiration (mm/day).

ETp = Potential evapotranspiration calculated by the modified penman equation (mm/day), and **Kc** = Crop coefficient, dimensionless.

The amount of water needed for land preparation for nursery or permanent field was recorded, beside the amount of water needed for raising the nursery or through the first nine days after transplanting (seedling establishment period), as well as the amount of water used for replenish the plots. Water depth at every irrigation was kept at 5 cm height.

G. Water relations

Total of water applied; i.e.. the amount of water delivered each plot plus amount of water applied in both nursery and permanent field for applying three water treatments was measured for each cultivar.

H. Water consumptive use

Soil moisture content was determined before and after each irrigation to calculate water consumptive use, according to Iseraelson and Hansen (1962), as follows:

$$\mathbf{Cu} = \sum_{i=1}^{n=1} \frac{\theta_2 - \theta_1}{100} \times \mathbf{Bd} \times \mathbf{D} \times 4200 \text{ m}^2$$

Where:

Cu = Water consumptive use in each irrigation (cm^3), θ_2 = Soil moisture percent after irrigation (%, d.b), θ_1 = Soil moisture percent before irrigation (%, d.b), **Bd** = Soil bulk density in (g/cm^3), **n** = Number of irrigation, **I** = Number of soil layer, **D** = Depth of soil layer of the soil (cm) **and 4200 m^2** = Area of fed.

I. Crop water use efficiency (CWUE)

It was calculated, according to Hansen *et al.* (1980) by the following equation:

$$\text{CWUE } (kg/m^3) = \frac{\textbf{Yield (kg/fed)}}{\textbf{Water consumptive use } (m^3/fed)}$$

Field water use efficiency (FWUE)

It was calculated according to Michael (1978) by the following equation:

$$\text{FWUE } (kg/m^3) = \frac{\textbf{Yield (kg/fed)}}{\textbf{Water applied } (m^3/fed)}$$

RESULTS AND DISCUSSION

Mean performance

Table (4). reveals that there were highly significant differences among the mean values of the crosses concerning the twelve rice characters. Milyang 54 cultivar gave the highest mean values, while, the lowest mean values were recorded for Sakha 103 for most studied characters. Comparing mean values, the F_1 mean values were higher than the highest parent for plant height. hulling % and 100 grain weight in the crosses I and II, indicating the existence of over dominance and this was ascertained again by the respective value of potence ratio, which exceeding unity. According to mean values, Milyang 54 cultivar was the best parent for drought recovery ability, and could be considered as a donor in crosses with drought tolerance. While, the F_1 mean values were higher than mid-parent values for days to 50 % heading, number of filled grains / panicle and milling %, in cross I; plant height in all studied crosses; panicle length, in cross II; sterility %, in crosses I and III; and head rice % and amylose content %, in crosses II and III, indicating the presence of partial dominance in the inheritance of these mentioned traits.

Table (4). Means and standard error of five populations for yield, its components and grain quality characters in three rice crosses.

Character	Cr.	P1	P2	F1	F2	F3
Days to 50% heading	I	86.34±2.47	112.84±5.42	105.63±2.31	95.51±3.27	95.41±2.44
	II	88.64±3.41	102.63±2.74	96.86±4.63	98.41±3.71	99.63±1.85
	III	90.72±4.63	107.26±3.21	100.41±3.74	95.62±4.21	95.81±3.29
Plant height (cm)	I	78.36±2.66	67.41±3.26	80.63±5.22	72.63±3.21	70.82±2.55
	II	75.91±3.21	72.55±6.27	79.42±6.21	70.21±3.62	69.52±2.71
	III	95.41±2.64	73.26±3.21	85.81±4.31	85.72±2.41	84.84±2.97
Panicle length (cm)	I	18.43±3.94	20.83±4.43	19.72±2.73	19.61±4.63	18.53±1.84
	II	20.86±3.34	17.96±3.74	20.16±3.41	19.31±1.24	19.19±2.63
	III	17.83±4.24	20.83±4.23	19.74±1.97	15.70±1.23	14.63±1.44
No. of panicles / plant	I	17.42±2.74	15.62±4.43	16.97±2.12	15.91±3.72	15.23±3.24
	II	13.26±5.31	11.46±2.71	14.28±3.16	13.19±1.97	12.52±3.21
	III	12.63±4.21	14.73±5.22	14.21±2.14	12.54±3.22	12.19±1.43
No. of field grains / panicle	I	113.52±3.21	92.63±2.74	109.14±5.12	95.33±3.26	94.62±2.71
	II	79.31±4.63	86.83±1.32	81.82±6.18	80.41±2.51	80.77±3.26
	III	85.71±2.74	96.81±2.86	95.31±3.11	92.67±2.83	89.13±1.42
100 grain weight (g)	I	2.23±0.81	2.37±0.42	2.39±0.16	2.21±0.32	2.01±0.13
	II	2.21±0.97	2.27±0.87	2.29±0.23	2.31±0.65	2.21±0.23
	III	2.39±1.21	2.35±0.73	2.33±0.36	2.31±0.36	2.30±0.19
Sterility (%)	I	8.98±2.31	12.16±2.31	11.41±2.74	10.82±1.84	9.63±2.64
	II	13.61±3.74	11.97±2.77	12.62±3.21	12.17±2.36	11.84±2.31
	III	9.06±2.81	12.6±3.21	11.41±2.14	9.74±1.49	10.21±1.47
Grain yield / plant (g)	I	23.74±3.21	20.81±3.42	21.63±4.26	18.81±2.51	17.44±2.24
	II	18.81±3.41	13.88±1.74	14.51±1.72	13.43±3.27	13.12±1.63
	III	16.52±1.74	14.64±3.21	14.67±3.27	14.47±2.21	14.23±2.41
Hulling (%)	I	76.63±1.74	82.36±3.21	83.41±2.73	80.29±3.62	79.21±1.81
	II	79.52±2.41	80.17±2.71	82.62±2.97	80.64±3.21	79.93±2.27
	III	77.21±3.61	85.62±1.31	79.83±3.21	76.97±4.26	75.26±1.98
Milling (%)	I	68.12±4.22	72.61±3.61	70.64±4.26	69.54±3.25	68.21±2.14
	II	69.82±3.71	75.52±3.84	72.13±3.21	71.31±1.62	70.31±3.41
	III	70.32±4.63	73.63±2.53	71.48±1.84	70.42±2.74	69.14±1.32
Head rice (%)	I	57.12±3.22	65.72±1.63	60.12±2.63	59.84±2.14	59.31±2.91
	II	49.32±1.34	68.66±2.11	62.66±2.41	62.61±4.33	60.31±1.27
	III	55.14±2.41	62.41±1.97	61.41±3.81	60.53±3.17	58.62±3.21
Amylose content (%)	I	18.63±1.26	17.62±2.21	18.32±2.71	17.97±2.82	17.28±1.44
	II	21.11±2.97	19.84±1.97	20.44±3.21	20.31±1.46	19.91±2.31
	III	20.21±2.71	18.53±2.39	19.82±2.11	18.92±2.16	19.63±1.46

On the other hand, the F_1 mean values were higher than the F_2 mean values for almost all studied characters in all studied crosses, indicating the presence of desirable inbreeding depression in F_2 population. There was an association between heterosis in F_1 and inbreeding depression in F_2 generations, so, non-additive gene effect played an important role in the inheritance of most of the studied traits. The most pronounced rice genotypes were Crosses I and II, Milyang 54 x Sakha 101 and Pi No 4 x Sakha 103, respectively, for most traits. Moreover, F_3 mean values were later in heading than the F_2 and approximately equal to mid parent or less than the F_2 mean values for the other studied characters in the three studied crosses. These results indicated that the variance of F_2 populations was higher than that of parents, F_1 and F_3. Similar results were reported by Sarawgi *et al.*, (2000), El-Abd (2003), Abd El-Lattef (2004) and Hammoud (2004), but with some few exceptions.

Genetic Parameters

Estimates of heterosis, nature of dominance and inbreeding depression

Heterosis as a deviation from mid (MP) and better-parent (BP), nature of dominance and inbreeding depression are listed in (Table 5). Highly significant and positive heterotic effects, relative to better parent, were recorded for days to 50 % heading, indicting that F_1 generation was later in heading than the better parent. Significant and highly significant differences of heterosis were found for all studied characters in all studied crosses, except for plant height, panicle length and amylose content, in cross I; number of filled grains / panicle, in cross II; sterility %, in crosses I and II; hulling %, in crosses II and III; and milling %, in the three studied crosses, when it measured as a deviation from mid and better parent. According to mean values, the over-dominance was found to be higher than unity for plant height, in cross II; panicle length and number of panicles / plant, in cross III; number of filled grains / panicle and grain yield, in all studied crosses; hulling %, in crosses II and III; and amylose content %, in cross I. On the other hand, in the other remaining crosses, grain yield and grain quality characters were controlled by incomplete dominance. These results indicated that the most pronounced crosses for days to 50

% heading, plant height, number of panicles / plant, number of filled grains / panicle, 100 grain weight and grain yield / plant were Milyang 54 x Sakha 101 and Pi No. 4 x Sakha 103 rice crosses. In addition, the degree of dominance was grater than unity for most of the studied traits indicating that over-dominance played a major role in their inheritance.

Table (5). Heterosis relative to mid-parent (M.P.) and better parent (B.P.), degree of dominance in F_1 and F_2 and inbreeding depression in F_2 and F_3 for yield, its components and grain quality characters.

Character	Cr.	Heterosis %		Degree of dominance		Inbreeding depression	
		M.P.	B.P.	F1	F2	F2	F3
Days to 50 % heading	I	0.03	12.49**	-0.08	0.51	6.42**	3.16*
	II	0.23	8.14**	-0.03	0.76	5.63**	0.02
	III	1.94	11.91**	0.21	0.38	5.27*	-0.03
Plant height (cm)	I	1.06	19.81**	1.41	0.37	11.97**	12.52**
	II	7.07**	9.62**	3.08	-8.39	11.34**	7.59*
	III	7.24**	30.78**	0.40	0.54	2.57	5.26
Panicle length (cm)	I	0.45	-5.32*	0.07	0.33	5.47**	5.29**
	II	3.86**	-3.35	0.51	0.55	5.26**	4.01*
	III	-3.05*	-10.03**	0.38	-1.47	11.12**	0.58
No. of panicles / plant	I	2.72*	-2.58	0.55	0.11	6.25**	-6.17*
	II	15.53**	7.69**	2.08	0.29	7.14**	14.28**
	III	3.87*	-3.53*	0.68	-1.51	7.26**	7.11*
No. of filled grains / panicle	I	5.88*	-3.86*	0.58	0.64	12.84**	7.33**
	II	-2.78	-6.92**	0.78	-0.02	2.53	0.61
	III	4.43*	-1.54	0.72	0.39	3.15	6.31*
100 - grain weight (g)	I	-8.26**	-10.97**	2.71	-1.14	-5.12**	4.73
	II	8.03**	-6.60**	3.61	-1.01	4.54*	8.33**
	III	-8.98**	-11.19**	-7.62	-5.02	-3.43	0.42
Sterility %	I	-1.51	15.92**	0.13	0.15	11.21**	7.49*
	II	-1.32	5.43*	0.72	0.18	-2.77	6.18*
	III	18.71**	54.64**	0.73	0.07	10.63**	10.51**
Grain yield / plant (g)	I	-2.89	-9.15**	0.08	-1.72	12.79**	10.12**
	II	-11.16**	-29.36**	0.24	-1.01	-6.34**	-14.14**
	III	-8.76**	-11.83**	-1.27	-1.94	-2.06	-8.58*
Hulling %	I	4.92**	1.27	1.53	0.04	4.99**	3.83**
	II	3.49	3.09	10.06	3.67	2.39	3.25*
	III	-1.92	-6.76**	0.27	-7.14	-1.42	-1.79
Milling %	I	0.39	-2.71	0.28	-0.21	1.55*	0.61
	II	-0.74	-4.48*	0.04	-0.59	2.77**	-0.24
	III	-0.71	-2.94	0.02	-0.05	0.05	-0.97
Amylose content (%)	I	0.93	3.97*	-1.64	1.94	1.91*	2.72*
	II	-1.17*	3.02	0.67	0.46	0.63	2.59*
	III	2.56**	6.96**	0.97	-0.95	4.54**	0.95

* and **. significant and highly significant at 0.05 and0.01 levels of probability, respectively.

Hence, it could be concluded that such populations might be valuable in breeding for earliness and shortness under drought conditions. These results were in agreement with those reported by Reddy and Nerkar (1995), Mishra *et al.* (1998), El-Abd (1999), Abd-Allah (2000) and El-Abd (2003). In addition, highly significant and positive estimates of inbreeding depression were observed for such characters. It was high for number of filled grains / panicle (12.84) followed by grain yield / plant (12.79) and plant height (11.97), especially in cross 1 (Milyang 54 x Sakha 101). Highly significant estimates of heterosis, accompanied with high and significant inbreeding depression value, indicated that number of filled grains / panicle, grain yield / plant and plant height traits might be under the major influence of dominance x dominance type of gene interaction, which, governing its inheritance in F1. while the significant heterosis as a deviation from mid-parent and better-parent always accompanied with low and insignificant inbreeding depression in most of the studied characters, in all crosses, indicating the importance of additive gene action which could be utilized in improving these traits. These findings are in agreement with those obtained by El-Abd (1999), Abd-Allah (2000), El-Abd (2003) Abd El-Lattef (2004) and Abd El-Lattef and Badr (2007).

Estimates of type of gene action

Samples of scaling test parameters (C and D) were estimated for grain yield and grain quality traits in the three studied crosses. Most of the computed parameters of scaling test were statistically significant, which indicated the presence of non-allelic interactions, and genotypic x environment type of gene interactions was important in the inheritance of most of the studied traits. Dominance gene action played a remarkable role in the inheritance of days to 50% heading, in all crosses: and plant height and panicle length, in cross I. Table (6) showed that mean effect parameter (m) was highly significant for all studied traits. suggesting that these traits

Table (6). Estimates of genetic component of generation mean of five parameter for yield, its components and grain quality characters.

Character	Cross	Genetic component of generation mean				
		m	d	h	l	i
Days to 50 % heading	I	95.61**	-11.24**	-3.21	34.69**	-28.68**
	II	100.41**	-6.99**	10.42**	-40.21**	15.53**
	III	95.32**	-8.77**	10.01**	-40.52**	13.45**
Plant height (cm)	I	72.63**	5.47**	6.31**	10.63**	15.31**
	II	70.21**	1.68	-12.42**	40.21**	-10.17**
	III	95.72**	16.12**	17.33**	-42.69**	51.68**
Panicle length (cm)	I	19.61**	-1.24	4.56**	-13.34**	8.99**
	II	19.31**	1.53*	0.69	2.66	2.51
	III	15.70**	1.59*	4.21**	-16.01	9.92**
No. of panicles / plant	I	15.91**	1.13	-4.66**	13.32**	4.98*
	II	13.19**	1.42*	3.32*	-2.66	5.06**
	III	12.54**	-1.13	0.67	2.86	-0.01
No. of filled grains / panicle	I	95.33**	-10.53**	-6.35**	69.34**	4.51*
	II	80.41**	-3.52	4.21*	-16.01**	1.72
	III	92.67**	-5.54**	10.11**	-8.21*	-0.34
100 – grain weight (g)	I	2.21**	-0.05*	-0.12	-1.41	-0.15
	II	2.31**	-0.01	0.32**	-0.24	0.11
	III	2.31**	-0.03*	0.18	-0.61	0.87
Sterility %	I	10.82**	-1.59*	4.85**	-13.33**	3.34*
	II	12.17**	0.85	2.64	-5.36*	5.63**
	III	9.74**	-2.61**	-1.33	10.66**	-9.17**
Grain yield / plant	I	18.81**	-1.53	0.65	13.35**	0.83
	II	13.43**	-2.54	-3.36**	2.66	-4.49**
	III	14.47**	-0.52	-2.67*	5.21*	-3.46*
Hulling %	I	79.29**	-3.12*	0.11	16.42**	-10.12**
	II	80.64**	-0.53	4.02**	0.46	2.41
	III	76.97**	-4.26**	-3.34*	2.64	-4.35*
Milling %	I	69.54**	-2.34	-2.61*	8.02**	-7.02**
	II	71.31**	-3.21**	-4.31**	16.41**	-12.42**
	III	70.42**	-1.54	-2.68*	5.23**	1.83
Head rice %	I	59.84**	-4.32*	-6.11**	8.42**	-9.22**
	II	62.61**	-9.54**	8.21**	-16.12**	15.74**
	III	60.53**	-3.52	7.26**	-18.69**	18.56**
Amylose (%) content	I	17.97**	0.51	1.43	7.96**	0.84
	II	20.31**	1.22*	2.64**	-5.23*	3.99*
	III	18.92**	1.43**	-2.11*	-8.11**	-1.13

* and **, significant and highly significant at 0.05 and0.01 levels of probability, respectively.

were expressional as quantitative inherited traits. Additive gene action (d) played an important role in the inheritance of days to 50% heading in all studied crosses; plant height, number of filled grains / panicle, 100 grain weight, sterility % and hulling %, in crosses I and III; panicle length, number of panicles / plant, milling % and head rice %, in crosses I and II: and amylose content % in crosses II and III. Moreover, Dominance gene action (h) played a greater role in all studied crosses for plant height, number of filled grains / panicle, milling % and head rice % and for days to 50 % heading, 100 grain weight, grain yield / plant, hulling % and amylose content%, in crosses II and III. Additive x additive type of gene interaction (l) was played an effective role for most of all studied traits in all the studied crosses. and for panicle length. number of panicles / plant and grain yield / plant, in crosses I and III. On the other hand, days to 50% heading, plant height, sterility %, milling % and head rice % in all studied crosses; number of panicles / plant, panicle length, number of filled grains / panicle. and amylose content % in crosses I and II; and plant height. grain yield / plant, and hulling % in crosses I and III, were affected by additive x dominance type of gene interaction. These findings suggests that additive gene effects made a significant contribution to the inheritance of the studied characters in these crosses. especially, in crosses I and II. The magnitude of dominance gene effect relative to the magnitude of additive gene effects was large for most of studied characters in the three studied crosses. The three types of gene interaction were important in the inheritance of the studied traits under drought conditions. These results were in agreement with those obtained previously by Souframanian *et al.* (1998), Abd-Allah (2000), El-Abd (2003) and Abd El-Lattef and Badr (2007).

Estimates of genetic variance, heritability and expected genetic advance

It is clear from Table (7) that additive genetic variance was higher than that of dominance genetic variance for days to 50% heading, plant height, number of filled grains / panicle, hulling % and head rice %, in all studied crosses; 100 grain weight and amylose content % in crosses I and II; and for panicle length. number of panicles / plant and grain yield / plant, in crosses II and III. On the contrary. the dominance genetic variance was higher than additive genetic variance in all studied crosses for sterility % and milling %: and in crosses I and III for panicle length. number of panicles / plant. 100 grain weight. grain yield / plant and amylose content

Table (7). Estimates of genetic variance, broad and narrow sense heritabilities in F_2 and F_3 generations and expected genetic advance for grain yield, its components and grain quality traits.

Character	Cr	Genetic variance		Heritability				G.S.	G.S.%
				F_2		F_3			
		½ D	¼ H	B.S.	N.S.	B.S.	N.S.		
Days to 50 % heading	I	٢٩,٤٢	٢٠,٢٨	٨١,١١	٤٨,٢٦	٧٢,٢١	٥٤,١٦	٧,٣٢	٨,٦٣
	II	٣٩,٥٣	٢٥,٩٤	٧٩,٢٦	٥٠,٧١	٦٣,٥٢	٢٢,٦٢	٨,٤٢	٩,٥٦
	III	٤٩,٢٢	٣١,٣٢	٧٨,٤٣	٤٩,٢١	٦٥,٧٣	٣٥,٤١	٦,٢١	٦,٩٧
Plant height (cm)	I	٣٨,٢١	٢٦,٩٢	٨٠,٢١	٣٦,٢٦	٧١,٤٢	٤٨,٣٦	١٠,٥٣	١٣,٠٨
	II	٤٢,٥٢	٢٣,٢٦	٧٩,١٣	٣٩,٢٨	٦٥,٢٧	٥٠,٢١	٨,٤١	١١,٢١
	III	٣٩,٨٤	٢٢,٦٦	٨٢,١٤	٤١,٥٣	٦٩,٣٢	٣٣,٢٦	٦,٢٧	٥,٩٧
Panicle length (cm)	I	٨,٦٣	٦,٢٨	٧٨,٤٢	٤٨,٢٢	٥٩,٦٢	٢٥,١٦	٥,٢١	١٨,٩٤
	II	١٠,٤٧	٩,٤١	٧٦,٤١	٤٤,٦٢	٦١,٢٢	١٨,٢٦	٨,٤٧	٢٢,٣٥
	III	١٥,٤٦	١٦,٢٩	٨٠,٢١	٣٩,٤٥	٦٥,٢١	٣٥,٣٦	٥,٣٢	٢١,٢٩
No. of panicles / plant	I	١٠,٧٣	١٥,٦٢	٧٣,٢١	٣٤,٢٧	٦٥,٤١	٢٥,٤٢	٤,٦٢	٢٧,٥٨
	II	١٥,١٩	٨,٤١	٦٩,٤٢	٢٠,٨٢	٥٤,٢١	١٤,٢٦	٥,٢٧	٣٠,٥٣
	III	٩,٢٧	١٧,٢٨	٧٥,٢٦	٣٤,٥١	٦٩,٧٢	٢٨,٤١	٣,٢١	٢٥,٤٧
No. of filled grains / panicle	I	٧٤,٦٢	٦٥,٨٢	٧٩,٤٢	١٧,٦٢	٥٥,٤٢	٢٦,٢٣	١١,٦٢	١٠,٢٦
	II	٤٦,٥٨	٢٩,٥١	٨٠,٦٣	٤١,٦٣	٧٢,٣٤	٤١,٢٥	١٣,٢٧	١٦,٤٥
	III	٧٠,٢٩	٢٧,٦٣	٧١,٤٢	٢٩,٢١	٦٨,٢١	٣٦,٢١	١٥,٦٣	١٧,٦٤
100 - grain weight (g)	I	٠,٠٣	٠,٠٢	٦٣,٢١	٣٦,٢١	٤٥,٦٣	١٥,٢١	١,٢٨	٢٥,٤٣
	II	٠,٠٥	٠,١٣	٧٩,٨٤	٥٤,٢١	٦٢,٥٤	٢٦,٢٤	٠,٢٩	١٣,١٨
	III	٠,٦٢	٠,٨٣	٧٢,٦٣	٣٣,٢٦	٥٠,٦٣	٣٢,١١	١,٤١	٢١,٤١
Sterility %	I	١٣,٥٤	٢٠,٢٦	٧٠,٢٦	٤٩,٤١	٦٩,٤١	٤٩,٣١	٣,٢٧	٢٨,٦٣
	II	١٩,٧٢	٣٠,٤١	٨٤,٢١	٥٠,٢٣	٨٠,٢٥	٥٠,٢٦	٦,٨٤	٢٦,١٢
	III	٩,٥٢	١٥,٤٢	٦٦,٥٢	٥٢,١١	٦٠,٤١	٤١,١٧	٤,٦٢	٢٤,٤١
Grain yield / plant (g)	I	١٣,٥٤	١٥,٨٧	٧٥,٢١	٤٠,٢٧	٦٩,٢٣	٣٠,٣٥	٥,٣٧	٢٥,٣١
	II	٢٩,٧١	٢٨,٢٦	٧٨,٤١	٢٨,١٦	٦٨,٢٤	٢٦,٣١	٤,٤١	٢٣,٩٢
	III	١٥,٦٢	١٢,٧٤	٦٩,٦٣	١٩,٢٥	٥٩,١٤	٤١,٢٥	٣,٢٧	٢١,٨٢
Hulling %	I	٥,٤٣	٤,٢٦	٧٠,٢٨	٤٠,٦٦	٦٨,٢٥	٥٥,٦٣	٦,٥٢	٨,٤٢
	II	١٦,٢٧	٨,٧٢	٨٠,٥١	٣٥,٤١	٧٥,٢١	٣١,١٤	٩,٦٣	١١,٣١
	III	٧,٢٦	٥,٤١	٧٩,٣٦	٢٠,٨٢	٦٠,١٤	٢٢,٤٤	٥,٤١	٦,٤٩
Milling %	I	١٨,٢١	٢٤,٦٢	٧٩,٦٢	٣٥,٦٣	٦٦,٩٢	٤٠,٢٦	٦,٢٧	١٢,١٦
	II	٢٥,٦٢	٢٨,٤٤	٨١,٢٦	٤٠,٢٦	٦٥,٢٣	٣٥,١٤	٧,٢٦	١٠,٥٢
	III	١٥,٣١	٣٠,٧٢	٨٤,٢٦	١٨,٥٤	٦٢,٦٣	١٨,٢٦	٨,٤٢	١٢,٤١
Head rice %	I	٣٢,٧٢	٢٠,٥١	٧١,٥٣	٤٠,٢١	٥٥,٢١	٢٢,١٧	٥,٢٣	٩,١٢
	II	٢٢,٥٤	١٧,٨٤	٦٩,٤٢	١٥,٦٣	٦١,٢٤	٢٥,٢٦	٩,١٣	١٨,٦٣
	III	٣٠,٦١	١٨,٦٢	٧٢,١٣	٢٠,٢٢	٦٥,٨١	٣٣,٤٢	٦,٤٢	١١,٣٧
Amylose content (%)	I	٢٢,٤١	١٥,٧١	٧٥,٢٤	٣٢,١١	٦٠,٢٧	٢٥,٣١	٦,٢٢	١٤,٢٤
	II	٣١,٦٢	٢٩,٧٢	٨١,٤١	٢٥,١٢	٨٠,٢١	٤٢,٦٣	٦,٣٤	١٠,١٩
	III	٢٩,٢٧	٤٠,٢٦	٥٩,٣٦	٣٤,١٥	٥٠,٤٢	١٨,٧١	٧,٢٦	١١,٥٤

Heritability in broad sense estimates (B.S.) were larger than their corresponding ones of narrow sense heritability (N.S.) for all studied characters in F_2 and F_3 generations. High broad sense heritability in F_2 generation were estimated for the attendant yield and grain quality traits. It was found to be moderate

(59.36%) for amylose content, in cross III, to high (84.21) for sterility %, in cross II. High narrow sense heritability was recorded, in cross II for 100 grain weight (54.21%), while it was ranged, from low to moderate, in other remaining grain yield and grain quality traits, in the three studied crosses. The variation among the heritabilities in both broad and narrow sense values, might be due to either gene expression of the trait or cross. On the other hand, heritability estimates in (broad sense) in F_3 generation ranged, from (80.25%) for sterility %, in cross II, to (45.60%) for 100 grain weight, in cross I. However, the lowest estimated value of narrow sense heritability was (14.26%) for number of panicles / plant, in cross II, while, the highest estimates was (55.63%) for hulling %, in cross I. The results also revealed that the magnitude of heritability in narrow sense in F_2 generation was lower than its corresponding one in F_3 generation for all studied characters, suggesting the increase contribution of additive gene effect in F_3 relative to F_2 generations. Additive gene affects increased in the subsequent generation, which help the breeders to select the best genotypes in this generation. So, these materials could successfully be used in the rice breeding program for drought tolerance.

The highest estimates of expected genetic advance was observed in all studied crosses for number of panicles / plant and sterility %. While the low estimates was detected for plant height, in cross III, indicating that additive genetic variance played an important role in the inheritance of the studied traits, especially for days to 50 % heading and plant height. Moreover, low to moderate estimates of heritability in narrow sense, accompanied with low to moderate expected genetic advance, were recorded for most of the studied traits, lead to conclude that effectiveness of selection of most the studied traits, might be practiced in the advanced generations. These results was in harmony with those of Mishra *et al.* (1998), El-Hissewy and Bastawisi (1998). Acharya *et al.* (1999), Abd-Allah (2000), Abd El-Aty *et al.* (2002), El-Abd (2003), Abd El-Lattef (2004). Hammoud *et al.* (2006) and Abd El-Lattef and Badr (2007).

Estimates of phenotypic correlation coefficient

Phenotypic correlation coefficient among all possible pars of the studied traits are presented in (Table 8) highly significant and positive estimates of phenotypic correlation coefficient was found among grain yield and each of number of panicle / plant, 100-grain weight and head rice %, in the three cross, while, it was significantly and positively associated with milling %, in crosses I and II, and negatively correlated with hulling %, in the three crosses. 100-grain weight was negatively correlated with number of panicle / plant, hulling % and milling %, in all the studied crosses, while, it was found to be significantly and positively associated with days to 50% heading in all crosses. Moreover, significant and positive estimates of phenotypic correlation coefficient was recorded plant height and days to 50% heading, in crosses I and III.; and with number of panicles / plant, in crosses I and II. Milling % was significantly and negatively associated with hulling % and head rice %. However, insignificant either positive or negative estimates of phenotypic correlation coefficient were recorded among other remaining traits. These results were in agreement with those of Mishra (1998), Acharya *et al.* (1999), Charngpei *et al.* (1999), Abd- Allah (2000), El-Abd (2003), Abd El-Lattef (2004), Abd El-Lattef *et al.* (2006) and El-Abd *et al.* (2007).

Table (8). Phenotypic correlation coefficient among all possible pars of some studied characters.

Character	Cr.	Days to 50 % heading (day)	Plant height (cm)	No. of panicles / plant	100 grain weight(g)	Hulling (%)	Milling (%)	Head rice (%)
Plant height (cm)	I	0.39*	---					
	II	0.32						
	III	0.38*						
No. of panicles / plant	I	0.35	0.39*	---				
	II	0.27	0.38*					
	III	0.31	0.18					
100 - grain weight (g)	I	0.39*	0.28	-0.39*	—			
	II	0.40**	0.29	-0.40**				
	III	0.38*	0.34	-0.39*				
Hulling (%)	I	0.18	0.26	0.11	-0.39*	—		
	II	0.28	0.11	0.24	-0.42**			
	III	0.14	0.28	0.31	-0.38*			
Milling (%)	I	0.28	0.31	0.25	-0.38*	-0.39*	—	
	II	0.31	0.21	0.21	-0.42**	-0.38*		
	III	0.28	0.25	0.30	-0.34	-0.28		
Head rice (%)	I	0.34	0.34	0.26	-0.38*	-0.33	-0.38*	---
	II	0.22	0.12	0.13	-0.39*	-0.29	-0.39*	
	III	0.32	0.29	0.34	-0.24	-0.36	-0.37	
Grain yield / plant(g)	I	0.29	0.39*	0.46**	0.46**	-0.39*	0.39*	0.40**
	II	0.39*	0.36	0.53**	0.54**	-0.41**	0.38*	0.53**
	III	0.34	0.34	0.49**	0.39*	-0.38*	0.35	0.46**

* and **, significant and highly significant at 0.05 and0.01 levels of probability. respectively.

Water intervals

Estimates of amount of water applied, water consumptive use m3/ fed: and actual evapotranspiration in (ET_C mm / day)are presented in Table (9). The results indicated that total water applied and water consumptive use were 4357.50 and 3360.42 m^3/ fed., respectively. While the highest water applied and water consumptive use values were 1260.00 and 971.88 m^3 / fed. Respectively, recorded in August. On the other hand, the lowest values were 821.52 and 633.78 m3 /fed., respectively, recorded in September.

Data in Table (9). also, showed that values of ETc increased in July and August followed by June, it was 7.26, 7.47 and 6.43 mm / day respectively. While in September, it was 5.03 mm / day. concerning potential evapotranspiration (ETp mm / day), five methods were used for estimation (ETp mm / day) the data showed insignificant differences among the them in pre-harvest period; e.g., months June, July and August value for (ETp mm / day). The evapotranspiration (ETp mm / day) decreased in emergence stage, while, it gradually increased with increasing the age of plant, but decreased with pre-harvest period in September, after that (ETp mm / day) was increased in June and July. The highest value was recorded by radiation followed by modified penman methods, and it were 6.72 and 5054 (mm / day), respectively. While, Pan evapotrances and Blany-Criddle were 4.32 and 4.90 (mm / day), respectively, in the opposite direction.

Table (9). Water applied m^3/fed., water consumptive use, actual evapotranspiration (mm / day), modified penman (M.P.), penman monteith (P.M), blanny and criddle, radiation and pan evaporation methods.

Months	Water applied M^3/fed.	Water consumptive use m^3/fed.	Evapotr-anspiration mm/day	ETp mm/day M.P.	P.M	Blanny and criddle	Radiations	Pan Evaporation	mean
June	1050.42	809.76	6.43	6.00	5.88	5.29	6.82	4.81	5.76
July	1225.56	945.00	7.26	6.00	5.56	5.19	7.29	4.58	5.72
August	1260.00	971.88	7.47	5.51	5.34	5.05	6.72	4.34	5.39
20 sep.	821.52	633.78	5.03	4.65	4.45	4.08	6.04	3.56	4.56
total	4357.50	3360.42	26.19	22.16	21.2	19.60	26.88	17.28	
mean	1089.37	840.10	6.54	5.54	5.31	4.90	6.72	4.32	

Concerning crop coefficient values (Kc%) in Table (10). it is clear that the effect of crop characteristics on crop water requirements was observed by crop coefficient, which represented the relationship between reference potential (ETp) and actual crop evapotranspiration (ETc). The values of crop coefficient for irrigation pattern (kc) (Table 10) showed slight increase after planting, but, decreased again at the end of growth season. It could be noticed that the nearest values to average (kc) was that of radiation equation. These results lead to recommend to use radiation, followed by modified-penman methods for estimating water consumptive use in rice. Same results were reported earlier by Nasir *et al.* (2002). Hussain *et al.* (2003), and Azam *et al.* (2005).

Table (10). Values of crop coefficient (kc) in 2008 season.

Month	Modified penman	Penman monteith	Blanny and criddle	Radiation	Pan Evaporation	mean
June	1.07	1.09	1.22	0.94	1.34	1.13
July	1.21	1.31	1.40	1.00	1.59	1.30
August	1.36	1.40	1.48	1.11	1.72	1.41
20 sep.	1.08	1.13	1.23	0.83	1.41	1.14
mean	1.18	1.23	1.33	0.97	1.52	

Estimates of grain yield (Kg / fed)., crop and field water use efficiency (CWUE %) and field water use efficiency (FWUE %) are tabulated in Table (11). The results indicated that the average of grain yield was significantly affected by breeding. The maximum values (2076.55 Kg / fed.) was found for the first parent (P_1) followed by F_1 generation (1778.35 Kg / fed.) and (1752.46 Kg / fed.) for the second parent (P_2). While, the minimum value was recorded by F_3, it was (1567.65 Kg / fed.). From the foregoing results, the highest average grain yield (2151.03 Kg / fed.) was recorded for the first cross. (Milyang 54 x Sakha 101), followed by cross III, (Dular x Sakha 104) which was (1586.13 Kg / fed.). While, the lowest value (1548.75 Kg / fed.) was recorded for the cross II, (Pi No. 4 x Sakha 103). These results were agree with those obtained by Efisue *et al.* (2004) who showed that grain yield potential in upland rice was found to be between (2.5 and 4.2 t/ ha), and farmers yield often did not realize more than one t/ha., due to a range of production biotic and biotic production constraints.

Crop and field water use efficiency (CWUE %)

Data in Table (11) also. illustrated that crop water use efficiency was significantly affected by irrigation methods. The maximum CWUE % values were recorded for the first parent (P_1) followed by F_1 generation and the second parent (P_2) bing 0.62, 0.53 and 0.52 (kg / m^3) respectively. While, the minimum value was obtained for F_2 and F_3 generations, and were 0.49 and 0.47 (kg / m^3) respectively. On the other hand, cross I, gave the highest value 0.64 (kg / m^3) of crop water use efficiency, followed by the crosses III and II, bing 0.47 and 0.46 (kg / m^3) respectively. The data showed that the highest crop water use efficiency 0.64 (kg / m^3) was recorded from one m^3 water irrigation in cross I (Milyang 54 x Sakha 101). Also data indicated the significant effect of irrigation method on FWUE %. The maximum FWUE % value was recorded for the first parent (P_1) followed by F_1 generation and the second parent (P_2). Whereas, the minimum value was recorded for F_3 generation. On the other hand the highest value of FWUE % was found in cross I, followed by crosses II and III. These results were in harmony with those obtained by Khan *et al.* (1999), Ahmed *et al.* (2002), Akbar *et al.* (2002), Yasin *et al.* (2003) and Ahmed and Karube (2005).

From the foregoing results, cross I (Milyang 54 x Sakha 101) could be recommended for growing under drought conditions to obtain the highest rice grain yield and the highest value of saving water at the same time.

Table (11): Crop and field water use efficiency under drought condition in 2008 season.

Character	Cross	P1	P2	F1	F2	F3	Average
Grain yield Kg/fed.	I	2500.00	2177.70	2271.15	1975.05	1831.20	2151.03
	II	1982.40	1450.05	1523.55	1410.15	1379.60	1548.75
	III	1747.20	1629.60	1540.35	1519.35	1494.15	1586.13
Average		2076.55	1752.45	1778.35	1634.85	1567.65	
CWUE %	I	0.74	0.62	0.68	0.59	0.55	0.64
	II	0.59	0.43	0.45	0.42	0.41	0.46
	III	0.52	0.49	0.46	0.45	0.44	0.47
Average		0.62	0.52	0.53	0.49	0.47	
FWUE %	I	0.57	0.50	0.52	0.45	0.42	0.49
	II	0.45	033	0.35	0.32	0.32	0.35
	III	0.40	0.37	0.35	0.35	0.34	0.36
Average		0.47	0.40	0.41	0.37	0.36	

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الملخص العربي

وراثة التبكير ومحصول الحبوب وبعض صفات الجودة في الأرز تحت ظروف ندرة المياة

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أجريت هذه التجربة بمحطة البحوث الزراعية بسخا – كفر الشيخ – مصر. خلال مواسم زراعة الأرز ٢٠٠٦ و٢٠٠٧ و٢٠٠٨ وذلك لدراسة وراثة

التكبير ومحصول الحبوب وبعض صفات الجودة في الأرز وذلك باستخدام العشائر الخمسة (الأبوين، الأب الأول والأب الثاني، والأجيال الثلاثة، الأول والثاني والثالث) لثلاثة هجن من الأرز هي ميلينج ٥٤ X سخا ١٠١ (الهجين الأول) و بي اى رقم ٤ X سخا ١٠٣ (الهجين الثاني) ودولار X سخا ١٠٤ (الهجين الثالث) تحت ظروف نقص المياه.

أشارت النتائج إلى أن النسبة المئوية لقيم قوة الهجين عند قياسها كانحراف عن متوسط الأبوين كانت عالية المعنوية موجبة أو سالبة لجميع الصفات المدروسة في الثلاثة هجن، ماعدا صفة عدد الأيام حتى ٥٠ % تزهير في الثلاثة هجن، وصفات طول النبات وطول النورة الدالية ومحصول حبوب النبات الفردي والنسبة المئوية لتصافى التبييض في الهجين الأول. علاوة على ذلك فقد كانت النسبة المئوية لقوة الهجين معنوية أو عالية المعنوية موجبة أو سالبة لجميع الصفات المدروسة في الهجن الثلاثة مع وجود بعض الاختلافات وذلك عند قياسها كانحراف عن أفضل الأبوين. إضافة إلى ذلك فقد كانت قيم التدهور الناتج عن التربية الداخلية معنوية أو عالية المعنوية موجبة أو سالبة لمعظم الصفات المدروسة في جميع الهجن، عدا صفتي عدد الحبوب الممتلئة / نورة و النسبة المئوية لمحتوى الاميلوز في الحبوب في (الهجين الأول)، وكل من النسبة المئوية للأرز السليم الأبيض و النسبة المئوية لمحتوى الاميلوز في الحبوب في (الهجين الثاني)، وكل من النسبة المئوية لتصافى التقشير و النسبة المئوية لتصافى التبييض في (الهجين الثالث)، هذا وقد لوحظت قيما مرتفعة للتدهور الناتج عن التربية الداخلية في الجيلين الثاني والثالث.

أوضحت النتائج أهمية كل من الفعل الاضافى والفعل السيادي للجين وكذلك تفاعلات التفوق في وراثة جميع الصفات المدروسة في جميع الهجن، حيث لعب التأثير السيادي للجين دورا هاما في وراثة معظم الصفات المدروسة في جميع الهجن، عدا صفات عدد الأيام حتى ٥٠% تزهير، وعدد الحبوب الممتلئة / نورة، ومحصول حبوب النبات الفردي، والنسبة المئوية لتصافى التقشير في (الهجين الأول)، وطول النورة الدالية، والنسبة المئوية للأرز السليم الأبيض في (الهجين الثاني)، وعدد النورات الدالية / نبات، والنسبة المئوية لتصافى التقشير فى (الهجين الثالث) والتي لعب التأثير الاضافى للجين دورا كبيرا فى سلوكها الوراثي. كما ساهم التفاعل الجيني الاضافى × الاضافى بقدر كبير في وراثة عدد الحبوب الممتلئة / نورة في (الهجين الأول) وكذلك فى وراثة صفتي عدد الأيام حتى ٥٠% تزهير، وطول النبات في كل من (الهجينين الثاني والثالث). بينما لعب التأثير الاضافى x السيادي دورا أساسيا في وراثة صفة عدد الأيام حتى ٥٠ % تزهير فى جميع الهجن.

تراوحت قيم درجة التوريث بالمعنى الضيق بين (١٥,٦٣%) لصفة النسبة المئوية للأرز السليم الأبيض إلي (٥٠,٢٣%) لصفة النسبة المئوية للعقم في (الهجين الثاني). هذا وقد سجلت اقل قيمة لدرجة التوريث بالمعنى الضيق لصفة عدد النورات الدالية / نبات (% ١٤,٢٦) فى الهجين الثاني ، بينما سجلت أعلى القيم لصفة النسبة

المئوية لتصافى التقشير (% ٥٥,٦٣) فى الهجين الأول. كما كانت النسبة المئوية للتحسين المتوقع من الانتخاب عالية في معظم الصفات المدروسة.

كما أشارت النتائج إلى وجود ارتباط معنوي موجب بين محصول حبوب النبات الفردي وكل من صفات عدد النورات الدالية / نبات ووزن المئة حبة والنسبة المئوية للأرز السليم الأبيض، فى جميع الهجن، بينما كان هذا الارتباط معنويا وموجبا مع النسبة المئوية لتصافى التبييض، فى الهجينين الأول والثاني، وكان معنويا وسالبا مع النسبة المئوية لتصافى التقشير فى الهجن الثلاثة. كما أوضحت النتائج أن كمية المياه المضافة للهجن المدروسة تراوحت بين ٣٣٦٠,٤٢ إلى ٤٣٥٧,٥٠ متر مكعب للفدان. كما أن المتر المكعب من المياه أعطى ٦٤٠ جرام من محصول حبوب الأرز وخاصة في الهجين الأول. وبناء على النتائج المشار إليها يمكن التوصية بزراعة نباتات الهجين الأول تحت ظروف نقص الرطوبة الأرضية وذلك لتفوقها فى محصول الحبوب بأقل كمية من المياة المتاحة.