J. Agric. Sci. Mansoura Univ., 34(2): 1153 - 1172, 2009

GENETIC BEHAVIOR FOR SOME ROOT CHARACTERS AND THEIR RELATION TO, SOME YIELD OTHER CHARACTERS UNDER DROUGHT CONDITION IN RICE (*Oryza sativa L.*)

Abd El-Lattef. A. S. M.* and A.A.Mady**

***Rice Res. Section Field Crop Res. Inst. Agr., Res., Cent. Sakha, Kafr El-Sheikh, Egypt**

****Water Management and Irrigation Systems Research Institute, NWRC, Cairo, Egypt.**

ABSTRACT

This investigation was caried out during three successive seasons 2006, 2007 and 2008 at Rice Research and Training Center, (RRTC) Sakha, Kafr El-sheikh, Egypt. Six rice genotypes with different drought tolerance were crossed to produce three crosses namely, RD23 (tolerant) X Sakha 102 (sensitive) cross I, BG35 (tolerant) X Giza 177 (moderate) cross II and Cica 4 (moderate) X Sakha 103 (sensitive) cross III. Six populations P1, P2, F1, BC1, BC2, and F2 for each cross were utilized in this investigation. The results indicated that high differences between the six parents for most of studied characters were determined. The rice variety RD 23 owned the highest mean values for most of all studied traits, while the lowest mean values were recorded for rice variety Sakha 103. Highly significant positive heterosis and heterobeltiosis were estimated for root characters. The best useful heterosis was recorded in crosses I and II for most studied characters. Over-dominance played an important role in the inheritance of root length, root number, root volume and root fresh weight in cross I. On the other hand, the negative over dominance values were recorded for root fresh weight in cross III and root / shoot ratio in cross II. Low and positive inbreeding depression values were estimated in the last two crosses, while moderate estimates were found in the first cross. Epistatic gene effect had a significant contribution of inheritance in most studied characters. The additive X additive gene interaction appears to contribute more than any other sources of epitasis. Additive genetic variance was greater than the dominance genetic variance for root fresh weight and no. of days to 50% heading, in cross III, root / shoot ratio in crosses I and II. Heritability in broad sense was ranged from low to high in the three studied crosses. While narrow sense heritability was moderate to low. The highest value of heritability estimates (58.54) was recorded for root length in cross II, Moderate to high values of predicted genetic advance were estimated for all studied crosses, these values 30.21 for root dry weight in cross II. Significant or highly significant positive phenotypic correlation were found between most of all studied characters in the three studied crosses specially between root characters and grain yield / plant under drought condition. The most desirable genotypes for root, yield and its related of studied characters were the parents, RD 23 and BG 35 and their crosses, proving to be useful genotypes in breeding program for drought tolerance. Concerning water saving, The results showed that the highest crop water use efficiency were 0.66 and 0.62 kg / m^3 recorded from 1 m^3flashing water irrigation in cross I (RD23 x Sakha 102) and cross II (BG35 X Giza 177). Therefore these crosses could be recommended to be grown under drought condition to obtain the highest rice grain yield Kg/m^3 and highest value of save water in the same time.

Keywords: Rice, root characters, grain yield, heterosis, heritability, inbreeding depression, genetic advance.

INTRODUCTION

Drought is the major problem for rice growing under rainfed lowland and upland condition, there for the rice is also grown in very limited areas in the Southern Delta and Middle Egypt. The rice area is annually supposed to be million faddans, but it highly increased during the last five years to better net return of rice comparing to other summer crops, despite of water of the Nile River is not sufficient for irrigation of both old and new reclaiming new lands (El-Hity et al 2005). To provide a basis for integrating physiological research with plant breeding objectives we define drought resistance in terms of relative yield of genotypes. Therefore, a drought tolerance genotype will be one which has a higher grain yield than others when all genotypes are exposed to the same level of water stress.

A major reason for the slow progress in breeding for drought tolerance in rice is the complexity of the drought environment, which often results in the lack of clear identification of the target environments (Mishra et al 2000),. The improvement strategy being used in Egypt considers three mechanisms that influence yield in the drought prone targets: yield potential as an important mechanism for wild drought (where yield loss is less than 50 %), drought escape (appropriate penology) and drought tolerance traits of sterility, days to heading. The plant breeding program uses rapid generation advance techniques that enable early yield testing in the target population of environments through inter-station and on farm trials. Although progress can be made by selection for yield in the target environments using root traits that are associated with drought tolerance can hasten that progress. Root characters that responsible for the adaptability to drought stress are root length and root / shoot ratio. The deep roots of rice plant help to explore different levels of soil moisture. The selection for desirable root characters through yield and its components has been a major objective in breeding for drought tolerance of rice plant. Therefore the present study aimed to determine the genetic variability and inheritance of some rice root and theire relation to yield and some other characters witch can be used as selection criterion for selecting drought tolerance genotypes

MATERIALS AND METHODS

A field experiment was carried out at the Farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during three successive summer seasons of 2006, 2007 and 2008 to achieve the other maintained objectives. Six rice varieties with different drought tolerance level namely, RD23, Sakha 102, BG35, Giza 177, Cica 4 and Sakha 103 were used.

Table (1): Mean values of eight rice characters under flushing water irrigation every seven days used as control.

Characters / genotypes	Root length (cm)	Root number / plant	Root volume (mm)	Root fresh weight (g)	Root dry weight (g)	Root / shoot ratio	Days to 50% heading	Grain yield / plant (gm)
RD23	26.23	148.32	52.34	32.64	8.45	25.88	99	38
Sakha 102	12.52	110.36	29.62	19.75	3.74	18.96	92	28
BG35	24.61	135.41	48.72	30.25	7.63	25.22	101	35
Giza 177	19.82	122.09	35.81	24.63	4.29	17.41	85	27
Cica 4	17.54	129.46	35.24	29.42	6.34	21.54	95	30
Sakha 103	13.65	118.71	22.54	20.78	3.97	19.10	92	25

According to the felowing data the six varieties were crossed to produce F_1 hybrid seeds of three crosses namely

I. RD23 (tolerant) X Sakha 102 (sensitive)
II. BG35 (tolerant) X Giza 177 (moderate)
III. Cica 4 (moderate) X Sakha 103 (sensitive)

Six populations P_1, P_2, F_1, Bc_1, Bc_2 and F_2 for each cross were utilized to determine the six genetic parameters, heterosis, heritability and genetic advance from selection of the studied characters.

A - Field experiment procedures:

In 2006 season the rice genotypes seeds were taken from the pure stock of the Rice Research and Training Center (RRTC), the parental genotypes were grown at RRTC Farm in three planting dates with ten days interval in order to over come the differences in flowering time between the parents. Thirty days old seedlings of each parent were individually transplanted in field in seven rows. Each row was 5 m long and included 25 hills. At flowering time, hybridization between parents was carried out following the technique proposed by Jodon (1938) and modified by Butany (1961). In 2007 season, parents and F_1 hybrid seeds of three crosses were planted under normal conditions. At heading, parents were crossed again to produce F_1 hybrid seeds of three crosses. Moreover, some of F_1 plants were left to be self pollinated to produce F_2 seeds, while some of other plants were crossed with their own parents to produce Bc_1 and Bc_2 seeds. At harvest, seeds of different generation were individually harvested to be grown in the next season (2008). Eighteen genotypes from different generation (6 parents, $3F_1$'s, 3 Bc_1's, 3 Bc_2's and $3F_2$'s,) were included in a randomized complete block design with three replications. Each replicate contained 10 rows of each P_1, P_2 and 4 rows of each F_1, Bc_1, Bc_2 and 20 rows of F_2. Rows were 5 m long and 20 x 20 cm apart and the all cultural practices were applied as recommended. Flushing water irrigation every 14 days was used. Nour (1989) reported that prolonging irrigation intervals more than 10 days resulted in yield reduction of 47 % and the reduction was significantly varied among the tested rice cultivars. At maximum tillering stage, a metal cylindrical sampler, 20 cm in diameter and 50 cm height, was forced into the soil, including one hill, to obtain its root system up to 50 cm depth and root characters were measured for all the six populations. At harvesting stage 30 plants from P_1, P_2 and F1,s, 60 plants from Bc_1's and Bc_2's and 200 plants from each F_2 population were taken individually at random and threshed separately to determine the grain yield / plant. The studied characters were root length, root number, root volume, root fresh weight, root dry weight, root / shoot ratio, no. of days to 50 % heading, sterility % and grain yield / plant.

B. water intervals

Physical Properties of the experimental field were determined according to FAO (1976) in table (2)

Table (2): 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	18.24	21.19	65.12	1.32	Clay
20-40	19.34	26.34	52.41	1.42	Clay
40-60	23.14	25.65	50.24	1.23	Clay

Monitoring soil moisture

Soil samples were collected before and two days after each irrigation from 3 successive layers (20 cm each) to determine soil moisture content (table 3).

Table (3): soil moisture contents of the experimental site

Soil depth, cm	Field capacity (F.C)%	Permanent wilting point (PWP) %	Available water (AW) cm
0-20	43.12	26.81	19.71
20-40	34.52	24.21	15.13
40-60	34.49	22.13	14.97

Climatologically elements:

Values of the climatologic elements were obtained from the meteorological station at El karakat, Kafer El-sheikh, governorate (table 4), situated at 30 to 47 N latitude and 31 longitude and 15 m altitude. It represents the circumstances and conditions of the North Delta. Average values of temperature, air relative humidity (RH %) and wind speed were recorded daily during the two years.

Table (4): Average meteorological data for two seasons (2007 and 2008).

Month	°C	RH, %	wind velocity, Km/day
June	23.22	68.14	117.10
July	24.16	70.16	100.96
August	25.18	70.95	76.42
Sept.	25.22	94.32	90.41

Estimation of the potential evapotranspiration (ETp):

ETp was estimated for 4 months from June until September in both seasons.

Modified penman:

where

$ET_o = c\,\{(W.\,R_n + (1-w).\,f(u)\,(ea - ed)\}$ **(FAO, 1990)**

ET_o = potential crop evapotranspiration in mm/day.

C = adjustment factor to compensate for the effect of day and night weather condition

W = temperature – related weighting factor.

R_n = net radiation in equivalent evaporation in mm/day.

f (u) = wind – related function.

(ea – ed) = difference between the saturation vapor pressure at mean air temperature and the mean actual vapor pressure of the air, both in mbar.

Blaney and Criddle

where

ET_0 = C{P(0.64T+8.13)} mm/day

Where:

ETo = potential evapotranspiration

T = mean daily temperature in C°.

P = mean daily percentage of total annual day time hours for given

C = adjustment factor which depends on minimum relative humidity, sunshine hours and daytime wind estimate.

Radiation method:

ETo = C X (W.Rs.)

Where

ETo = potential crop evapotranspiration in mm/day

C = adjustment factor which depends on mean humidity and daytime wind condition

W = weighting factors which depends on temperature and altitude

Rs = the solar radiation expressed in equivalent evaporation in m/day.

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, besides 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.

Water relations:

Total 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 variety.

Water consumptive use:

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

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

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).

$4200m^2$ = area of fed.

Crop water use efficiency, (CWUE)

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

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

Field water use efficiency, (FWUE):

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

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

Statistical and genetical analysis:

The data collected under field conditions of the present study were subjected to the proper statistical analysis of Randomized Complete Block Design experiment as described by Sanedecor and Cochran (1961). Significant of the genetic effects is tested in a similar manner as done in case of scaling tests. The amount of heterosis expressed in individual cross was determined by comparing the F_1 mean performance to the mid-parent and better-parent average values and it was estimated to the formula by Mather (1949) and Mather and Jinks (1971). The relative potence ratio (P) was used to determine the nature of dominance and its directions according to the formula given by Wigan (1944) and Mather and Jinks (1971). Inbreeding depression (I.d.) was estimated according to Mather and Jinks (1971). Expected and predicted values of genetic advance (GS and GS %) were calculated by Johnson et al. (1955). Phenotypic correlation coefficient between all studied characters was determined by Burton (1995).

RESULTS AND DISCUSSION

A - Mean values

The mean values of the studied characters in the six populations of the three studied crosses are presented in Table (5). The results showed that there are high differences between the six parents for all root characters. The RD23 variety gave the highest mean values for all studied characters, while the lowest mean values were recorded for Sakha 103. The F1 mean values were higher than the highest parent in cross I for root length, root number, root volume and root fresh weight, while the lowest F1 means were recorded for root fresh weight and root dry weight in cross III and for root / shoot ratio and days to 50 % heading in cross II. Also the F1 mean values were higher than the means of two parents in all studied crosses for the remaining studied characters.

Table (5): Means and standard error of the six populations for rice root and some other characters in the three studied crosses.

character	cross	P1	P2	F1	BC1	BC2	F2
Root length	I	28.26±1.26	15.25±2.61	29.31±3.21	24.71±2.11	17.13±1.73	21.63±2.41
	II	27.31±2.81	20.54±2.41	23.27±2.41	21.84±1.71	19.27±2.14	19.32±1.42
	III	21.74±1.32	14.63±2.13	19.73±1.37	16.42±1.21	14.92±2.19	17.63±2.31
Root number / plant	I	156.21±6.62	129.32±8.41	159.62±7.32	149.66±9.41	131.27±3.41	149.87±7.81
	II	151.74±5.41	139.41±4.26	143.23±4.36	142.84±5.41	140.26±3.72	142.12±8.47
	III	141.54±3.26	122.44±3.13	140.36±3.97	138.72±4.63	129.41±4.68	139.37±6.41
Root volume	I	60.74±3.72	34.62±4.21	61.43±4.62	51.36±3.72	35.31±4.17	40.63±5.22
	II	58.32±2.41	40.74±3.14	51.42±3.27	49.21±4.24	42.62±3.72	45.14±4.16
	III	40.63±4.22	32.62±3.72	36.81±5.18	38.31±5.23	35.83±4.16	36.26±2.12
Root fresh weight	I	48.31±2.41	24.34±1.47	49.63±1.47	39.54±3.71	30.41±3.21	35.26±4.21
	II	45.62±3.26	32.27±3.42	39.54±3.42	35.41±1.42	32.52±2.73	36.81±3.74
	III	42.43±1.54	25.51±2.41	24.21±2.32	26.32±2.63	23.47±1.45	25.23±2.53
Root dry weight	I	9.54±4.26	5.42±0.93	7.23±1.97	6.94±0.97	5.52±0.42	6.21±1.76
	II	8.63±3.72	6.63±1.79	6.81±1.11	6.82±1.23	6.94±1.34	6.13±0.93
	III	7.27±5.14	5.27±2.41	5.11±1.32	5.97±1.14	5.63±0.78	5.84±1.21
Root /shoot ratio %	I	20.75±2.41	18.38±2.41	17.75±2.73	15.38±1.54	16.66±1.33	17.14±1.43
	II	18.77±1.73	17.73±1.77	15.38±1.21	16.66±2.12	18.75±2.36	16.66±2.31
	III	20.87±3.21	18.01±3.63	19.83±2.71	19.23±3.26	17.85±1.73	19.16±1.94
Days to 50 % heading	I	108.62±4.51	96.31±3.21	105.66±8.31	105.41±5.41	98.72±2.71	99.63±4.31
	II	106.41±3.21	92.72±1.72	107.54±6.24	103.21±6.32	92.63±3.12	106.51±2.72
	III	101.53±6.23	95.61±6.54	99.31±3.41	100.36±8.71	96.27±2.18	96.13±3.31
Sterility %	I	13.62±1.73	22.73±1.84	34.46±2.11	15.56±20.1	19.54±1.93	18.19±1.42
	II	14.71±1.84	18.54±1.73	28.31±3.24	16.34±1.99	17.62±2.61	20.62±2.31
	III	19.51±1.62	25.63±1.54	19.62±1.67	19.92±1.84	22.27±1.74	18.72±2.12
Grain yield / plant	I	30.42±2.71	15.47±1.77	29.64±2.61	29.41±2.63	16.63±2.61	15.54±1.97
	II	28.63±3.25	21.73±1.89	23.31±3.24	22.63±1.97	18.54±3.51	16.34±2.14
	III	20.92±1.97	13.51±2.74	14.61±1.67	19.52±2.51	13.21±1.98	13.63±1.66

I. RD23 (tolerant) X Sakha 102 (sensitive)
II. BG35 (tolerant) X Giza 177 (moderate)
III. Cica 4 (moderate) X Sakha 103 (sensitive)

These results indicated that presence of partial and over-dominance for these traits which were verified by the computed values of potence ratio, heterosis and heterobeltosis. It is well known that the higher root characters enable plant to grow safety under drought stress condition so RD23, BG35 and their crosses could be recommended under water stress. On the other hand the F2 mean values were lower than the F1 in all studied crosses for most studied characters. These results indicated that the existence of significant inbreeding depression in F2 generation. Moreover, the F2 mean values were higher than the F1 for root fresh weight and root dry weight in cross III and for root / shoot ratio, days to 50 % heading, and sterility % in cross II. These results showed that the transgressive segregation was observed. While BC1 and BC2 mean values tended towards the mean values of the recurrent parents with some exceptions.

Finally, from the foregoing results, it could be concluded that, the expression of heterosis in the F1 might be followed by considerable inbreeding depression in F2 performance, indicating that the non additive gene effects governed the inheritance of such characters. This is logic and expected since there is a tendency towards homozygosity witch is accelerated by 40 % for each salved generation. The most desirable genotypes for root, characters were presents for parents, RD 23 and BG 35 and their crosses, proving that these genotypes should be useful in breeding program for drought tolerance. These results are in agreement with those reported by El-hity (1993), Abdallah (2000), Mishra et al (2000), Bansal et al. (2000) and Abd El-lattef (2005)

1- Genetic parameters:-

1-1. Estimates of heterosis, nature of dominance and inbreeding depression.

It's clear from Table (6), that highly significant and positive estimate of heterosis as a deviation from mid and better-parent were exhibited in all studied crosses for most studied characters. Highly significant positive heterotic effects as a devotion from mid- parent was recorded for root length and root number in crosses I and III. While significant negative heterosis was recorded for root fresh weight, root dry weight, , sterility % and grain yield / plant in cross III. Highly significant and positive heterosis as deviation from better parent was recorded for no. of days to 50 % heading in crosses II and III. On the other hand significant negative heterosis was recorded for the remaining studied characters in the three studied crosses.

Degree of dominance were greater than one unity for root length, root number, root volume and root fresh weight (table 6). in cross I. While negative over dominance were recorded for root / shoot ratio and no. of dyes to 50% heading in cross II. Meanwhile, partial dominance was recorded for all the remaining studied characters in the three studied crosses.

Concerning to inbreeding depression, high significant and positive inbreeding depression was recorded for grain yield / plant (30.52) and root volume (27.36) in cross I, while the insignificant low inbreeding depression was recorded for sterility % (0.15) in cross I.

Table (6): Estimates of heterosis as a deviation from mid and better parents and degree of dominance of rice root and some other characters in the three studied crosses.

characters	cross	heterosis		Degree of dominance	Inbreeding desperation
		M.P.	B.P.		
Root length	I	-14.28**	-15.34**	1.46	13.12**
	II	-1.03	-14.81**	-0.06	18.17**
	III	11.76**	-9.52**	0.57	10.19**
Root number / plant	I	11.97**	1.92	1.25	6.36**
	II	0.69	-3.97	0.16	2.06
	III	8.39**	0.71	0.15	2.11
Root volume	I	22.21**	-8.33**	1.16	27.36**
	II	4.08	-12.06**	0.22	11.76**
	III	1.93	-10.12**	0.18	-8.33*
Root fresh weight	I	11.11**	-16.66**	1.03	12.52**
	II	2.63	-13.33**	0.15	7.69*
	III	-14.28**	-25.11**	-1.14	-25.11**
Root dry weight	I	-3.34	-22.14**	-0.10	14.28**
	II	2.71	-25.12**	-0.19	-11.76**
	III	-14.84**	-28.71**	-0.89	-2.93
Root /shoot ratio %	I	1.37	-15.31**	0.81	3.43
	II	11.76**	-16.66**	-4.12	-6.66
	III	1.46	-4.76	0.66	20.12**
Days to 50 % heading	I	2.94	9.37	-0.51	5.71
	II	9.81**	18.88**	-1.12	12.14**
	III	1.02	42.11**	-0.33	3.03
Sterility %	I	3.68	38.46**	-0.14	0.15
	II	3.72	14.28**	-0.31	-25.32
	III	-6.51**	5.26	0.49	10.15
Grain yield / plant	I	18.51**	-8.57**	0.66	30.52**
	II	-3.44	-15.15**	-0.28	25.11**
	III	-9.52**	-31.57**	-0.57	10.26

Where * significant at 0.05 % and ** highly significant at 0.01 %.

Finally, from .the foregoing results it could be indicated that the average percentages of heterosis as a deviation from mid- and better- parent were highly significant and positive in most studied characters in the three studied crosses. The cross I, (RD23 X Sakha 102) showed higher estimates of heterosis followed by cross II, (BG35 X Giza 177), for root length, root number, root volume, no. of days to 50 % heading, and grain yield / plant. They showed highly significant positive heterotic effects proving that they useful hybrid combination for improving these characters in breeding drought tolerance program.

In addition the significant heterosis as a deviation from mid-and better parent always accompanied by low and insignificant inbreeding depression in most of the studied characters in the three studied crosses indicated the importance of additive gene action which could profitably be utilized in improving these characters. These results were agreement with those obtained by. El-hity (1993), El-Hissewy *et al.* (1994), Price *et al.* (1997), El- Hissewy and El- Kady (1999), Abd El-Aty *et al.* (2002), Abd El-lattef (2004) and El-Wahsh and Hammoud (2007).

1-2. Estimates of gene action and genetic effects of genes:-

Results in Table (7) show the scaling test for adequacy of additive and dominance model and genetic components of generation mean of studied characters in the three studied crosses. Most of the computed parameters of scaling test were statistically significant. indicated the presence of non- allelic interaction. These results revealed that genotype x environment interaction was important in the inheritance of all studied characters. As shown in Table (8), additive, dominance and all types of gene interaction were positive or negative significant and highly significant in the three studied crosses for root number, root volume, root fresh weight, days to 50 heading, and grain yield / plant. The role of additive and dominance genetic variance was more pronounced than the other three types of gene interaction in cross I for root length. While the additive was more important than dominance for root / shoot ratio, in cross III. On the contrary, the dominance genetic variance was more important than additive for root length, root dry weight in crosses II and III and sterility % in cross III. On the other hand, the dominance by dominance genetic type of interaction played an important role for sterility % in cross I and II. In addition, the individual types of digenic epistatic gene effects, the significant additive x dominance gene effects were exhibited more frequently than the other two types of digenic epistatic, but the estimates of the dominance x dominance gene effects have relatively greater magnitude for all the studied characters. Two of these epistatic gene effects apparently counteract each other.

Table (7): Scaling test for adequacy of additive and dominance model of rice root and some other characters in the three studied crosses

Characters	crosses	A	B	C
Root length	I	-4.63±0.92**	1.32±0.31	-7.32±1.74*
	II	-7.28±1.24**	-3.41±0.21	-11.81±1.92**
	III	-8.72±2.63**	-5.63±1.31	5.71±1.43
Root number / plant	I	-31.84±1.84**	-26.41±4.63**	49.63±3.27**
	II	2.74±0.92	-4.62±1.94	-3.47±1.36
	III	-7.68±1.73**	-6.41±2.63**	35.94±5.27**
Root volume	I	-13.42±2.46**	-19.63±3.61**	-4.51±0.31
	II	-11.38±5.41**	-7.21±2.42**	-2.47±0.41
	III	-6.72±2.31**	2.41±1.79	14.81±3.27**
Root fresh weight	I	-10.92±3.81**	-4.79±1.82	-24.63±4.21**
	II	-14.62±5.41**	-741±2.63**	3.21±1.31
	III	-4.38±2.44	7.89±1.94**	7.47±2.41**
Root dry weight	I	-4.75±1.79**	-1.32±0.81	1.32±0.21
	II	-2.81±1.31**	1.43±0.72	-2.74±0.31*
	III	-1.84±0.41	1.32±0.61	-2.63±0.94*
Root /shoot ratio %	I	-2.93±1.21	-5.81±2.11**	1.86±0.21
	II	1.32±0.84	3.72±1.91	-7.26±2.31**
	III	-3.84±0.93	-6.81±2.01**	-10.41±0.92**
Days to 50 % heading	I	-3.41±1.71	-5.32±1.46	-18.42±2.11**
	II	-7.62±2.41	-13.84±2.28**	-34.81±4.83**
	III	0.94±0.31	-2.63±1.41	-10.72±2.62**
Sterility %	I	-1.32±0.46	-2.74±0.81**	1.73±0.41
	II	2.84±0.97**	0.38±0.07	16.87±2.63**
	III	-1.44±0.84	-1.72±0.81*	-12.32±3.82**
Grain yield / plant	I	-14.62±2.41**	-10.84±2.61	-39.77±4.61**
	II	-7.26±1.63	-8.53±2.47*	-31.24±3.21**
	III	4.88±1.82	-3.72±1.62	-13.52±2.61**

Where * significant at 0.05 % and ** highly significant at 0.01 %.

Table (8): Genetic components of generation mean for rice root and some other characters in the three studied crosses.

Characters	crosses	Genetic component of means				
		d	h	i	j	L
Root length	I	4.62**	37.54**	4.81	-2.51	-1.31
	II	1.37	72.51**	6.32**	-2.49	5.81
	III	2.86	-6.53**	-8.27**	-1.52	21.63**
Root number / plant	I	11.63**	-33.64**	-50.94**	-2.64	107.63**
	II	9.84**	10.32**	10.32**	3.25**	-8.82
	III	9.64**	-11.54**	-22.59**	-0.57	35.74**
Root volume	I	16.42**	-2.34	12.63**	3.29**	20.82**
	II	7.84**	-4.28**	2.84	-2.34*	16.73**
	III	3.41	-10.39**	-10.72**	-1.79	8.92
Root fresh weight	I	9.91**	2.68	-2.94	-3.66**	16.73**
	II	4.26**	-7.54**	-8.41**	-2.54*	27.24**
	III	3.74*	-18.53**	-22.73**	-0.59	29.81**
Root dry weight	I	0.42	2.34**	-2.31	-1.32	8.17*
	II	0.13	1.83*	0.87	-1.08	2.31
	III	0.34	-1.32	0.39	-0.56	2.84
Root /shoot ratio %	I	1.84	-8.46**	-6.93**	0.31	16.21
	II	-2.44	1.59	4.53	-1.53	-7.41
	III	2.63*	1.53	8.27**	1.59	1.84
Days to 50 % heading	I	7.48**	13.84**	10.63**	1.63*	-2.87
	II	11.62**	23.11**	14.82**	3.71**	6.54**
	III	4.84	9.42*	8.68*	1.82*	-6.84**
Sterility %	I	-4.63	-3.54	-4.63	0.58	7.29**
	II	-1.82	-1.42	-14.87**	1.31	12.37**
	III	-3.62	8.21**	10.63**	0.46	-8.72**
Grain yield / plant	I	7.29**	22.51**	18.21**	-0.51	3.87
	II	4.35*	14.59**	16.53**	0.49	-1.63
	III	7.84**	11.42**	14.81**	3.51	-15.33**

(d = additive, h = dominance gene effect) and (i = additive x additive, j = additive x dominance, l = dominance x dominance gene interaction

The additive x additive gene effects which were mostly significant and positive indicating enhancing effect in the inheritance. The additive x dominance gene effects exhibited less frequently than the other two types. In contract, most of the dominance x dominance gene effects was negative significant suggesting a diminishing effect due to this type of gene effect and undesirable epistasis.

It could be concluded that epistatic gene effect had a significant contribution in the inheritance of most studied characters. At least one epistatic gene effect was significant for all studied characters in the three crosses. The additive x additive gene interactions appears to contribute more to epistatic effect than any other source of epistasis. Also, these findings suggest that epistatic effect could be an important major contributor to gene actions in the present genetic materials and characters under present study. These findings agreed with those at. Hong and Ichii (1996), Acharya *et al.* (1999), Abdallah (2000), Mishra et al (2000), Abd El-Aty *et al.* (2002) and Abd El-lattef (2006).

1-3. Estimates of genetic variance, heritability and genetic advance:-

Additive genetic variance, dominance genetic variance, broad and narrow- sense heritability and genetic advance estimates of all studied characters for the three studied crosses were shown in table (9).

Table (9): 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 root and some other characters in the three studied crosses.

Characters	crosses	Genetic variance		Heritability		G S	GS %
		1/2 D	1/4 H	Broad sense	Narrow sense		
Root length	I	4.26	4.92	63.51	46.73	4.63	19.41
	II	3.24	8.27	60.62	58.42	5.42	29.21
	III	9.31	10.26	54.41	35.31	5.31	26.63
Root number	I	62.42	78.21	60.84	19.62	9.41	6.04
	II	55.62	62.42	53.39	38.41	8.27	5.63
	III	58.42	70.81	67.65	26.52	6.31	4.31
Root volume	I	40.53	42.31	54.41	41.84	8.41	20.11
	II	59.81	61.42	75.82	32.63	9.52	20.74
	III	23.73	48.54	49.54	27.54	4.14	10.82
Root fresh weight	I	20.32	24.27	62.33	38.82	8.73	22.85
	II	36.45	69.31	96.42	31.71	6.41	16.63
	III	19.62	15.84	48.14	38.63	3.62	10.41
Root dry weight	I	2.63	3.54	72.36	15.51	1.41	16.66
	II	4.41	5.32	79.54	56.62	2.62	20.41
	III	3.52	6.81	81.71	30.73	1.71	16.26
Root/ shoot ratio %	I	0.97	0.72	77.62	54.14	1.62	5.88
	II	1.32	0.14	75.81	49.25	0.97	16.67
	III	0.46	0.76	86.55	31.41	0.84	16.42
Dyes to 50 % heading	I	20.63	28.63	74.21	49.63	6.26	6.16
	II	29.42	35.41	81.27	50.11	8.41	8.51
	III	33.51	32.36	55.63	32.52	5.28	5.21
Sterility %	I	11.41	13.63	62.73	29.41	3.41	16.66
	II	18.52	20.53	74.26	41.62	3.62	15.41
	III	8.61	10.41	58.41	35.87	2.71	11.13
Grain yield / plant	I	18.63	20.74	81.52	25.41	5.62	13.31
	II	25.41	20.63	69.44	36.63	4.11	19.57
	III	23.62	30.71	78.81	22.52	4.13	23.52

Additive genetic variance was higher than the dominance genetic variance for root fresh weight and no. of days to 50% heading in cross III, root / shoot ratio in crosses I and II. The relative magnitude of the additive genetic variance was approximately one times or more than that of the dominance genetic variance in each cross. These results indicated that the additive genetic variance played an important role in the inheritance of root fresh weight, no. of days to heading and root / shoot ratio, than of the dominance genetic variance. On the contrary dominance genetic variance estimates were higher than the additive genetic variance for root length, root number, root volume, root dry weight, sterility % and grain yield / plant in the three studied crosses, root fresh weight in cross I and root / shoot ratio in cross III. These results indicated that, dominance genetic variance was more important than the additive genetic variance regarding these aforementioned characters in the three studied crosses.

Broad- sense heritability estimates were ranged from moderate (48.14) for root fresh weight to high (86.55) for root / shoot ratio in cross III. Estimates of heritability in narrow sense were moderate (58.42) for root length in cross II to low (15.51) for root dry weight in cross I indicates that the selection for this character will be more effective in late generations. Moreover, moderate to low values of predicted genetic advance were estimated for all studied crosses. Moderate values of predicted genetic advance (29.21) were recorded for root length in cross II. Low genetic advance with low heritability for these traits could be expected because this trait is under polygenic control, additive and dominance components of variation were significant in the inheritance of these traits, but dominance component was higher than the additive one. It suggested that early generation selection may not be effective in improving these characters. The previous results of genetic variances and heritability estimates for root, yield and its related traits revealed that the dominance genetic variance had more important role in the inheritance of most of these characters than the additive genetic one, and this finding differs from character to another and also between crosses. Heritability estimates in broad sense were moderate to high in most of cases indicating the effect of the environmental condition on these characters. Moreover, heritability estimates in narrow sense were mostly moderate to low. This was expected due to the high estimates of dominance genetic variance resulted for most characters. This in turn suggested that these treats behaved in a quantitative manner on improving of grain yield and its component could be achieved in late generation. This conclusion may be useful to the breeder for rice in planning a selection program for improvement the yield in such crosses, also, the use of hybridization of their improvement under drought condition. Similar results were obtained by. El-Hity (1993), El-Hissewy *et al.* (1994) El- Hissewy and El- Kady (1999), Mishra et al (2000), Bansal et al. (2000), Abd El-Aty *et al.* (2002) and El-Wahsh and Hammoud (2007).

2-phenotypic correlation coefficients among all possible pairs of the studied traits:-

The phenotypic correlation coefficient was estimated among all possible combinations of studied characters in the F2 generation of the three studied crosses. The results presented in table (10). It is clear that, the phenotypic correlation coefficient was positively significant or highly significant between root length and root volume, root / shoot ratio, and grain yield / plant in the three studied crosses. Also root number was highly significant and positive correlation coefficient with root volume, root dry weight, root to shoot ratio, and grain yield / plant in the three studied crosses. Concerning root volume the positive significant or highly significant phenotypic correlation coefficient were recorded between root volume and root / shoot ratio and grain yield / plant in all studied crosses. On the other hand positive significant or highly significant coefficients were recorded between root fresh weight in crosses I and II and root dry weight and root / shoot ratio in the three crosses.

Significant and highly significant and positive phenotypic correlation coefficient ware recoded between root dry weight and root / shoot ratio and grain yield / plant in the first two crosses. While positive highly significant correlation were recorded between root / shoot ratio and no. of days to 50% heading and grain yield / plant in the three studied crosses. and between no. of days to 50% heading with sterility % and grain yield / plant in the first two crosses. On the contrary, negatively significant and highly significant phenotypic correlation coefficient was recorded between sterility % and root length, root number, root volume, root fresh weight and root dry weight in all studied crosses. Grain yield / plant were highly significant and positive strongly correlated with root length, root number, root volume, root dray weight, root / shoot ratio, and no. of days to 50% heading in the three studied crosses. On the contrary, the grain yield / plant were highly significant and negative strongly correlated with sterility % in the three studied crosses. Similar results were obtained by. Hanamaratti et al. (1997), El-Hissewy and Bastawisi (1998), Mishra (1998), Abdallah (2000) and Abd El-Aty *et al.* (2002)

Table (10): phenotypic correlation coefficients among all possible pairs of the studied characters

	Root length	Root number	Root volume	Root fresh weight	Root dry weight	Root to shoot ratio %	Days to 50% heading t	Sterility %
Root number	-0.23 -0.24 -0.29	——						
Root volume	0.45** 0.38** 0.42**	0.36** 0.38** 0.41**	——					
Root fresh weight	0.34* 0.36** 0.24	0.26 0.24 0.12	0.29 0.24 0,19	——				
Root dry weight	0.33 0.34 0.31	0.36** 0.31* 0.35*	0.29 0.21 0.26	0.39** 0.35** 0.27	——			
Root to shoot ratio %	0.34* 0.39** 0.22	0.41** 0.35* 0.34*	0.36** 0.38** 034*	0.35* 0.37** 0.31*	0.36** 0.38** 0.22	——		
Days to 50 % heading t	0.26 0.21 0.29	0.28 0.29 0.26	0.29 0.27 0.12	0.21 0.14 0.19	0.26 0.22 0.21	0.38** 0.49** 0.34*	——	
Sterility %	-0.35* -0.39** -0.29	-0.39** -0.31* -0.35*	0.34*- 0.31*- -0.25	-0.36** -0.35* -0.31*	-0.35* -0.31* -0.24	0.28 0.18 0.20	0.38** 0.34* 0.28	——
Grain yield / plant	0.49** 0.56** 0.39**	0.51** 0.34* 0.35*	0.35* 0.45** 0.31*	0.22 0.24 0.12	0.34*- 0.46** 0.25	0.45** 0.55** 0.36**	0.55** 0.59** 0.37**	0.64**- -0.46** 0.54**-

Where * significant at 0.05 % and ** highly significant at 0.01 %.

B- water intervals

Estimates of amount of water applied, water consumptive use m^3/ fed: and actual evapotranspiration in (ETC mm / day) are presented in Table (11).

Results in table (11) reported that total water applied and water consumptive use were 4786.61and 3586.36 m^3/ fed respectively. While the highest water applied and water consumptive use values were 1361.31 and 998.31 m^3 / fed. recorded in August. On the other hand, the lowest values were 942.26 and 684.26 m3 /fed. recorded in September.

Data in table (11).showed that values of ETc increased in July and August followed by June (7.82, 7.93 and 7.31 mm / day) respectively. While in September was 6.11 mm / day. Potential evapotranspiration (ETp mm / day): in table (11), showed that five methods were used for estimation (ETp mm / day) these data showed insignificant deference among these methods in pre-harvest period, e.g. months June, July and August value for (ETp mm / day). The evapotranspiration (ETp mm / day) was decreased in emergence stage, while, it increased gradually with increase age of plant and decreased with pre-harvest period in September, after that ETp mm / day increased in June and July. The highest value was recorded by radiation followed by Blany-Criddle methods were 6.37 and 4.91 mm / day, resp. While, Pan Evapotrances and modifid penman were 4.84 and 4.73 mm / day, resp. in the opposite direction.

Table (11): water applied m3/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 m3/fed	Water consumptive Use m^3/fed.	Evapotranspiration mm/day	Etp mm/day M.P.	penman monteith	Blanny and criddle	radiation	Pan Evaporation	mean
June	1131.62	916.63	7.31	7.01	5.61	5.91	5.78	5.21	6.13
July	1351.42	987.12	7.82	7.29	5.01	5.72	6.47	5.01	6.22
August	1361.31	998.31	7.93	7.84	4.32	4.91	7.12	4.93	6.07
20 sep.	942.26	684.26	6.11	5.21	4.01	3.11	6.11	4.01	4.79
total	4786.61	3586.36	29.17	27.35	18.95	19.65	25.48	19.36	21.47
mean	1196.65	896.59	7.29	6.83	4.73	4.91	6.37	4.84	5.81

Concerning crop coefficient values (Kc, %) in table (12), indicated that the effect of crop characteristics on crop water requirements are showed by crop coefficient which represents the relationship between reference potential (ETp) and actual crop evapotranspiration (Etc). The values of crop coefficient for irrigation pattern (kc) showed slight increase after planting and decreased again at the end of growth season. It could be noticed that the nearest values to average (kc) this of radiation equation. These results lead to recommend to use radiation followed by penman monteith and modified-penman methods for estimating water consumptive use in rice. These results are in agreement with those obtained by Nasir *et al* (2002), Hussain *et al* (2003), and Azam *et al*, (2005),

Table (12): Values of crop coefficient (KC) in 2008 season.

Month	Modified penman	Penman monteith	Blanny and criddle	rediation	Pan Evaporation	mean
June	1.15	1.11	1.12	1.01	1.41	1.16
July	1.39	1.35	1.39	1.12	1.63	1.38
August	1.42	1.39	1.49	1.22	1.74	1.46
20 sep.	1.17	1.19	1.33	0.98	1.51	1.24
mean	1.28	1.26	1.33	1.08	1.57	1.31

Estimates of grain yield (Kg / fed)., crop water use efficiency (CWUE %) and field water use efficiency (FWUE %).

Data presented in table (13) indicated that the average of grain yield was significantly *affected* by breeding. The maximum values 3150.41 Kg / fed. was found for the first parent (RD 23) followed by F_1 generation (3045.21 Kg / fed) in cross I. While the minimum value was recorded by F_2 (1365.22 Kg / fed) in the third cross. From the foregoing results, the highest average yield 2345.33 Kg / fed. was recorded for the first cross (RD23 x Sakha 102) followed by cross II (BG35 x Giza 177) was 2251.13 Kg / fed. resp. While, lowest value1610.25 Kg / fed. was recorded for the third cross (Cica 4 x Sakha 103). These results were agree with those obtained by Yasin *et al.* (2003) who showed that yield potential in the upland rice is estimated to be between 2.5 t/ha and 4.2 t/ha, farmers yield often do not realize more than 1 t/ha. due to a range of a biotic production constraints.

Table (13): Crop and field water use efficiency under drought condition in 2008 season

Character	Cross	P1	P2	F1	BC1	BC2	F2	Average
Grain yield Kg/fed.	I	3150.11	1575.13	3045.21	3045.11	1680.36	1575.31	2345.23
	II	3006.15	2205.42	2415.26	2310.31	1890.81	1681.92	2251.13
	III	2100.36	1365.84	1471.63	1995.84	1365.41	1365.22	1610.25
Average		2752.64	1715.94	2310.33	2450.81	1645.71	1540.37	2068.87
CWUE %	I	0.88	0.61	0.84	0.84	0.52	0.46	0.66
	II	0.83	0.44	0.67	0.64	0.46	0.43	0.62
	III	0.58	0.38	0.41	0.55	0.38	0.36	0.44
Average		0.76	0.47	0.64	0.67	0.45	0.42	0.57
FWUE %	I	0.66	0.46	0.63	0.63	0.39	0.37	0.48
	II	0.62	0.32	0.51	0.48	0.35	0.33	0.46
	III	0.43	0.28	0.31	0.41	0.28	0.27	0.33
Average		0.56	0.34	0.48	0.51	0.34	0.31	0.42

Crop and field water use efficiency (CWUE, %)

Data in table (13) reported that crop water use efficiency was significantly affected by flashing water irrigation methods. The maximum CWUE, % values were found for the first parent followed by F_1 generation (0.88 and 0.84 kg / $m^{3)}$ in cross I resp. While the minimum value was recorded by F_2 generation (0.36 and kg / m^3) in cross III. On the other hand, cross one gave the highest mean value (0.66 kg / m^3) of crop water use efficiency followed by cross II (0.62 kg / m^3). These data showed that the highest crop water use efficiency 0.66 and 0.62 kg / m^3 was recorded from 1 m^3flashing water irrigation in cross I (RD23 x Sakha 102) and cross II (BG35 X Giza 177) resp. Also data indicated that the significant effect of flashing water irrigation method on FWUE, %. The maximum FWUE, % value was recorded for the first parent followed by F_1 generation in cross I. While the minimum value was recorded in F_2 generation in the third cross. On the other hand the highest value of FWUE, % was found in, cross I followed by crosses II and III. These results are agreement with those obtained by Khan et al (1999), Akbar et al (2002), Yasin et al (2003), and Ahmed and Karube (2005).

From the fore going results the cross I (RD23 x Sakha 102) and cross II (BG3 5 X Giza 177) could be recommended to growing under drought condition to obtain the highest rice grain yield kg / m^3 and highest value of save water in the same time.

REFERENCES

Abd El-lattef A.S. M. (2004). Studies on behavior of some characters related to drought tolerance in rice breeding Ph.D. Thesis, Fac. of Agric., Tanta University.

Abd El-latif (2005). Genetic analysis for some root characters in some rice varieties and its relation to drought. Egypt, J. Agric. Res., 83(5B), 289-303. Ab d El-lattef A.S. M., A.B. EL-Abd and A.A. Abdallah (2006). Genetic studies of rice root characters related to drought tolerance. First field crops conference. 22-24 August: 71-81.

Abd-allah(2000). Breeding study on rice (*Oryza sativa L*). ph. D. These, fac. of Agric., Menoufiya University, Shibin El-Kom, Egypt.

Abd El-Aty, M. S., A. B. El-Abd and A. A. Abdallah (2002). Genetic analysis of quantitative traits in rice. 1- Yield and its related characters. J. Agric. Sci. Mansoura Univ., 27 (7): 4399-4408.

Acharya, B.; B. Swain and K. Pande (1999). Variation in drought tolerance, its Anatomical basis and inheritance in low land rice. India Central Rainfed Lowland Rice Research Station. *Oryza* .1999, 36: A, 378-379.

Ahmed, M.M. and J. Karube, 2005. Comparison of Coagulation critical concentration between kaolinite and montmorillenite under different pH conditions.Trans. Jpn. Soc. Irrigation Drainage and Reclamation Engineering, Japan, (237) 7-12

Akbar, G., M. Yasin, Z. Hussain, M.M. Ahmed and Z. Khan, 2002. Rootzone salinity management using skimming dugwells with raingun sprinkler irrigation. Sarhad Journal Agriculture, 18(4): 415-425

Azam, M., S. Ahmed, Z. Hussain, M. Yasin, M. Aslam and R. Majeed, 2005. Efficiency of water and energy use for production of organic wheat. Science Technology and Development, 24 (1): 25-29.

Bansal, U.K., R.G. Saini and N. S. Rani (2000). Heterosis and combining ability for yield, its component and quality traits in some scented rice. Tropical Agriculture 77(3)180-187.

Burton, G.W. (1995). Quantitative inheritance in pearl millet (pennisetum glaucum). Agron. J. 43(9): 409-417.

Butany, W.T. (1961). Mass emasculation in rice. In ster. Rice Comm Newsletter. 9:9-13

El-Hissewy, A.A. and A.O. Bastawisi (1998). The inheritance of some root characters associated with drought tolerance in rice. Egypt. J. Agric. Res.76 (3).

El-Hissewy, A.A.; M.A. El-serafy and A.S. Ghanem (1994). Genetic variability of some root characters of rice associated with drought resistance. Egypt. J. Appi. Sci., 9(6): 431-438

El-Hissewy, A.A. and A.A. El-Kady (1999). Response to selection in three crosses of rice Egypt. J. Appi. Sci., 14(1): 115-122.

El-Hity, M.A. (1993). Estimates of genetic parameters for grain yield and some of its components in three rice crosses. Alex. J. Agric. Res.38(3):335-350.

El-Hity M.A.; S.H. Abou-Khadra, A.A. El-Hissewy, M.S. Abd El-Aty and A.S.M. (2005). Genetic analysis for some root characters in some rice varieties and its relation to drought. Egypt, J. Agric. Res., 83 (5B).

Hong, D.L. and M. Ichii (1996). Genetic analysis of short root in rice. Chinese Journal of Rice. 8(4): 200-204.

El-Wahsh, S.A. and S.A.A. Hammoud (2007). Evalution of rice promising lines for blast disease resistance and some agronomic characteristics. J. Agric. Res. Kafer El-sheikh Univ.,33(1): 140-157.

FAO (1976). Physical and chemical methods of soil and water analysis. Soil Bull. No. 10, FAO, Rome, Italy.

FAO (1990). Report on the expert consultation on revision of FAO methodologies for crop water requirements. Land water devel. Div.; Roma, Italy.

Hanamaratti, N.G.; S.K. Nadaf; P.M. Salimath and S.J. Patil (1997). Correlation among grain yield and yield attributes over seasons in upland rice genotypes, Karnataka, India, J. of Agric. Scihces. 10:1, 250-259

Hansen. V.W.: D.W. Israelsen andQ.E. Stringharm. (1980). Irrigation principle and practices 4th ed. Wiley and Sons. New York.

Hussain, S., A.T. Sarwar, M.I. Lone, R. Roohi and F.S. Hamid, 2003. Effect of different soil moisture conservation practices on evapotranspiration and growth of young tea Plants. Asian Journal of Plant Sciences, 2(2): 188-191.

Israelsen, o. w. and V. W. Hansen, (1962). Irrigation principles and practices 3rd Ed. John wiley and Sons. New Yourk

Jodon, N.E. (1938). Experiments on artificial hybridization of rice. J. Amer. Soc. Agron., 30: 249-305.

Johnson, H.W.; H.F. Robinson and R.E. Comstock (1955). Estimates of genetic and environmental variability in soybean. Agron. J. 47:214-222.

Khan, M., T. Hata, A. Tada and H. Tanakamaru, 1999. Potential of estimating flood hydrographs by SCS and simple models for an experimental watershed in Pakistan. Journal of Irrigation Drainage and Reclamation Engineering, Japan, 1(20): 61-67.

Mishra, D.K.; C. B. Singh and D. Senadhira (2000). Recent advances and future strategies for breeding salt tolerance rice varieties. Proceeding of the 32nd IRRI conference Philipins.

Mishra, D K. (1998). Association of various agronomic characters with yield in segregation population of rice under different environments. India Annals of Agric. Res. 1998, 19: 3, 245-249.

Mather, K. (1949). Biometrical Genetic. Dover publication, Inc. London.

Mather, K. and J. L. Jinks (1971). Biometrical Genetic. Cornell Univ., Press Ithaca, N. Y., 231 PP.

Michael, A.M. (1978). Irrigation Theory and Practice. Vikas Publishing House PVT.Ltd.

Nasir, A, K. Uchida, M. Shafiq and M. Khan, 2002. Monitoring soil erosion in a mountainous watershed under high rainfall zone in Pakistan. Rural and Environmental Engineering, Japan, 43 (8): 23-30.

Nour, M.A.M. (1989). Studies on fertilization and irrigation on rice. Ph.D. thesis,Fac. Agric., Tanta univ., Egypt.

Price, A.H.; A.D. Tomos and D.S.Virk (1997). Genetic dissection of root growth in rice. I: A hydroponic Screen. Theoretical and Applied Genetics. 95: 1-2, 132-142.

Sanedecor, G.W. and W.G. Cochran (1961). Statistical methods. 5th ed. Iowa state Univ.

Wigan, L.G. (1944). Balance and potence in natural, Population. J.Genet.46:150-160

Yasin, M., S. Ahmed, Z. Hussain, P.M. Moshabbir and M. M. Ahmed, (2003). Optimum water utilization in Pakistan: adaptation of pressurized irrigation systems. Science Technology and Development, 21(2): 43-62.

دراسة السلوك الوراثى لبعض صفات الجذور وعلاقتها ببعض صفات المحصول فى الارز تحت ظروف الجفاف

أشرف صلاح مصطفي عبد اللطيف* –عادل احمد ماضي**
*مركز البحوث والتدريب في الأرز–سخا–كفر الشيخ– مصر
** المركز القومي لبحوث المياه بالقاهرة – معهد بحوث إدارة المياه وطرق الري

تم اجراء هذه البحث لدراسة وراثة بعض صفات الجذور وعلاقتها ببعض الصفات الاخرى فى الارز تحت ظروف الجفاف وتم استخدام ستة أصناف هي ار دى 23 (متحمل لنقص الرطوبة الأرضية) وسخا 102 (حساس لنقص الرطوبة الأرضية) و بى جى 35 (متحمل لنقص الرطوبة الأرضية) وجيزة 177 (متوسط التحمل لنقص الرطوبة الأرضية) وسيكا 4 (متوسط التحمل لنقص الرطوبة الأرضية) و سخا 103 (حساس لنقص الرطوبة الأرضية) وتم إجراء التهجين بين كل زوج من هذة الأصناف والحصول على ثلاثة هجن هي

I– هي ار دى 23 x سخا 102 (متحمل لنقص الرطوبة الأرضية x حساس لنقص الرطوبة الأرضية)

II - بى جى 35 x جيزة 177 (متحمل لنقص الرطوبة الأرضية x متوسط التحمل لنقص الرطوبة الأرضية)

III- سيكا x سخا 103 (متوسط التحمل لنقص الرطوبة الأرضية x حساس لنقص الرطوبة الأرضية)

وذلك بهدف دراسة وراثة بعض صفات الجذور وعلاقتها ببعض الصفات الاخرى فى الارز تحت ظروف الجفاف وذلك من خلال تقدير مكونات التباين الوراثي في كل من الآباء والجيل الأول والجيل الرجعى الاول والجيل الرجعى الثانى والجيل الثاني عن طريق تقدير ستة مكونات وراثية هي المتوسط والتباين الاضافى والتباين السيادي والتفاعل بينهما وتأثيرهما على الصفات المدروسة تحت ظروف نقص الرطوبة الأرضية.

وكانت النتائج كالآتي :

وجد من الدراسة أن هناك تباين كبير في مختلف الصفات المدروسة بالنسبة للآباء تحت ظروف نقص الرطوبة الأرضية وخاصة صفات الجذور حيث أعطت الأصناف المتحملة لنقص الرطوبة اعلى قيم للمتوسطات لمختلف الصفات المدروسة متفوقة على باقي الآباء كما أعطت نباتات الجيل الأول قيم اعلى من الآباء بالنسبة لصفة طول الجذر وعدد الجذور وحجم الجذر والوزن الغض للجذر فى الهجين الاول وصفة 50 % تزهير فى الهجين الثانى مما يشير لوجود سيادة فائقة لهذة الصفات المدروسة بينما أعطت باقى الصفات قيم وسطية بين الاباء مما يشير الى تاثر تلك الصفات بالوراثة الجزئية. بينما جاءت قيم الجيل الثاني مساوية تقريبا لمتوسط الآباء واقل من قيم الجيل الأول. كما لعبت قوة الهجين دورا كبيرا في معظم الصفات المدروسة حيث أشارت النتائج إلى وجود معنوية عالية لقوة الهجين في معظم الصفات ماعدا صفة طول الجذر وعدد الجذور وحجم الجذر والوزن الغض للجذر والوزن الجاف للجذرومحصول الحبوب للنبات الفردى فى الهجين الثانى وصفة نسبة المجموع الجذرى الى الخضرى وعدد الأيام حتى 50 % تزهير للهجين الاول والثالث لمتوسط وأفضل الإباء. كما لعب كلا من التأثير الإضافي والسيادي دوراً كبير في معظم الهجن المدروسة وخاصة الهجين الأول والثاني.

كما كان للتفاعل بينهما خاصة التأثير الاضافى × الاضافى دورا هاما في وراثة طول الجذر وعدد الجذور وحجم الجذر والوزن الغض للجذر. بينما كانت قيم التباين الوراثي المضيف اعلي من قيم التباين الوراثي السيادى في كل من نسبة المجموع الجذرى الى الخضرى فى الهجين الاول والثانى وصفة عدد الايام حتى 50% تزهير فى الهجين الثالث وصفة محصول النبات الفردى من الحبوب فى الهجين الثانى بينما كان التباين السيادى اكبر من المضيف فى باقي الصفات لمختلف الهجن المدروسة.

تراوحت قيمة درجة التوريث في المدى الواسع من متوسطة إلي مرتفعة في مختلف الصفات بينما تراوحت قيمة درجة التوريث في المدى الضيق من منخفضة الى متوسطة بالنسبة لمختلف الصفات. كما جاءت نسبة التحسين المتوقع من الانتخاب من منخفضة إلي مرتفعة وكان الهجين الاول و الثاني إعلي القيم ارتفاعا مقارنة بباقي الهجن المدروسة في معظم الصفات المدروسة.

كان هناك ارتباط معنوي موجب بين محصول النبات الفردي ومعظم الصفات المدروسة وخاصة طول الجذر للنبات الفردي وحجم الجذر ووزن الجذر الغض ونسبة المجموع الجذري إلى المجموع الخضري وعدد الأيام حتى 50 % تزهير كما كان هناك ارتباط معنوي سالب بين محصول النبات الفردي وكلا من نسبة العقم. كما أوضحت النتائج أن المتر المكعب من المياه أعطى 660 جرام من محصول حبوب الأرز وخاصة في الهجين الأول و620 جرام للهجين الثانى ولذا وبناء على النتائج المشار إليها يمكن التوصية بزراعة نباتات الهجين الأول والثانى تحت ظروف نقص الرطوبة الأرضية لاعطائة اعلي كمية حبوب وإجراء الانتخاب الفردي لعدد من الأجيال للحصول على نباتات أكثر تحملا من كلا الأبوين.