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EFFECT OF GENOTYPIC X ENVIRONMENTAL (G X E) AND GENETIC VARIABILITY ON RICE YIELD AND GRAIN QUALITY CHARACTERS

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ABSTRACT

Fifteen rice varieties and five promising lines were grown at Sakha and Gemmeiza Farm Stations during 2006 and 2007 seasons. The effect of genotype x environment (G x E) interactions and genotypic (GCV) and phenotypic (PCV) coefficients of variability, broad sense heritability, genetic advance and phenotypic correlation coefficients were estimated for days to 50% heading, plant height, panicle length, no. of panicles/ plant, no. of filled grains/panicle, sterility%, 100-grain weight, grain yield/plant, grain shape, hulling%, milling%, head rice%, grain elongation, gelatinization temperature (GT.), gel consistency (GC) and amylose content. The results indicated that the interaction of genotypes x location was highly significant for plant height, panicle length, no. of panicles/ plant, no. of filled grains/panicle, grain yield/plant, and significant for head rice%, and gelatinization temperature. The interaction of variety x location x year was highly significant for all studied characters except gel consistency and amylose content characters. Genotypic and phenotypic coefficient of variation (GCV,PCV) were found to be high for no. of filled grains/panicle, days to 50% heading, amylose content, grain elongation and head rice. Broad- sense heritability estimates ranged from moderate to high for all studied characters. High expected genetic advance was associated with high heritability. High heritability values coupled in plant height, no. of filled grains/panicle, gel consistency, milling %, hilling % and head rice%. These results indicated that individual plant selection for these characters should be effective and satisfactory for successful breeding purpose. The genotypes, GZ 8951-9-7-1-3, Sakha, 101, GZ 8372-13-1-3-1, Sakha 104, Giza 176, GZ 8494-2-1-3-1, Sakha 102, Giza 178, GZ 8455-6-8-3-1 and Sakha 103 gave the highest mean values for the yield and its component characters under Gemmeiza Farm Station. Highly significant and positive phenotypic correlation was found between grain yield/plant and each of panicle length, no. of panicle/plant, no. of filled grains/panicle, 100-grain weight, hilling %, milling % and head rice at both locations

Keywords: Rice – Genotypic - Environmental - Genetic variability – Grain yield – Grain quality.

INTRODUCTION

Rice is one of the most cereal crops affected by environmental condition, therefore the genotypic x environmental (GE) interaction is very important in breeding programs of rice improvement. Concerning the confounding effects it introduces in comparison among genotypes tested at different locations and different years, therefore the genotype x environmental (GE) interaction is a concern to breeders as to reduce. The knowledge of the magnitude and the nature of GE interaction is a value of determining the number of years and locations to estimate the level of precision necessary to measure differences among genotypes (Allard and Bradshow 1964).

Widening of the genetic diversity for the Egyptian varieties is the main target of Egyptian breeders to reach the highest yield potential under different environmental conditions. Many years ago, most of Egyptian rice verities were having a narrow genetic background for tall in height, late in heading and sensitive to adverse soil. All there constraints negatively affected the yield (Badawi and Draz 2004). The estimates of variability in respect of yield and its heritable components in the material with the breeder is working are therefore, prerequisites for any breeding program.

Hence, it is also necessary to spilt the phenotypic variability into heritable and non-heritable components with the help of certain genetic parameters such as genotypic (GCV) and phenotypic (PCV) coefficients heritability and genetic advance.

More than one environments is very important for breeders to make based selection on the ranking of genotypes, therefore fifteen rice varieties and five promising lines were grown under two locations and two years to determine the relative magnitudes of genotypes, environmental, GE interaction, extent of genetic variability, heritability and expected genetic advance for yield and its related characters and some grain quality and the association between all possible pairs of the studied characters.

MATERIALS AND METHODS

Two experiments were carried out at the Experimental Farm of Sakha and Gemmiza Agricultural Research Stations during two successive rice growing seasons; 2006 and 2007 to study the genotypic x environmental (GE) interaction, genetic variability, heritability and genetic advance for yield and its related characters as well as grain quality characters for 20 genotypes. These genotypes are: Sakha 101, Sakha 102, Sakha 103, Sakha 104, Giza 176, Giza 177, Giza 178, IET 1444, Milyang 97, BG 35, Cica 4, RD 23, GZ 1368, Rieho, Ratna, GZ 8372-13-1-3-1, GZ 8951-9-7-1-3, GZ 8455-6-8-3-1, GZ8479-6-2-3-1 and GZ 8484-2-1-3-1. All these genotypes were grown in a randomized complete block design with three replication. Thirty days old seedlings of each genotype were individually transplanted in 10 rows / replicate. Rows were 5 m long, 20 cm apart with 20 cm between plants.

Data were recoded on each plant, ten competitive plants / replicate were randomly selected to record observations on yield and its attributes, viz. days to 50% heading, plant height, panicle length, number of panicles/plant, number of filled grains/panicle, sterility %, 100-grain weight and grain yield/plant according to standard evaluation system for rice (IRRI, 1996). Duplicate samples from each replicate for every genotype were used in the grain quality test. The grain quality traits, namely grain shape, hulling %, milling %, head rice %, grain elongation, gel consistency, gelatinization temperature and amylose content were estimated according to Khush *et al.*,(1979) and little *et al.* (1968). Maczinger (1963) showed that the three-way interactions were usually of greater importantce of various crops. Therefore the data were analyzed as a three-way factorial as discussed by kempthorne (1952) and Comstock and Moll (1963).

Genotypes (G), years (Y), and locations (L) were treated as random effects. The G x L x Y interaction was tested by the error mean square, while G x L and G x Y interactions were tested by mean square of the G x L x Y interactions. The main effect of genotype was tested as suggested by Cohran (1951) with effective degree of freedom according to Satterthwaite (1946). Phenotypic and genotypic coefficients of variability (PCV and GCV), broad – sense heritability and expected genetic advance at 5 % selection were estimated by using formula suggested by Johanson *et al.* (1955). Phenotypic correlation coefficients were estimated by the method of Dewey and Lu (1959).

RESULTS AND DISCUSSION

Genotype x environment (GE)

The mean values of yield and its related characters of 20 rice genotypes grown in two years and two locations are presented in Table (1). Data showed, highly significant differences among genotypes for grain yield and associated traits, indicating that rice genotypes differed in their genetic potential for grain yield and its components. The interaction between genotypes and locations was highly significant for plant height, panicle length, no. of panicles/plant, no. of field grains / panicle and grain yield / plant, but significant for sterility % and 100-grain weight. Mean squares of genotypes x year interaction was significant only for panicle length, 100 grain weight and grain yield / plant indicating that some of the studied varieties were superior in some years than the others so, it could not be recommend which variety would be suitable in certain years and locations. The interaction among genotypes x location x year was highly significant for all yield and related characters as shown in Table (1). This means that the interaction between the genotypes and years was not stable at different locations.

Table (1): Mean squares of yield and its related characters of 20 rice genotypes grown over two years and two locations.

S.O.V.	d.f	Days to 50% heading	Plant high	Panicle length	No. of panicles / plant	No. of filled grains /panicle	Sterility %	100-grain weight	Grain Yield / plant
(G) Genotypes	19	103.26**	94.32**	25.46**	23.61**	108.53**	19.53**	2.30**	34.68**
G x location	19	5.63	16.94**	20.26**	19.62**	25.63**	9.54*	0.94*	28.54**
G x years	19	3.42	0.84	6.45	8.23	1.26	0.92	-1.32	18.61
G x l x y	19	20.64**	36.41**	19.52**	20.64**	40.93**	12.16**	2.17**	25.92**
Error	158	10.84	9.41	5.23	1.94	3.26	7.42	5.32	9.41

* and ** significant and highly significant at 0.05 and 0.01 levels, respectively

Mean square values of grain quality characters are given in Table (2). Highly significant differences among genotypes for grain quality characters, indicating that rice genotypes differed in their genetic potential for grain quality characters. The interaction of variety x location was highly significant for hulling % and milling %, but, head rice and gelatinization temperature were only significant. The interaction of genotypes x years was not significant for all grain quality characters except for gelatinization temperature. This indicates that the genotypes were not superior in some years than the others for all the grain quality characters, except for gelatinization temperature.

These significant and highly significant values for genotypes x locations interaction show that the grain yield and its related characters and grain quality were affected by location and evaluated genotypes responded differently by locations. These data were expected as soil type, drainage and fertility level vary from place to place (El-Hissewy and El-kady 1990). Moreover, the non significance for the interaction of genotypes x years show that the performance of the genotypes was basically the same in each of the two years of testing. If genotypes x year interaction actually is greater than the estimates obtained, it would be desirable to evaluate the genotypes in more than one year (Liang *et al.,* 1966), while it would be possible to shorten the evaluation program of potential new varieties by testing them at an adequate number of locations in one year only. The significant interaction indicated that the genotypes involved responded differently when grown under different environments. While the significant three- factor interaction of genotypes x locations and years illustrated that the genotypes x locations interaction varied. From here, the relatively larger genotypes x locations x years interaction must be due to one or more aspects of environment for which the pattern of variation among locations differs from year to year.

Table (2): Mean squares of grain quality characters of 20 rice genotypes grown over two years and two locations.

S.O.V.	d.f	Grain shape	Hulling %	Milling %	Head rice %	Grain Elongation	G.T	G.C	A.C
(G) Genotypes	19	8.64**	78.62**	97.36**	71.66**	0.87**	0.31**	0.94**	10.81**
G x location	19	0.35	26.27**	28.72**	30.82*	0.34	0.37*	0.52	7.62
G x years	19	0.16	2.63	9.28	3.25	0.21	0.28*	0.31	2.41
G x l x y	19	4.27**	19.92**	28.61**	38.24**	0.59*	0.36*	0.64	5.31
Error	158	2.51	5.51	4.28	8.79	0.19	0.21	0.81	1.72

*** and ** significant and highly significant at 0.05 and 0.01 levels, respectively**

The mean values of eight yield and its related characters for the genotypes grown at Sakha and Gemmeiza Farm Stations during 2006 and 2007 seasons are presented in table (3). A wide range of days to 50% heading was detected and ranged from 91.13 days in GZ.8479-6-2-3-1 to 111.64 days in Rieho at Gemmiza farm station. The genotypes. GZ8479-6-2-3-1, Giza 177, Sakha 103, Milyang 97, Sakha 102, and GZ8951-9-7-1-3 were found to be earlier than the others. The values were 90.49 and 91.13, 93.36 and 92.07, 93.63 and92.84, 93.17 and 94.14, 95.49 and 94.26 and 99.25 and 97.13 at Sakha and Gemmeiza, resp. Significant differences among the genotypes studied were observed for Sakha and Gemmeiza conditions. The mean values in plant height ranged from 90.14 cm to 115.16 cm and from 91.68 cm to 116.32 cm in sakha 101, GZ8455-6-8-3-1,GZ 8479-6-2-3-1 and IET 1444 for both Sakha and Gemmeiza conditions, respectively.

The panicle length ranged from 17.62 to 25.72 cm and from 18.41 to 27.13 cm in Rieho and sakha 101 at Sakha and Gemmeiza Farm Stations, respectively. The tallest panicles were recorded for Sakha 101, Milyang 97, GZ8494-2-1-3-1, Sakha 102, GZ 8372-13-1-3-1, GZ 8479-6-2-3-1, BG 35 and GZ 8951-9-7-1-3 at both two locations. Moreover, number of panicles/plant varied from 12.31 in Ratna to 24.44 in Giza 178 and from 11.26 in Cica 4 to 25.46 in Sakha 101 at Gemmeiza and Sakha farm station respectively. The mean values of number of filled grains / panicle ranged from 104.42 in Ratna to 157.64 in Sakha 101 and from 110.48 in Riho to 170.26 in Sakha 104 at Sakha and Gemmeiza Farm Stations; respectively.

Table (3): Mean performance for grain yield and its related characters of rice genotypes grown over two years at two locations.

Genotype	Days to 50% heading		Plant high (cm)		Panicle length (cm)		No. of panicles/plant		No. of filled grains / panicle		Sterility (%)		100-grain weight (g)		Grain yield/plant (g)	
	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza
Sakha 101	109.21	106.36	90.14	96.63	25.72	27.13	22.63	25.46	157.64	169.81	8.73	5.26	2.52	2.61	43.12	45.63
Sakha 102	95.49	94.26	103.22	107.31	20.21	24.36	21.72	23.63	152.41	159.36	9.44	6.52	2.41	2.54	38.41	41.31
Sakha 103	93.63	92.84	98.34	100.46	20.81	22.41	19.46	21.46	132.42	135.61	9.32	5.41	2.31	2.32	36.41	39.84
Sakha 104	103.41	101.26	105.31	109.41	22.62	23.63	22.81	23.51	156.63	170.26	7.24	7.18	2.52	2.54	40.53	44.28
Giza 176	113.14	111.46	101.24	103.63	21.34	22.97	20.21	21.26	122.41	125.36	6.61	4.81	2.34	2.38	42.41	42.73
Giza 177	93.36	92.07	95.14	98.42	21.24	22.31	19.63	22.52	115.42	120.36	8.41	6.91	2.51	2.63	35.61	38.62
Giza 178	105.46	104.28	101.63	100.62	20.51	23..32	24.44	20.41	129.42	135.41	7.27	7.14	2.16	2.32	40.42	41.46
IET 1444	100.12	102.36	115.16	116.32	22.26	24.12	18.12	19.82	125.42	137.51	8.31	7.62	2.33	2.51	36.31	38.28
Milyang 97	93.17	94.14	105.41	115.26	25.32	26.36	21.31	23.41	123.63	125.14	9.26	10.42	2.24	2.26	38.14	39.27
BG 35	106.31	107.24	107.62	106.32	22.26	23.73	16.34	18.41	115.26	114.13	9.54	8.35	2.12	2.32	32.41	32.44
Cica 4	111.32	110.14	108.41	110.26	21.14	22.63	13.14	11.26	110.14	115.23	8.30	6.26	2.36	2.44	33.14	33.26
RD 23	107.36	105.24	99.23	99.41	19.63	19.98	19.11	19.81	115.36	119.12	12.46	8.24	2.31	2.32	30.64	31.82
GZ 1368	101.42	101.14	108.64	105.64	22.42	23.32	20.42	21.63	122.41	125.63	8.36	6.48	2.63	2.61	35.48	37.36
Rieho	110.26	111.64	101.81	102.36	17.62	18.41	14.26	17.23	112.24	110.48	10.62	10.25	2.54	2.64	34.63	36.24
Ratna	110.91	109.62	100.63	100.12	19.42	20.16	12.31	13.42	104.42	112.31	6.42	6.84	2.45	2.53	30.26	32.13
GZ 8372-13-1-3-	102.31	101.14	102.53	91.68	23.25	24.11	20.83	20.32	115.31	120.62	8.73	5.61	2.54	2.61	40.36	44.53
GZ 8951-9-7-1-3	99.25	97.13	103.12	93.62	23.17	23.73	22.21	22.36	156.75	161.47	6.11	7.63	2.41	2.52	42.12	46.82
GZ 8455-6-8-3-1	103.60	101.14	90.48	98.76	22.42	22.26	21.83	22.52	140.16	158.25	10.26	11.23	2.33	2.41	38.14	40.62
GZ 8479-6-2-3-1	90.49	91.13	91.16	99.63	22.36	23.24	20.21	21.97	148.48	152.41	9.26	9.48	2.52	2.63	39.36	39.48
GZ 8494-2-1-3-1	101.00	100.14	109.12	110.41	24.21	25..31	22.62	22.82	131.31	145.23	8.16	8.27	2.51	2.54	41.42	42.71
Range from	93.17	91.13	90.14	91.68	17.62	18.41	12.31	11.26	122.241	110.48	6.11	4.81	2.12	2.26	30.26	31.82
to	113.14	111.64	115.16	116.32	25.72	27.13	24.44	25.46	57.64	170.26	12.46	11.23	2.63	2.64	43.12	46.82
Grand mean	102.56	101.73	101.91	103.31	21.89	23.16	19.68	20.66	129.36	135.68	9.11	7.49	2.41	2.48	37.87	39.89
L.S.D $_{0.05}$	4.31	3.62	4.24	3,71	4.22	4.12	2.37	3.22	5.42	4.86	3.52	4.72	0.95	1.26	6.47	5.47
L.S.D $_{0.01}$	7.25	8.41	5.32	6.28	5.62	4.92	5.41	4.67	8.63	7.42	4.63	4.96	1.79	1.84	8.63	7.62

In addition, the lowest estimates of sterility % were 6.11% in GZ 8951-9-7-1-3, 6.42% in Ratna, 6.61% in Giza 176, 7.24% in Sakha 104 and, 7.27% in Giza 178 at Sakha Farm Station. The lowest estimates of sterility % was recorded in Giza 176 (4.81%), Sakha 103 (5.41%) and GZ8372-13-1-3-1(5.61%) at Gemmeiza Farm Station. The lowest sterility % at Gemmiza Farm Station indicated to high yielding and superior rice genotypes compared with other rice genotypes.

High weights of 100-grain were detected in Sakha 101, Sakha 104, Sakha 102, GZ 8494-2-1-3-1, Giza 177 and GZ 8372-1-13-1-3-1. According to high number of panicles / plant, 100-grain weight and lowest mean values for panicle length, sterility % in , GZ 8951-9-7-1-3, Sakha, 101, GZ 8372-13-1-3-1, Sakha 104, Giza 176, GZ 8494-2-1-3-1, Sakha 102, Giza 178, GZ 8455-6-8-3-1 and Sakha 103, these genotypes had high grain yield / plant (46.82, 45.63, 44.53, 44.28, 42.73, 42.71, 41.46, 41.31, 40.62 and39.84 g) under Gemmeiza farm station.

Mean values of eight grain quality characters for the 20 genotypes are presented in Table (4). Mean values of grain shape showed a wide range from 1.79 for Giza 177 to 3.59 for Milyang 97 at Gemmiza Farm Station these results indicated that the grain genotypes ranged from medium to long grain shape.

Concerning to mean values of hulling %, Giza 177 variety has highest (83.8 %) followed by GZ 8372-13-1-3-1 (83.2%) at Gemmeiza Farm Station while, Milyang 97 variety was lowest (73.8 %) indicating a wide range of genetic variability among these genotypes.

Mean values of milling % exhibited a wide range from 76.2% for GZ 8951-9-7-1-3 to 65.4 % for IET 1444 at Gemmiza and Sakha Farm Stations resp. It could be concluded that there was a wide range of genetic variation among the genotypes used in this study. It is clear from Table (4) that the mean values of the genotypes showed a wide range of head rice percentage, from 49.21% to 68.64 for Cica 4and GZ 8372-13-1-3-1 and from 50.31% to 69.51% for Sakha 101 and RD 23 at Sakha and Gemmiza Farm Stations, respectively.

Table (4) show the mean values of cooking and eating quality characters namely, grain elongation, gelatinization temperature(G.T.), gel consistency (G.C.) and amylase content (A.C.) for fifteen rice varieties and five promising lines at Gemmeiza and Sakha Farm Stations. The mean values of grain elongation of the genotypes showed Sakha 103 variety had a wide volume after cooking; the increasing value was 0.83 % at Gemmiza Farm Station. While, RD 23 variety had a narrow volume after cooking, the increasing value was 0.25 % at Sakha Farm Station.

Low gelatinization temperature mean values were found in the GZ 8494-2-1-3-1 (6.96), GZ 8951-9-7-1-3 (6.64), Giza 177 (6.72), Sakha 104 (6.64), Sakha (6.52) and Sakha 101 (6.43). These results indicate that these genotypes take a shorter cooking time comparing with the others studied.

Low gel consistency (over 60 mm) were recorded for all studied genotype except Cica 4 (42 mm) and Rieho (55.1 mm) varieties at Sakha farm station these finding indicated that these genotypes had a soft gel consistency. It could be stile along time as soft grains after cooking.

Table (4): Mean performance of grain quality characters of rice genotypes grown over two years at two locations.

Genotypes	Grain shape		Hulling %		Milling %		Head rice %		Elongation		Gelatinization temperature		Gel consistency		Amylose content	
	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza	Sakha	Gemmiza
Sakha 101	2.13	2.21	81.60	82.30	73.60	75.21	68.31	69.51	0.79	0.80	6.12	6.43	98.62	98.43	18.7	18.3
Sakha 102	2.15	2.14	78.62	80.43	70.51	74.62	67.22	68.73	0.71	0.72	6.14	6.25	89.24	87.54	19.3	19.4
Sakha 103	2.10	2.12	79.90	80.91	71.10	72.84	64.71	65.91	0.82	0.83	6.33	6.52	93.27	92.35	18.5	18.2
Sakha 104	2.03	2.09	77.20	78.63	72.84	72.63	65.63	68.36	0.72	0.73	6.25	6.64	95.63	96.49	19.5	19.2
Giza 176	2.19	2.29	80.90	81.41	72.30	73.24	56.42	63.62	0.53	0.60	6.12	6.23	95.21	95.15	21.9	20.6
Giza 177	1.76	1.79	82.60	83.82	73.17	75.41	67.44	68.43	0.66	0.69	6.34	6.72	78.30	79.40	19.5	18.9
Giza 178	1.90	2.02	78.12	79.61	70.84	72.42	65.71	66.31	0.39	0.45	5.33	6.31	71.91	72.62	19.3	18.8
IET 1444	2.24	2.23	75.70	77.66	65.40	68.10	58.47	59.22	0.30	0.52	4.16	4.43	90.53	94.63	28.6	29.3
Milyang 97	3.51	3.59	73.80	79.60	67.91	70.73	55.22	59.85	0.42	0.43	6.32	6.23	66.32	65.47	28.4	29.7
BG 35	2.36	2.43	76.30	77.20	68.33	69.82	54.63	55.84	0.47	0.45	6.54	6.62	66.55	70.42	29.3	28.5
Cica 4	3.10	3.40	78.20	78.33	68.23	69.37	49.21	50.31	0.29	0.30	6.22	6.34	43.42	45.36	21.5	21.2
RD 23	2.90	2.60	79.10	79.76	68.36	68.95	57.56	58.83	0.25	0.30	4.24	4.11	65.84	75.22	30.3	29.5
GZ 1368	2.20	2.21	78.20	82.81	68.41	71.16	58.82	63.81	0.33	0.48	5.13	6.23	87.23	88.53	25.2	23.3
Rieho	3.10	3.30	77.60	83.13	69.22	71.34	60.71	62.32	0.45	0.49	6.36	6.36	55.15	55.64	23.2	22.3
Ratna	2.51	2.60	76.20	77.12	65.96	68.12	58.23	59.64	0.39	0.40	2.73	3.12	90.61	94.36	28.7	29.4
GZ 8372-13-1-3	2.21	2.36	82.30	83.21	73.82	75.13	68.67	66.71	0.50	0.69	6.14	6.26	91.32	95.25	18.3	17.6
GZ 8951-9-7-1-3	2.43	2.39	80.60	81.22	75.14	76.25	65.21	68.73	0.68	0.75	5.32	6.94	86.44	90.33	16.2	16.8
GZ 8455-6-8-3-1	2.34	2.23	81.20	82.43	73.32	74.72	66.15	68.32	0.62	0.54	2.51	3.22	90.56	92.25	18.6	17.2
GZ 8479-6-2-3-1	2.56	2.46	82.10	81.32	74.20	75.64	68.22	67.26	0.52	0.65	4.36	5.43	94.42	94.63	15.4	19.8
GZ 8494-2-1-3-1	2.22	2.33	79.40	80.40	71.31	73.26	65.33	65.91	0.49	0.52	5.42	6.96	93.23	94.22	18.3	17.9
Range from	1.76	1.79	73.80	77.12	65.40	68.10	49.21	50.31	0.25	0.30	2.51	3.12	43.24	45.36	15.4	16.8
to	3.51	3.59	82.60	83.82	75.15	76.25	68.67	69.51	0.82	0.83	6.54	6.96	98.62	98.43	30.3	29.7
Grand mean	2.29	2.43	78.98	80.56	70.69	72.44	62.09	63.88	0.51	0.56	5.37	5.83	82.19	83.91	21.93	21.79
L.S.D $_{0.05}$	0.63	2.21	3.62	3.17	2.67	1.97	4.63	3.87	4.63	3.28	1.42	0.99	0.21	0.22	3.72	4.37
L.S.D $_{0.01}$	1.67	1.36	4.17	3.66	3.14	2.48	5.24	6.64	5.22	4.37	1.97	1.82	0.34	0.41	4.56	5.24

Low amylose content % 16.8%, 17.2%, 17.6%, 17.9 %, 18.3 %, 18.4 %, 18.8 % and 18.9 % for GZ 8951-9-7-1-3, GZ 8455-6-8-3-1, GZ 8372-13-1-3-1, GZ 8484-2-1-3-1, Sakha 101, Sakha 103, Giza 178 and Giza 177 respectively. While Cica 4, Giza 176 and Rieho had intermediate amylose content (21.2 %), (21.9 %) and (22.3 %) respectively and high amylose content were determined for the other remaining genotypes. These results indicated that genotypes with low amylose content % was more sticky compared with that of including interaction or high amylose content%.

Genetic Parameters

Variance components, genetic variability, broad sense heritability and genetic advance are presented in table (5).

Table (5): Variance component, genotypic (G.C.V), phenotypic (P.C.V.) coefficient of variability, broad sense heritability (H%) and genetic advance (GS %) for grain yield and associated traits of 20 rice genotypes across two years and two locations.

Character	Component of Variance			Genetic variability		H^2B	Genetic advance	
	σ^2g	σ^2e	σ^2ph	G.C.V.	P.C.V.		G.S.	G.S %
Days to 50% heading	47.18	32.63	79.81	50.51	66.12	0.76	15.46	14.97
Plant height	31.62	21.81	52.43	32.32	42.37	0.80	18.28	19.38
Panicle length	18.30	15.92	30.62	29.17	39.52	0.52	5.94	25.46
No. of panicles/plant	5.17	3.24	8.41	11.73	19.46	0.66	6.28	26.59
No. of filled grains / panicle	61.03	40.59	101.62	78.26	96.31	0.75	10.94	10.08
Sterility %	5.45	3.97	9.32	15.14	25.62	0.62	4.62	23.65
100-grain weight	3.01	2.41	5.43	10.42	13.26	0.54	5.41	59.74
Grain yield/plant	27.32	9.63	36.95	18.44	22.53	0.43	6.92	19.95

The (σ^2g) was greater than that of (σ^2e) in all the studied characters for yield and its component. While, high estimates of phenotypic (σ^2ph) and genotypic (σ^2g) variances (101.62 and 61.03) were recorded for number of filled grains / panicle followed by 79.81 and 47.18 for days to 50% heading, 52.43 and 31.62 for plant height indicating better scope for the genetic improvement in these characters. These results indicated that days to 50% heading was more affected by the environmental condition than number of filled grains/panicle and plant height.

On the other hand, the extent of coefficient of variation showed that high estimates of genotypic (G.C.V.) and phenotypic (P.C.V.) were located for number of filled grains/panicle, days to 50% heading and plant height. These data indicated that these characters confirmed to be high variable, while a moderate influence of environment was indicated by nearly moderate estimates of abroad-sense heritability in most of them. Low values of G.C.V. for the remaining studied traits showed lack of inherent variability and limited scope for improvement through selection for these characters. Moreover, convenient estimates of G.C.V. coupled with high broad sense heritability and high genetic advance for plant height, days to 50% heading, number of filled grains/panicle and number of panicles /plant. These characters showed to be highly heritable, points to the predominance of additive gene effect, easily fixable and can be taken as unit characters for effective selection.

These results are in agreement with theose of Basavaraja *et al.*, (1997), Marekar and Siddiqui (1997), Kumar *et al.*, (1988), Singh *et al* ., (1998), Niranjana *et al.*, (1999), Sadhukhan and Chattopadhyay (2000) and El-Abd (2003).

Table (6) show estimates of phenotypic (σ^2ph), genotypic (σ^2g) and environmental variance (σ^2e), phenotypic coefficient of variation (P.C.V), genotypic coefficient of variation (G.C.V.), heritability in broad-sense (H%) and genetic advance% (G.S. %) for 8 rice grain quality characters. The genotypic variance (σ^2g) was greater than that of (σ^2e) in all grain quality characters except hulling % and grain elongation. The highest values of genotypic variance (σ^2g) and phenotypic variance (σ^2ph) were recorded for amylase content (9.87 and 15.13) followed by head rice % (6.47 and 10.73) and milling % (4.60 and 5.62) these results suggested that amylose content, head rice % and milling % were more affected by environmental condition more than the other characters study.

Table (6): Variance component, genotypic (G.C.V), phenotypic (P.C.V.) coefficient of variability, broad sense heritability (H%) and genetic advance (GS %) for grain quality characters of 20 rice genotypes across two years and two locations.

Character	Component of Variance			Genetic variability		h^2B	Genetic advance	
	σ^2g	σ^2e	σ^2ph	G.C.V.	P.C.V.		G.S.	G.S %
Grain shape	0.32	0.32	0.64	9.85	16.21	0.59	1.25	14.46
Hulling %	1.45	2.97	4.42	8.94	9.65	0.76	3.26	4.14
Milling %	4.60	1.02	5.62	7.97	8.42	0.79	9.26	9.51
Head rice %	6.47	4.26	10.73	15.82	20.71	0.69	8.13	11.34
Grain elongation	0.23	0.42	0.65	18.62	25.31	0.59	2.47	13.61
Gelatinization temperature	0.68	0.31	0.99	8.41	13.62	0.62	1.43	4.61
Gel consistency	2.31	0.48	2.97	3.14	3.52	0.81	12.79	42.83
Amylose content	9.87	5.26	15.13	23.21	24.81	0.65	4.63	2.83

Moreover, the phenotypic coefficient of variability (P.C.V), was greater than genotypic coefficient of variability (G.C.V.) for all studied characters. High (G.C.V) values were recorded for amylose content (23.21) followed by grain elongation (18.62), these findings indicated that the selection for improving these traits in early generation would be effective. The low values of (G.V.C) for the other remaining studied characters indicated lack of inherent variability and limited scope for improvement through individual plant selection and would be effective in late generations.

Heritability estimates were moderate to high for all studied characters. High heritability estimates were recorded for gel consistency (81%), followed by milling % (79%) and hulling % (76%) according to high genetic variability. The genetic advance could be an efficient parameter for effective selection for hulling %, milling %, head rice and amylose content in conjunction with genotypic (G.C.V.) coefficient for variability and for efficient genetic advance in these traits. Similar results were reported by Govidarasu and Natarajan (1995), Pathak and Sharma (1996), Chikkalingaiah *et al.*, (1999), El-Abd (1999), Sarawgi *et al.*, (2000) and El-abd (2003)

Phenotypic correlation coefficient among all possible pairs of the studied characters.

I-Phenotypic correlation coefficient among yield and it's related and grain quality characters at Sakha Farm Station:

As shown from table (7). The phenotypic correlation coefficient at Sakha Farm Station, were negatively significant for grain shape with plant height (-0.44), panicle length (-0.36),and negatively highly significant with no. of panicles /plant (-0.52), no. of filled grain/panicle (-0.41), and grain yield/plant (-0.42), while the positive significant and highly significant for grain shape with sterility % (0.38) and 100-grain weight (0.52).

Significant negative phenotypic correlations were found between hulling % and no. of panicles/plant (-0.48), no. of filled grain/panicle (-0.39), and grain yield/plant (-0.39), while correlation was positive with 100-grain weight (0.49).

On the other hand, negative significant correlations were recorded for milling % and head rice % with no. of panicles, no. of filled grain/panicle and grain yield/plant and the positive significant and highly significant were recorded for 100-grain weight with milling % and head rice %.

But the insignificant phenotypic correlation coefficient were recorded for the other remaining studied characters at Sakha farm station. These results are in agreement with those obtained by Basavaraja *et al.*, (1997), Marekar and siddiui (1997), Kumar *et al.,* (1998), El-Abd (1999), Chaudhari *et al.*, (2000), Sarawgi *et al.*,(2000), Abd El-lattef, *et al.,* (2006), El-Abd *et al* ., (2007) and Abd El-lattef and Badr (2007).

II- phenotypic correlation coefficient between yield and its related characters and grain quality characters at Gemmeiza Farm Station.

Data in table (7) show negative correlation between grain shape, hulling %, milling %, head rice % with plant height (-0.41), (0.31), (-0.28), panicle length (-0.45) no. of panicles/plant (-0.62), (-0.53),(-0.42), no. of filled grains/panicle (-0.52), (-0.42),(-0.35) and grain yield/plant (-0.48), (-0.50), (-0.42) and (-0.39) respectively. While the positive highly significant phenotypic correlation coefficient were recorded for grain shape %, hulling %, milling% and head rice% with days to 50% heading (0.38), (0.35), (0.36), sterility % (0.41), (0.38), (0.39), and 100-grain weight (0.61), (0.52), (0.48) respectively. On the other hand, the insignificant phenotypic correlation coefficient was recorded for the other remaining studied characters under Gemmeiza farm station. These data show strong phenotypic correlation coefficient between grain yield and its related characters with grain quality characters at Gemiza farm station comparing with Sakha Farm Station to environmental condition effect.

Table (7): Estimates of phenotypic correlation coefficient among grain yield and its related characters with grain quality characters at sakha and gemmiza over two years.

Character	Days to 50% heading	Plant height	Panicle length	No. of panicles /plant	No. of filled grains/panicle	Sterility %	100-grain weight	Grain yield/plant
Sakha Farm Station								
Grain shape	0.22	-0.44*	-0.36*	-0.52**	-0.41**	0.39*	0.52**	-0.42**
Hulling %	0.21	-0.25	0.14	-0.48**	-0.39*	0.30	0.49**	-0.39*
Milling %	0.18	0.21	0.25	-0.35*	-0.42**	0.28	0.38*	-0.45**
Head rice %	0.28	0.11	0.22	-0.29	-0.66**	0.24	0.40**	-0.44**
Gel consistency	0.15	0.13	0.15	0.18	0.14	0.28	0.28	0.32
Gelatinization temperature	0.20	0.12	0.26	0.22	0.28	0.16	0.18	0.28
Grain elongation	0.22	0.26	0.18	0.15	0.13	0.18	0.26	0.15
Amylose content	0.16	0.18	0.23	0.28	0.25	0.11	0.22	0.18
Gemmiza Farm Station								
Grain shape	0.38*	-0.41*	-0.45**	-0.92**	-0.52**	0.41**	0.61**	-0.48**
Hulling %	0.35*	-0.31*	0.29	-0.53**	-0.42**	0.38**	0.52**	-0.50**
Milling %	0.36*	-0.28*	0.18	-0.42**	-0.35*	0.39**	0.48**	-0.42**
Head rice %	0.37*	0.25	0.27	-0.38*	-0.48**	0.38*	0.51**	-0.39*
Gel consistency	0.18	0.25	0.15	0.25	0.25	0.13	0.38*	0.28
Gelatinization temperature	0.26	0.18	0.28	0.28	0.30	0.25	0.25	0.29
Grain elongation	0.22	0.26	0.13	0.19	0.22	0.12	0.16	0.30
Amylose content	0.15	0.22	0.11	0.22	0.18	0.12	0.23	0.18

* and ** significant and highly significant at 0.05 and 0.01 levels, respectively

III- Phenotypic correlation coefficients among all possible pairs of yield and its related characters and grain quality characters.

The phenotypic correlation coefficients were estimated among all possible combinations of yield and its related characters and grain quality characters (table 8).

Positive significant or highly significant phenotypic correlation coefficient was recorded for panicle length with no. of panicles /plant (0.46), no. of filled grains / panicle (0.52). Also sterility % with plant height (0.39), no. of panicles / plant (0.43) and 100-grain weight (0.68), Also grain shape with no. of field grains / panicle (0.42) and 100 grain weight (0.62). hulling % with 100 grain weight (0.48) and grain shape (0.44), milling % with 100 grain weight (0.41), grain shape (0.48) and hulling % (0.54), head rice % with 100 grain weight (0.39), grain shape (0.42), hulling % (0.62) and milling % (0.45), gelatinization temperature with gel consistency (0.55), grain elongation with grain shape (0.42) and gelatinization temperature (0.39), amylose content with gel consistency (0.39) and grain elongation (0.42) and grain yield / plant with panicle length (0.49), no. of panicles / plant (0.66), no. of field grains / panicle (0.52), 100 grain weight (0.51), grain shape (0.42), hulling % (0.45), milling % (0.39) and head rice (0.52).

Table (8): Estimates of phenotypic correlation coefficient among all possible pairs of yield and its related characters and grain quality characters over two locations, and two years (2006 and 2007).

Character	Days to 50% heading	Plant height	Panicle length	No. of panicles/ plant	No. of filled grains/ panicle	Sterility %	100-grain weight	Grain shape	Hulling %	Milling %	Head rice %	Gel consistency	Gelatinization temperature	Grain elongation	Amylose content
Days to 50% heading	--														
Plant height	-0.44**	--													
Panicle length	0.25	0.28	--												
No. of panicles/plant	0.36	0.32	0.46**	--											
No. of filled grains/panicle	0.38	-0.40**	0.52**	-0.42**	--										
Sterility %	0.26	0.39*	-0.41**	0.43**	-0.48**	--									
100-grain weight	-0.40**	-0.42**	-0.39*	-0.41**	-0.39*	0.68**	--								
Grain shape	0.39	-0.38	-0.32	-0.37	0.42**	0.32	0.62**	--							
Hulling %	0.25	0.11	0.25	0.28	0.33	0.25	0.48**	0.44**	--						
Milling %	0.18	0.15	0.26	0.36	0.22	0.31	0.41**	0.48**	0.54**	--					
Head rice %	0.26	0.12	0.31	0.22	0.34	0.28	0.39*	0.42**	0.62**	0.45**	--				
Gel consistency	0.12	0.23	0.25	0.28	0.26	0.19	0.28	0.36	0.22	0.36	0.13	--			
Gelatinization temperature	0.14	0.18	0.28	0.12	0.21	0.25	0.16	0.25	0.28	0.32	0.26	0.55**	--		
Grain elongation	0.22	0.26	0.16	0.26	0.11	0.28	0.25	0.42**	0.32	0.25	0.32	-0.42**	0.39*	--	
Amylose content	0.15	0.19	0.22	0.18	0.28	0.26	0.32	0.26	0.25	0.18	0.21	0.39*	0.32	0.42**	--
Grain yield/ plant	-0.48**	-0.41**	0.49**	0.66**	0.52**	-0.47**	0.51**	0.42**	0.45**	0.39*	0.52**	0.25	0.15	0.26	0.31

* and ** significant and highly significant at 0.05 and 0.01 levels, respectively

Negative significant or highly significant phenotypic correlation coefficient were recorded for plant height with days to 50 % heading (-0.44), no. of field grains / panicle with plant height (-0.40) and no of panicle / plant (-0.42), sterility % with panicle length (-0.41) and no of field grains / panicle (-0.48), 100-grain weight with days to 50 % heading (-0.40), plant height (-0.42), panicle length (-0.39), no. of panicle / plant (-0.41) and no. of field grains / panicle (-0.39), grain elongation with gel consistency (-0.42) and grain yield/plant with days to 50% heading (-0.48), plant height (-0.41) and sterility % (-0.47).

But the insignificant positive or negative phenotypic correlation coefficient was recorded for other remaining studied character as shown in table (8). These results were agreement with those obtained by Singh *et al*., (1997), Mokate *et al*., (1998), Meeanakshi *et al*., (1999), Chaudhari *et al*., (2000) ,Abd –El-lattef (2004), Abd –El-lattef et al. (2006) and ,Abd –El-lattef and Badr (2007).

Finally, from the forgoing results the most desirable mean values were detected from the genotypes, GZ 8951-9-7-1-3, Sakha, 101, GZ 8372-13-1-3-1, Sakha 104, Giza 176, GZ 8494-2-1-3-1, Sakha 102, Giza 178, GZ 8455-6-8-3-1 and Sakha 103for most of all studied characters at Gemmiza farm station.

Grain yield / plant character was strongly phenotypic correlation positive or negative with many of other characters as days to 50% heading, plant height, panicle length, no. of panicles/plant, no. of filled grains/panicle, sterility %, 100-grain weight, grain shape, hulling %, milling % and head rice % at Gemmiza farm station indicating that these genotypes affected by the interaction between genotypes and environmental condition.

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تأثير التفاعل بين التركيب الوراثي والبيئة والاختلافات الوراثية علي صفات المحصول ومكوناته وصفات الجودة في الأرز

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أجريت هذه الدراسة بمزرعة مركز البحوث الزراعية بمنطقتين هما محطة البحوث الزراعية بسخا ومحطة البحوث الزراعية بالجميزة خلال موسمين زراعيين (٢٠٠٦-٢٠٠٧) وذلك بهدف دراسة تأثير التفاعل الوراثي والبيني والاختلافات الوراثية ودرجة التوريث بمعناها الواسع والنسبة المئوية للتحسين الوراثي المتوقع من الانتخاب بنسبة ٥% وتقدير معامل التلازم المظهري لعدد١٥ صنفا اشتملت علي أهم الأصناف الحديثة والمنزرعة ومقارنتها بعدد ٥ سلالات مبشرة حيث تم دراسة ثماني صفات للمحصول ومكوناته وهي عدد الأيام حتي ٥٠% تزهير - طول النبات - طول الدالية- عدد الداليات للنبات الفردي- عدد الحبوب الممتلئة بكل دالية-النسبة المئوية للعقم - وزن ١٠٠حبة- محصول النبات الفردي من الحبوب. كما درست ثماني صفات للجودة وهذه الصفات هى: شكل الحبة- نسبة التقشير- نسبة التبييض- تصافي نسبة التبييض -نسبة استطالة الحبة بعد الطهي- نسبة الجل بالحبة- درجة حرارة الجلتنه- نسبة الأميلوز بالحبة .

أوضحت النتائج المتحصل عليها ما يلي :

كان هناك تأثير معنوي جداً لتفاعل الصنف مع منطقة الزراعة لمعظم الصفات المدروسة مثل طول النبات - طول الدالية- عدد الداليات للنبات الفردي- عدد الحبوب الممتلئة بكل دالية - محصول النبات الفردي بينما في حالة التفاعل بين التركيب الوراثي مع الموقع مع السنة فقد كان هناك تاثير معنوي فقط لنسبة تصافي التبييض بينما كانت هناك معنوية عالية لكل الصفات المدروسة

كما أوضحت النتائج أن أعلي قيم لكل من معامل الاختلافات الوراثي والبيئي قد سجلت لكل من عدد الحبوب الممتلئة بالدالية-عدد الأيام حتي ٥٠% تزهير - نسبة الأميلوز بالحبة- ونسبة الاستطالة بعد الطهي وكذلك نسبة تصافي التبييض كما تراوحت درجة التوريث في المدي الواسع من متوسطة إلي عالية واختلفت باختلاف الصفات المدروسة كما تراوحت النسبة المئوية للتحسين الوراثي المتوقع من الانتخاب من منخفضة الي عالية في معظم الصفات المدروسة لارتباطها بدرجة التوريث.

كما أشارت النتائج إلي وجود ارتباط معنوي جداً لمحصول النبات الفردي مع معظم الصفات المدروسة مثل عدد الداليات بالنبات الفردي -عدد الحبوب الممتلئة بالدالية- وزن ١٠٠ حبة - نسبة العقم. كما كانت العلاقات بين الصفات المدروسة اكثر ارتباطا فى مزرعة الجميزة عنها فى مزرعة سخا.

بناءا علي النتائج المشار إليها سجلت التراكيب الوراثية التى تشمل كل من الصنف سخا ١٠١ والسلالة المبشرة جى زد ٨٩٥١-٩-٧-١-٣ والسلالة المبشرة جى زد ٨٣٧٢-١٣-١-٣-١ والصنف سخا ١٠٤ والصنف جيزة ١٧٦ والسلالة جى زد ٨٤٩٤-٢-١-٣-١ والصنف سخا ١٠٢ والصنف ١٧٨ والسلالة المبشرة جى زد ٨٤٥٥-٦-٨-٣-١ أفضل قيم للمتوسطات لكل من صفات محصول النبات وصفات الجودة كما كان هناك ارتباط معنوى موجب وسالب بين صفة محصول النبات الفردى من الحبوب وبين العديد من الصفات الاخرى سواء مكونات المحصول وايضا صفات الجودة تحت ظروف مزرعة البحوث الزراعية بالجميزة مما يشير الى ان انتاج التراكيب الوراثية من الحبوب ماهو الا محصلة التفاعل بين التراكيب الوراثية والبيئة ولعب ما يعرف بالوراثة المكانية (genetic zone) دورا هام جدا فى زيادة الانتاجية لدى بعض التراكيب الوراثية عن البعض الاخر.