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GENETIC VARIABILITY, HERITABILITY AND ASSOCIATIONS BETWEEN YIELD ATTRIBUTES AND GRAIN QUALITY TRAITS IN RICE (*Oryza sativa* L.)

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ABSTRACT

Information on genotypic (GCV) and phenotypic (PCV) coefficients of variability, broad sense heritability, genetic advance and phenotypic correlation coefficients were obtained for 22 yield attributes and several grain quality characters of 24 local and exotic rice genotypes grown at the farm of Rice Research and Training Center, Sakha,Kafr El-Sheikh , Egypt during 2001 and 2002 seasons.

Results revealed that 100-grain weight, number of filled grains/panicle, grain elongation, days to 50% heading, number of panicles/plant, and grain yield/plant had high coefficient of variation at both the genotypic (GCV) and phenotypic (PCV) Levels. Broad-sense heritability estimates were low to high for all characters studied and ranged from 30% to 89% for grain elongation and panicle weight, respectively. Expected genetic gain as a percentage of the population mean was high for most studied traits. However, high heritability coupled with high genetic advance were recorded for 100-grain weight, panicle weight, number of primary branches/panicle, grain shape, grain length and panicle length suggesting the preponderance of additive gene effects in the expression of these traits.

Grain yield/plant exhibited positively strong positive-correlation with number of panicles, panicle weight, number of primary branches/panicle, and number of filled grains/panicle, but it was negatively associated with sterility % and Hulling %. Gelatinization temperature was significantly positively correlated with grain length, grain elongation and amylose content (%).

Key words: ***Rice, Genetic variability, Genetic advance, Heritability, Correlation, Yield components, Grain quality characters.***

INTRODUCTION

Rice is one of the principal cereals world wide. The hope for improved nourishment of the worlds population depends on the development of better rice varieties. Breeders should recognize their obligation to make available information concerning newly discovered sources of important characters. Rice breeders are particularly fortunate because many important characters are simply inherited and major genes seem to play an unusually prominent role in quantitative inheritance. Despite this, unfavorable genetic linkages have never prevented the recombination of any important characters. Jennings *et al* (1979).

Success in crop improvement relies on the magnitude of genetic variability and the extent to which the desirable characters are heritable. The estimates of variability in respect of yield, its heritable components in the material with which the breeder is working are therefore, prerequisites for any breeding programme. Hence, it 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. Heritable improvement in the yield is an ultimate aim of plant breeders which calls for selection on the basis of yield components which are heritable.

Keeping the foregoing in view, the present study was undertaken on a fairly large number of Egyptian and exotic rice varieties to study the extent genetic variability, heritability and expected genetic advance for yield, its attributing traits and some cooking and eating quality traits and determine the association between all possible pairs of the studied traits.

MATERIALS AND METHODS

The present investigation was carried out at the Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2001 and 2002 rice growing seasons. The objectives were to estimate the genetic variability, heritability, genetic advance and phenotypic correlation coefficients among all possible pairs of yield and grain quality traits of 24 rice genotypes including 13 prominent Egyptian varieties and 11 exotic adapted varieties introduced from the various rice growing regions of the world.

The experiment was laid out in a randomized complete block design with three replications. Thirty days old seedling of each genotype were individually transplanted in 10-rows/replicate. Rows were 5 m long, 20 cm apart with 20 cm between plants. Normal cultural practices were followed in both seasons.

At harvesting, 10 competitive plants/replicate were randomly selected to record observations on yield and its attributes, viz., days to 50% heading, plant height (cm), number of panicles/plant, panicle length, panicle weight, number of primary branches/panicle, number of filled grains/panicle, 100-grain weight, sterility % and grain yield /plant according to the standard evaluation system for rice IRRI (1996). Meanwhile, observation for various grain quality traits were made on the basis of a composite seed sample from the selected plants from each replicate. The quality characteristics studied included hulling %, milling %, head rice %, grain length, grain shape, gelatinization temperature, grain elongation, gel consistency and amylose content %.

Grain length was determined as average of 15 grains of rough rice per genotype. Grain shape, hulling %, milling % and head rice % were estimated according to Khush *et al.* (1979). Amylose content % was estimated by the method outlined by Williams *et al.* (1958). Gelatinization temperature was measured in terms of alkali disintegration, six uniformly milled grains/replicate were placed in small petri plate containing 1.7 % KOH solution at 30 ±1°C for 14 hours. Samples were scored for the nature and degree of disintegration following the procedure outlined by IRRI (1975). Moreover, gel consistency was measured as described by Cagampang *et al* (1973). Proportionate change in the length / width ratio of grain on cooking was used as criterion to measure grain elongation in the present study, this criterion takes into consideration change in both length and width of grain on cooking. The proportionate change (PC) in L/W ratio was calculated (Sood and Siddiq, 1980) as shown below:

$$PC = \frac{L_f / W_f - L_o / W_o}{L_o / W_o}$$

Where, L_f, W_f: Length and width of the grain after cooking; Lo, Wo: Length and width of the grain before cooking, respectively. The following criterion was adapted for classifying varieties with respect to grain elongation:

Degree of elongation	Proportionate change (PC)
Very high	> 1.00
High	0.70 – 1.00
Medium	0.40 – 0.69
Low	0.10 - 0.39
Poor	< 0.10

The data thus obtained for each character was statistically combined over the two seasons according to Le Clerg *et al* (1962). The phenotypic and genotypic coefficients of variability (PCV, GCV), broad-sense heritability and expected genetic advance at 5% selection intensity were computed by using formulae suggested by Johnson *et al* (1955). The ghenotypic correlation coefficients were calculated as per the method of Dewey and Lu (1959).

RESULTS AND DISCUSSION

Per se performance of genotypes

Table (1) illustrates that wide range of variability was recorded for all the studied characters, suggesting the presence of significant genetic variability during studied genotypes. Days to 50% heading varied from 90 days in Sakha 103 to 123 days in Giza 171. Giza 177, Shin 2, Hexi 5, Suweon 351 and Sakha 102 were the earliest rice genotypes compared with the latest genotypes, Giza 171, Giza 172, Egyptian Yasmin, Kim Rad F_{87} and Giza 176. Plant height ranged between 90.33 cm in Sakha 101 and 138.67 cm in Giza 172, the most desirable plant height was disclosed in Sakha 101, Shin 2, Giza 175, Giza 181, Giza 177 and Giza 182 which having a short plant height, hence, its was resistant to lodging. On the contrary, the genotypes, Giza 171 and Giza 172 had the tallest plant height 134.67 and 138.67 cm, respectively.

In addition, number of panicles/plant varied from 18.00 in Giza 172 to 26.33 in Giza 178, which were numerous in Giza 178 followed by Giza 175 and Egyptian Yasmin. However, length and weight of panicle varied widely from 18.25 in Hexi 5 to 27.45 in Egyptian Yasmin, and from 2,42 in Hexi 5 to 5.24 in Kim Rad F_{87}, respectively. The heaviest panicle weight was recorded in Giza 175, Milyang 97, Giza 176, Sakha 101 and Toride 1 rice genotypes. Number of primary branches/panicle was ranged between 6.93 and 13.00 branch in Hexi 5 and Giza 176, respectively.

More filled grains/panicle were displayed by Sakha 101 followed by Sakha 104, TKY 1014, Pi No. 4, Giza 171 and Giza 178. Furthermore, high mean values of 100-grain weight were detected in Giza 181, Egyptian Yasmin, Giza 182, Kim Rad F_{87}, Sakha 101 and Sakha 104. Meanwhile, the lowest estimates of sterility % were observed in Giza 171, Giza 176, Sakha 101, Hexi 5, Sakha 104 and Giza 172 rice genotypes. Greatly, the Egyptian rice varieties namely, Sakha 101, Sakha104 and Giza178 besides the exotic variety, TKY 1014 were high yielding and superior rice varieties compared with other rice genotypes.

Distinctly, as shown in Table (2) the mean values of hulling % and milling % varied from 75.36% to 82.77 and from 66.21 to 75.38 in TKY 1014 and Giza 171 rice genotypes, respectively. However, Pi No.4 rice variety has the highest head rice % followed by Giza 171 and Sakha 101, while low estimates were recorded in Kim Rad F_{87}, TKY 1014, Shin 2 and Egyptian Yasmin. In addition, length of rough grain varied from short 7.01 mm in Hexi 5 to long 10.64 mm in Giza 182. The length/width (L/W) ratio of milled grains was ranged between 2.03 mm in Pi No. 4 to 4.35 mm in Egyptian Yasmin. Meanwhile, most of the studied rice genotypes had bold

Table 1. Range and mean performance for yield and yield component characters of 24 Egyptian and exotic rice varieties, 2001 and 2002 seasons (Combined data).

Genotypes	Origin	Heading 50 %	Plant height	Panicles /plant	Panicle length	Panicle weight	Branches /panicle	Filled G./P.	100 G. W.	Sterility %	Grain Y. / P.
Giza 171	Egypt	123	134.67	19.33	20.45	5.11	11.57	133	2.40	5.15	36.53
Giza 172	Egypt	120	138.67	18	21.79	3.85	10.47	122	2.25	6.73	35.18
Giza 175	Egypt	103	96	23	25.41	5	11.15	127	2.17	9.95	42.39
Giza 176	Egypt	110	101	20.67	24.16	4.43	13	114	2.44	5.45	43.64
Giza 177	Egypt	92	98.33	19.67	21.03	3.37	11.02	115	2.51	7.08	40.16
Giza 178	Egypt	104	98	26.33	23.57	4.44	11.20	130	2.12	8.23	44.46
Sakha 101	Egypt	111	90.33	22.67	23.74	4.59	11.87	157	2.54	6.19	46.53
Sakha 102	Egypt	94	105	20	20.43	3.95	11.92	141	2.44	6.90	42.73
Sakha 103	Egypt	90	101.67	19	21.04	4.13	11.70	138	2.34	7.09	41.26
Sakha 104	Egypt	102	106.67	21.33	20	4.36	10.55	150	2.53	6.34	45.43
Giza 181	Egypt	112	97.67	19.33	21.95	3.67	9.20	129	2.74	7.13	42.05
Giza 182	Egypt	109	98.67	20.67	24.26	3.44	10.23	131	2.60	7.51	42.42
E. Yasmin	Egypt	119	104.33	22	27.45	5.11	11.93	128	2.73	8.75	42.92
Kim Rad F87	Japan	114	109.67	20	22.99	5.24	12.38	124	2.57	7.14	40.51
TKY 1014	Japan	101	122.67	21.33	22.13	3.73	11.87	141	2.17	10.62	44.15
IET 1444	India	105	122.33	19	23.18	4.29	10.53	125	2.30	8.82	39.81
Milyang 97	Korea	95	115.33	20.67	26.62	4.15	10.40	129	2.27	9.35	42.81
Suweon 531	Korea	93	98.67	19.33	19.68	2.77	9.85	115	2.14	7.77	37.14
BG 35-2	Sri Lanka	107	106	18.67	22.58	3.10	10.47	116	2.10	9.64	35.16
Toride 1	Japan	103	113.67	19.67	24.47	4	10.47	112	2.17	10.69	36.73
Pi No. 4	Japan	95	106	20.33	22.36	3.29	10.55	141	2.43	8.27	41.65
Shen 2	Japan	92	93.67	19	22.77	3.56	9.77	122	2.39	7.87	39.74
BL 1	Japan	94	115	19.33	23.52	3.50	10	125	2.19	7.62	40.79
Hexi 5	China	92	107.33	19	18.25	2.42	6.93	105	2.44	6.25	32.09
Range		90-123	90.33-138.67	18-26.33	18.25-27.45	2.42-5.24	6.93-13	105-157	2.10-2.74	5.15-10.69	32.09-46.53
L.S.D. 0.05		8.32	5.14	3.37	1.51	0.45	1.36	10.85	1.55	2.17	3.90
L.S.D. 0.01		15.14	9.36	6.14	2.75	0.81	2.47	19.76	3.83	3.96	7.10

Table 2. Range and mean performance for rice grain quality characters of 24 Egyptian and exotic rice varieties, 2001 and 2002 seasons (Combined data)

Genotypes	Origin	Hulling %	Milling %	Head rice %	Grain length	Grain shape	G. T.	Grain elong.	G. C.	A. C. %
Giza 171	Egypt	82.77	75.38	68.85	7.54	2.44	6.00	0.80	96.00	19.57
Giza 172	Egypt	82.40	74.66	68.00	7.24	2.19	6.00	0.70	98.00	17.70
Giza 175	Egypt	79.67	71.70	65.75	7.34	2.79	4.67	0.47	64.00	29.43
Giza 176	Egypt	77.67	71.71	63.86	7.65	2.20	5.67	0.17	67.67	19.90
Giza 177	Egypt	82.13	73.40	66.54	7.62	2.29	7.00	0.66	78.67	19.60
Giza 178	Egypt	78.03	70.76	64.72	7.46	2.59	4.67	0.19	71.33	19.57
Sakha 101	Egypt	81.13	73.48	68.68	7.65	2.10	6.00	0.89	99.00	18.70
Sakha 102	Egypt	78.33	72.25	67.53	7.57	2.14	6.00	0.71	89.33	18.60
Sakha 103	Egypt	79.90	70.00	65.55	7.48	2.11	6.00	0.81	95.67	19.10
Sakha 104	Egypt	77.62	71.08	67.77	7.34	2.06	7.00	0.71	97.67	19.30
Giza 181	Egypt	78.92	69.23	65.36	10.23	3.45	6.00	0.21	87.00	19.63
Giza 182	Egypt	77.47	68.20	65.03	10.67	3.45	5.00	0.18	88.00	19.53
E. Yasmin	Egypt	77.34	68.56	61.80	10.55	4.35	4.67	0.17	69.00	19.00
Kim Rad F87	Japan	79.37	75.38	58.73	7.78	2.19	4.67	1.12	94.00	16.70
TKY 1014	Japan	75.36	66.21	59.65	7.54	2.41	6.00	0.90	92.33	21.31
IET 1444	India	81.44	70.25	66.12	10.54	3.41	5.67	0.36	90.67	24.07
Milyang 97	Korea	78.22	71.93	66.89	10.47	3.60	5.33	0.24	84.00	16.31
Suweon 531	Korea	80.49	72.35	67.89	7.43	2.13	5.33	0.09	73.33	16.08
BG 35-2	Sri Lanka	78.49	73.54	69.59	7.18	2.40	6.00	0.20	52.33	22.50
Toride 1	Japan	81.53	70.83	66.69	7.55	2.26	5.00	0.06	59.33	21.07
Pi No. 4	Japan	82.69	72.80	70.64	8.01	2.03	5.00	0.25	79.33	16.43
Shen 2	Japan	79.32	70.86	60.10	7.16	2.38	5.67	0.05	56.00	16.85
BL 1	Japan	79.45	71.17	67.51	8.98	2.90	5.67	0.61	95.00	16.40
Hexi 5	China	82.13	72.39	63.97	7.01	2.23	5.67	0.06	48.00	17.55
Range		75.36-82.77	66.21-75.38	58.73-70.64	7.01-10.64	2.03-4.35	4.67-7.00	0.05 1.12	48.00-99.00	16.08-29.43
L.S.D. 0.05		1.76	1.61	3.17	1.75	0.67	0.94	0.82	1.02	4.09
L.S.D. 0.01		3.21	2.93	5.77	3.19	1.22	1.71	1.49	1.86	7.44

(coarse) grain shape 2 mm to 3 mm, while, grain shape was ranged between 3.1 mm and 4 mm in four rice genotypes namely, Giza 181, Giza 182, IET 1444 and Milyang 97 suggesting that these genotypes had fine (slender) grain shape, while only Egyptian Yasmin has a long grain shape (more than 4 mm).

Gelatinization temperature as measured by alkali digestion scores was found to vary from intermediate in four rice genotypes, Giza 175, Giza 178, Egyptian Yasmin and Kim Rad F_{87} to low in other remaining genotypes, indicating that the rice genotypes under study need a short time when cooked conduce to save energy. Furthermore, it is customary to use liner expansion as the measure of grain elongation. But this seems to be a poor measure, as it fails to take into account the widthwise swelling which is independent of lengthwise swelling. Hence, proportionate change in the L/W ratio of grain on cooking as detailed under material and methods was taken as the measure of elongation in the present study. The results revealed wide variation for this trait, the range being from poor (0.05) to very high (1.12) in Shin 2 and Kim Rad F87, respectively. Seven out of the twenty four studied genotypes were showing elongation exceeding 0.7, which exhibited high grain elongation, while, Suweon 351, Toride 1, Shin 2 and Hexi 5 were found to be the poor grain elongated rice genotypes. (less than 0.1). On the other hand, gel consistency was ranged from medium (Legth of gel, 41 to 60 mm) in flaky rices, Hexi 5, BG 35-2, Shin 2 and Toride 1 to soft gel consistency (length of gel more than 60 mm) in other remaining genotypes, which subsist a soft grain for a long time after cooking. However, the amylose content % varied from 16.08% in Suweon 351 to 29.43% in Giza 175. It was of considerable interest to note that a majority of the genotypes under study showed less than 20% amylose especially in all Egyptian rice varieties except Giza 175, which has amylose content % more than 25 per cent. Moreover, intermediate amylose content % were observed for four exotic genotypes viz, TKY 1014, IET 1444, BC 35-2 and Toride 1. Varieties with low amylose content % were more sticky compared with that of including intermediate or high amylose content %.

Genetic parameters

Estimates of components of variance, phenotypic (σ^2ph), genotypic (σ^2g) and environmental (σ^2e) variances; phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad-sense heritability (B^2 h) for yield and its attributes traits are presented in Table (3). The results illustrated that the magnitude of genotypic variance was grater than that of environmental variance for all the studied traits. However, high estimates of phenotypic (σ^2ph) and genotypic (σ^2g) variances were observed for number of filled grains / panicle followed by days to 50 % heading, plant height and

Table 3. Estimates of component of variance; genotypic (GCV) and phenotypic (PCV) coefficients of variability; broad-sense heritability (h^2B)and the expected genetic advance (G.S.%) for yield and its attributes characters

Characters	Grand Mean	Component of variance			Genetic variability		h^2B	Genetic advance	
		σ^2g	σ^2e	σ^2ph	GCV	PCV		G. S.	G.S.%
Days to 50% heading	103.33	53.77	24.24	77.90	51.94	75.39	69	12.53	12.12
Plant height (cm)	107.56	37.37	9.25	46.62	34.74	43.35	80	11.27	10.48
No. of panicles/plant	20.35	6.16	3.98	10.14	30.27	49.85	61	3.98	19.58
Panicle length (cm)	22.66	5.33	0.80	6.13	23.52	27.06	87	4.43	19.57
Panicle weight (g)	3.82	0.60	0.07	0.67	15.65	17.50	89	1.51	39.47
No. of primary branches/panicle	10.79	1.90	0.65	2.55	17.65	23.64	75	2.46	22.77
No of filled grains/panicle	127.92	71.73	41.26	112.99	56.07	88.33	63	13.90	10.87
Sterility %	7.77	1.79	1.65	4.44	23.02	44.32	52	1.96	25.56
100- grain weight (g)	2.37	1.46	0.85	2.31	61.75	97.44	63	1.98	83.71
Grain yield / plant	40.68	13.66	5.33	18.98	33.57	46.67	72	6.46	15.87

Table 4. Estimates of component of variance; genotypic (GCV) and phenotypic (PCV) coefficients of variability; broad-sense heritability (h^2B)and the expected genetic advance (G.S.%) for grain quality characters

Characters	Grand mean	Component of variance			Genetic variability		h^2B	Genetic advance	
		σ^2g	σ^2e	σ^2ph	GCV	PCV		G. S.	G.S.%
Hulling %	79.70	3.81	1.09	4.90	7.78	6.14	78	3.55	4.45
Milling %	71.60	4.63	0.91	5.54	6.47	7.74	84	4.06	5.66
Head rice %	65.72	8.49	3.52	12.00	12.91	18.27	71	5.05	7.68
Grain length (mm)	8.16	1.26	1.07	2.34	15.47	28.62	54	1.70	20.85
Grain shape (mm)	2.59	0.33	0.16	0.49	12.78	18.85	68	0.98	37.68
Gelatinization temperature	5.61	0.32	0.31	0.63	5.70	11.21	51	0.83	14.8
Grain elongation	0.44	0.10	0.24	0.34	22.73	77.27	30	0.36	81.82
Gel consistency	80.24	0.95	0.37	1.32	1.18	1.65	72	1.39	0.49
Amylose content	19.37	6.70	5.85	12.55	34.59	64.79	53	3.90	20.13

grain yield/plant indicating better scope for the genetic improvement in these characters. Moreover, the extent of coefficients of variation indicated that high estimates of genotypic (GCV) and phenotypic (PCV) coefficients of variability were exhibited for 100-grain weight, number of filled grains/panicle, days to 50% heading, plant height, number of panicles/plant and grain yield/plant. These findings detected that these specified characters confirmed to be highly variable, whereas a moderate influence of environment were indicated by nearly moderate estimates of broad-sense heritability in most of them.

On the other hand, convenient estimates of GCV coupled with high broad-sense heritability and high genetic advance were exhibited for panicle length, panicle weight, number of primary branches / panicle and grain yield / plant, meanwhile, there were not much difference between PCV and GCV, thus, these characters showing to be highly heritable, points to the predominance of additive gene effect, easily fixable and can be taken as unit characters for effective selection. Sadhukhan and Chattopadhyay (2000) had been reported that grain yield / plant had high phenotypic (PCV) and genotypic (GCV) coefficients of variation. However, the highest estimates of GCV was noted in number of grains / panicle, while, 100-grain weight and plant height traits had moderate to high estimates of GCV and PCV values. They also added that broad-sense heritability estimates were moderate to high for all the characters studied. The results are in confirmatory with those of Roy *et al.* (1995), Manonmani *et al* (1996), Reddy and Kumar (1996), Basavaraja *et al.* (1997), Marekar and Siddiqui (1997), Saravanan and Senthil (1997), Singh *et al.* (1997), Kumar *et al.* (1998), Mokate *et al* (1998). Singh *et al* (1998) and Niranjana *et al* (1999).

Conspicuously, Table (4) shows that the genotypic variance was prominent than that of environmental variance for grain quality characters except grain elongation. However, (σ^2g) and (σ^2e) variances were approximately equivalent in case of gelatinization temperature indicating the influence of environmental components of variation on the expression of these two mentioned characters. The phenotypic (PCV) coefficients of variability estimates were larger than the genotypic (GCV) coefficients of variability for all the studied grain quality characters, the highest estimated values of both (PCV) and (GCV) were recorded in grain elongation, amylose content %, grain length, grain shape and head rice %. Moreover, the broad-sense heritability estimates ranged from 30% in grain elongation to 84% in milling %. Among the studied characters, only grain elongation exhibited lower magnitude of heritability, while, grain length, grain shape, gelatinization temperature and amylose content % traits disclosed moderately high estimates of heritability (more than 50%). In addition, high estimates of heritability were detected for milling %, hulling %, gel consistency and head rice %, their investigated values were 84%, 78%, 72% and 71%, respectively, thus the criteria for selection might be selected from among these characters.

The expected genetic advance exhibited considerable range (0.48 to 37.68%) for the traits. Grain shape expressed the highest estimate value of genetic advance (37.68%) followed by grain length (20.85%), amylose content % (20.10%) and gelatinization temperature (14.80%). These findings illustrated that considerable level of improvement could be achieved in these traits by selection from segregating population. The results of the present study revealed that the genetic advance could be most efficient parameter for effective selection and, hence, heritability alone should not be considered. Thus, it should be in conjunction with genotypic (GCV) coefficient of variability and for efficient genetic advance in the traits both the parameters must be considerably high viz, amylose content%, grain length, and grain shape. These three traits expressed high genetic advance with high genotypic (GCV) coefficients of variability. Sarawgi *et al.* (2000) had been reported that the heritable component of variation was relatively high in grain shape, grain length, gel consistency and gelatinization temperature. They also annexed that heritability coupled with genetic advance was high for gel consistency, gelatinization temperature and grain shape. Similar results were reported previously by Marekar and Siddiqui (1994), Govidarasu and Natarajan (1995), Pathak and Sharma (1996), Chikkalingaiah *et al.* (1999), El-Abd (1999) and Sadhukhan and Chattopadhyay (2000).

3- Phenotypic correlation coefficients.

The Phenotypic correlation coefficients among all possible pairs of yield attributes traits are presented in Table (5). Lucidly, grain yield/plant was positively and strongly-correlated with each of number of panicles/ plant (0.768), number of primary branches/panicle (0.606), panicle weight (0.539), panicle length (0.356) and 100-grain weight (0.280), these findings indicated that these mentioned characters are the principle yield components. Therefore, any selection based on these characters will bring the desired improvement in grain yield/plant. However, plant height showed significant negative correlation with grain yield/plant.

Moreover, among yield attributes traits, days to 50% heading was highly significantly and positively correlated with number of primary branches/panicle and number of filled grains/panicle. Furthermore, plant height was positively and significantly correlated with sterility %, while, it was negatively and significantly associated with number of panicles/plant and number of filled grains/panicle. However, number of panicles/plant was highly significantly and positively correlated with each of panicle length,

Table 5. Estimates of phenotypic correlation coefficients among all possible pairs of yield and its attributes characters over two seasons (2001 and 2002)

Characters	1	2	3	4	5	6	7	8	9
1-Days to50% heading	1								
2-Plant height (cm)	0.142	1							
3-No. of panicles/plant	0.085	-0.470**	1						
4-Panicle length (cm)	-0.042	-0.034	0.441**	1					
5-Panicle weight (g)	0.261	0.126	-0.451**	0.614**	1				
6-No. of primary branches/panicle	0.366**	0.021	0.403**	0.402**	0.716**	1			
7-No of filled grains/panicle	0.357**	-0.288*	0.624**	0.334*	0.594**	0.526**	1		
8-Sterility %	0.158	0.308*	0.078	0.469**	-0.316*	0.076	-0.297*	1	
9-100- grain weight (g)	0.033	-0.199	0.021	-0.004	0.087	-0.202	-0.051	-0.132	1
10-Grain yield / plant	0.212	-0.342*	0.768**	0.356**	0.539**	0.606**	0.719**	-0.081	0.280*

* and ** : Significant at 0.05 and 0.01 levels, respectively.

Table 6. Estimates of phenotypic correlation coefficients among all possible pairs of grin quality characters over two seasons (2001 and 2002)

Characters	1	2	3	4	5	6	7	8	9
1-Hulling %	1								
2-Milling %	0.503**	1							
3-Head rice %	0.325*	0.415**	1						
4-Grain length (mm)	-0.119	0.462**	-0.055	1					
5-Grain shape (mm)	-0.166	0.509**	-0.178	0.899**	1				
6-Gelatinization temperature	-0.162	0.131	0.246	0.420**	-0.315*	1			
7-Grain elongation	-0.044	0.346*	-0.217	-0.400**	-0.424**	0.386**	1		
8-Gel consistency	-0.083	0.096	0.145	0.219	0.003	0.144	0.512**	1	
9-Amylose content	0.067	0.237	0.009	0.311*	0.301*	0.364**	-0.380**	-0.121	1
10-Grain Yield / Plant (g)	-0.553**	0.342*	0.188	0.260	0.206	0.238	0.330*	0.443**	0.236

* and ** : Significant at 0.05 and 0.01 levels, respectively

number of primary branches/panicle and number of filled grains/panicle, while, such estimate was negative and significant with panicle weight (-0.451).

Panicle length showed positive significant association with each of panicle weight, number of primary branches/panicle, number of filled grains/panicle, and sterility %. Meanwhile, panicle weight was positively and strongly-correlated with number of primary branches/panicle and number of filled grains/panicle, while, it showed negative association with sterility %. Moreover, the phenotypic correlation coefficient was highly significant and positive between number of primary branches/panicle and number of filled grains/panicle, on the contrary, it was negative between number of filled grains/panicle and sterility %. However, insignificant either positive or negative estimates of phenotypic correlation coefficients were exhibited among the other neglected rice characters. These results were in coincidence with those obtained previously by Roy *et al* (1995), Reedy and Kumar (1996), Basavaraja *et al* (1997), Marekar and Siddiqui (1997), Singh *et al* (1997), Kumar *et al* (1998), Mokate *et al* (1998), Meenakshi *et al* (1999), Chaudhari *et al* (2000) and Sadhukhan and Chattopadhyay (2000).

The data represented in Table (6) revealed that grain yield/plant was significantly and positively associated with milling %, (0.342), grain elongation (0.330) and amylose content % (0.443), while it showed significant negative association with hulling % (-0.553). However, significant positive estimates of phenotypic correlation coefficients were recorded between hulling % and both milling % and head rice %. Large positive correlation were found between milling % and each of head rice, grain length, grain shape and grain elongation. Furthermore, grain length showed highly significant and strong positive correlation with grain shape, gelatinization temperature and amylose content %, while, it was significantly and negatively correlated with grain elongation. Significant negative estimates of phenotypic correlation coefficients were observed between grain shape and both gelatinization temperature and grain elongation, while, it was positively correlated with amylose content %. Moreover, highly significant and positive estimates of phenotypic correlation coefficients were detected between gelatinization temperature and both grain elongation and amylose content %. Meanwhile, grain elongation showed highly significant positive and negative association with gel consistency and amylose content %, respectively. In addition, insignificant either positive or negative correlation were noted among other derelict characters. These findings were in harmony with those reported earlier by Govidarasu and Natarajan (1995), Shi and Shen (1996), Chen *et al* (1997), Marekar and Siddiqui (1997), Singh *et al* (1998), El-Abd (1999) and Sarawgi *et al* (2000).

Overall look, the data on various characteristic of the studied genotypes has helped not only to have basic information of the extent of natural variation for the various characters and their selection-reliability, but also to identify the best donors that combine most of desirable yield attributes and grain quality characteristic. These promising genotypes would be of considerable value to breeders engaged in the development of high yielding varieties. Hence, breeders can be choosing donor parents for the hybridization programme as well as in making selection for high yielding and coveted grain quality lines in segregating population.

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تقدير الاختلافات الوراثية و درجة التوريث ومعامل الارتباط الظاهرى للصفات المحصولية وصفات جودة الحبوب فى الأرز

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أجريـــت هـــذة الدراسة بمزرعة مركز البحوث والتدريب فى الأرز – سخا – كفرالشيخ مصر خلال مواسم زراعة الارز ٢٠٠١-٢٠٠٢ وذلك بهدف تقدير كل من معامل الاختلاف الوراثى والبيئى ، درجـــة التوريـــث بمعناها الواسع ، النسبة المئوية للتحسين الوراثي المتوقع من الإنتخاب بنسبة ٥ % وأيضا تقدير معامل التلازم المظهرى وذلك لإثنين وعشرون صفة محصولية و صفات جودة الحبوب فى الأرز بإستخدام أربعة وعشرون تركيبا وراثيا من الأرز اشتملت على أهم أصناف الأرز المحلية بالإضافة إلى بعض الأصناف المستوردة.

أوضحت النتائج أن أعلى قيم لكل من معامل الاختلاف الوراثي ومعامل الاختلاف البيئي قد ســـجلت على صفات وزن ١ لـــ ١٠٠ حبة ، عدد الحبوب الممتلئة/نورة ، درجة استطالة الحبوب بعد الطهي ، عدد الأيام إلى ٥٠ % تزهير ، عدد النورات الدالية نبات ومحصول النبات الفردي. و كانت درجة التوريث بالمعنى الواسع منخفضة إلى عالية لجميع الصفات المدروسة حيث تراوحت بين ٣٠% إلى ٨٩% لصفتي درجة استطالة الحبوب بعد الطهي ووزن النورة الدالية علي الترتيب.

وكانـــت النســبة المــئوية للتحســين الوراثي المتوقع من الانتخاب عالية في معظم الصفات المدروســة ومــن ناحية أخرى فقد سجلت كل من درجة التوريث والنسبة المئوية للتحسين الوراثي المتوقع من الانتخاب قيماً عالية لصفات وزن الـــ ١٠٠ حبة، وزن النورة الدالية، عدد الأفرع الأولية / نورة، شكل الحبة، طول الحبة وطول النورة الدالية مشيرة إلى أهمية تأثير الفعل المضيف للجين في السلوك الوراثي لهذه الصفات .

كمـــا أشارت النتائج إلى أن محصول النبات الفردي قد ارتبط ارتباطاً قويا وموجبا مع كل من عدد النورات الدالية /النبات، وزن النورة الدالية ، عدد الأفرع الأولية / نورة ، عدد الحبوب الممتلئة /نـــورة في حين ارتبط ارتباطا معنويا سالباً مع النسبة المئوية للعقم والنسبة المئوية لتصافي التقشير .وأضـــافه الي ذلك. فان درجة حرارة الجلتنة قد ارتبط ارتباطا معنويا موجبا مع طول الحبة ودرجة استطالة الحبوب بعد الطهي والنسبة المئوية لمحتوي الحبوب من الأميلوز .

مجلد المؤتمر الثالث لتربية النبات- الجيزة ٢٦ أبريل ٢٠٠٣

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