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Strategies and Methodologies of Improving Rice Genotypes in Egypt

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The present investigation was carried out at the Experimental Farm of the Rice Research and Training Center (RRTC), Sakha, Kafer EL-Shiekh, Egypt, during the period from 2004 to 2011 rice growing seasons to evaluate some Delta- Med materials under Egyptian conditions and also to develop a new rice lines using a crosses between Egyptian and Spain varieties to enhance the former genotype yielding ability. A total of 14 entries including 7 Egyptian varieties i.e, Giza 177, Giza 178, Sakha 101, Sakha 102, Sakha103, Sakha 104 and Giza 182 and 7 Spanish ones, namely, Bala, Susan, Bahia, Bomba, Montsianejj , Senia and Tebre. The results showed that there were significant differences between Egyptian varieties and Delta-Med varieties as well as among each group itself. The Egyptian varieties exceeded the Delta-Med entries in grain yield and associated. For Spanish and Delta-Med genotypes, grain yield were generally low, had generally shorter duration and higher 1000 grain weight. Using crosses between Egyptian and Spain varieties to enhance the former genotype yielding ability, these lines, along with a specific breeding program designed for Spain materials, to be evaluated in Spain in the few coming years. The progenies from each cross were advanced under normal conditions using the pedigree method technique. The best selected lines from F6 generation (2010) were promoted to be grown as F7 generation in 2011 season. These lines were found to be resistant to blast disease in addition to possess useful traits associated with high yielding ability. Phenotypic coefficient of variation (PCV) was high for all the character studied and genotypic coefficient of variability (GCV) showed the same trend as for phenotypic coefficient of variability. Heritability estimates were high for all studied traits studied. Highly significant positive phenotypic correlation coefficients were determined between grain yield /plant and all yield a

Keywords: Rice, Grain, Plant, Breeding, Yielding, Egypt.

INTRODUCTION

Rice is likely the most important food crop in the world. Almost half of the world's population depends on rice as their staple food. Rice is the most important crop directly consumed by humans. With around 600 M t produced

Annually on 149 M ha in 2003, rice accounts for 23% of the world's caloric intake, Khush et al, 2003. Rice production increased by 130% between 1966 and 2000, while the population of low income countries increased by an average of 90% over the same period.

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The world population is predicted to reach approximately 8 billion by 2030 and there is therefore a need to further increase rice production by 40% in the next 25 years, (IRRI, 1996).

Therefore, to meet the needs of the growing world population, conventional breeding methods need to be combined with recent achievements in rice biotechnology. The rice growing area in Egypt is about half million hectares with a national average yield of 10.00 tons/ ha. This significantly high productivity is mainly due to the development of short duration varieties with a higher yield potential, resistance to biotic and a biotic stresses, better grain quality in combine with an excellent extension network through the national campaign of rice (RRTC. 2007).

As a part of the international co-operation with Delta Med. Countries, an initiative were carried out at the institute of Agroambiental Terres Ebre. Spain, to evaluate six of our newly released varieties, along with four checks in 2004 season. The Egyptian varieties were significantly different in their behavior under Spain conditions. The objectives of the current work is to evaluate some Spain materials under Egyptian conditions and also to start an initiative to develop a new anther culture derived lines using a crosses between Egyptian and Spain varieties to enhance the former genotype yielding ability, these lines, along with a specific breeding program designed for Spain materials, to be evaluated in Spain in the few coming years.

This is supposed to be an example of effective collaboration between two of the Delta-Med countries and to enhance the scientific exchange between the two nations

The objectives of the current work is to evaluate some Delta Med materials under Egyptian conditions and also to develop a new rice lines using a crosses between Egyptian and Spain varieties to enhance the former genotype yielding ability.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental Farm of the Rice Research and Training Center (RRTC), Sakha, Kafer EL-Shiekh, Egypt, during three successive rice growing seasons 2005, 2006 and 2007 to evaluate some Delta Med materials under Egyptian conditions and also to develop a new rice lines using a crosses between Egyptian and Spain varieties to enhance the former genotype yielding ability.

A total of 14 entries including 7 Egyptian varieties i.e, Giza 177, Giza 178, Sakha 101, Sakha 102, Sakha103, Sakha 104 and Giza 182 and 7 spanish ones, namely, Bala, Susan, Bahia, Bomba, Montsianejj, Senia and Tebre. The tested materials were grown in randomized complete block design (RCBD) with three replications, each plot were 7 rows 5 m long with a plant spacing 20 X20 cm, the nurseries were raised till age of 30 days, then, they were transplanted with 2-3 seedling / hill. The fertilization was applied as recommended rate and time of application. These genotypes have a wide range of variation due to their different genetic background. Data was recorded on the grain yield (tons/ ha), heading date (days), no. productive tillers/plant, Plant height(cm), panicle length(cm), panicle weight(g), fertility percentage(%) and 1000 grain weight(g). At first, the data were analyzed by the ordinary analysis of variance to test the significance of differences among the fourteen genotypes. The genotypes mean squares were found to be significant; for all traits studied in their combined data The combined analysis was calculated over the two years to test the interaction of the different genetic components with the two years as two different environmental conditions. Homogeneity test was done followed by Bartlet (1937) before one proceeds with the computations of the combined experiments and the error variances of the tests were homogenous.

In 2005, seeds of the above mentioned varieties were grown in three successive sowing dates with 10 days intervals to overcome the difference of heading date among them. Thirty days after sowing, seedlings of each variety were individually transplanted in the permanent field in three rows, five meters long and 20 cm between plants and rows. Crossing was carried out between some Delta-Med varieties and Egyptian parents to produce F1 hybrid seeds. Bulk emasculation method was practiced by using hot water technique. The hybrid seeds were grown in the winter glass house to produce F1 generations and the normal F1 at the experimental farm at 2006.The list of the crosses made during 2005 rice growing season are presented in Table(1).

In 2006 season, a total of 24 crosses besides their parents were grown in a randomized complete block design (RCBD) with three replications, each replicate consisted of five rows for each parent and F1 cross. Each row was 5 m long and contained 25 hills with 20 cm between rows. Weeds were chemically controlled by applying two liters of Saturn/ feddan four days after transplanting. Nitrogen fertilizer was applied as recommended rate and time of application. The crosses listed in (Table 1) was designed as to fulfill most of our breeding objectives, i.e., yield potential, resistance to biotic stresses, earliness and grain quality parameters. The hybrid seeds of these crosses were divided in two groups, the first was grown in the winter nursery of the glass house of RRTC to be grown as F2 in the Experimental farm of RRTC in 2006. The second group was kept to be grown as F1 generation in 2006.

Table 1: list of crosses made during 2005 season between Delta -Med and Egyptian rice varieties

.

No.	Crosses	Source
1	Bahia / Giza 177	NC – 2005 – 51
2	Bahia / Giza 178	NC – 2005 – 79
3	Bahia / Sakha 101	NC – 2005 – 126
4	Bahia / Sakha 102	NC – 2005 – 147
5	Bahia / Sakha 103	NC – 2005 – 172
6	Bahia / Sakha 104	NC – 2005 – 196
7	Bahia / Egyptian Yasmine	NC – 2005 – 200
8	Bahia / Yun Len 18	NC – 2005 – 229
9	Bahia / Geyhwa 7	NC – 2005 – 230
10	Bahia / Onpo 1	NC – 2005 – 231
11	Bahia / GZ 6522-15-1-1-3	NC – 2005 – 277
12	Bahia / GZ 7842-4-1-3-1	NC – 2005 – 317
13	Bahia / CT 9852-B-2-1-2-4PM	NC – 2005 – 359
14	Bomba / Giza 177	NC – 2005 – 52
15	Bomba / GZ 1368-S-5-4	NC – 2005 – 100
16	Bomba / Sakha 101	NC – 2005 – 127
17	Bomba / Sakha 102	NC – 2005 – 148
18	Bomba / Sakha 103	NC – 2005 – 173
19	Bomba / Sakha 104	NC – 2005 – 197
20	Bomba / Balado	NC – 2005 – 228
21	Bomba / GZ 6522-15-1-1-3	NC – 2005 – 278
22	Bomba / GZ 7842-4-1-3-1	NC – 2005 – 318
23	Bomba / GZ 7456-13-6-5-3-	NC – 2005 – 335
24	Bomba / GZ 7563-20-10-8-1	NC – 2005 – 381

Table 2: Mean performance data of Delta-Med materials grown at Sakha, 2010

Genotype	Days to heading	Plant height	Panicle length	Tillers numbers	Grain yield/ha	Fertility %	1000-g-weight
Giza 177	96.00	100.00	26.00	20.33	9.98	89.10	22.30
Giza178	98.00	102.00	24.60	28.66	10.70	94.00	21.90
Giza182	106.00	98.00	23.60	21.66	9.15	87.92	23.80
Giza 181	112.30	110.00	27.60	25.00	9.52	85.12	26.40
Sakha 101	111.00	91.00	19.60	29.66	11.00	93.95	28.80
Sakha102	98.00	107.00	28.60	26.00	9.50	95.52	27.40
Sakha103	94.00	104.00	26.00	22.66	9.90	86.19	22.10
Sakha104	106.00	108.00	26.30	27.33	10.50	93.64	27.60
Bala	94.00	95.00	22.00	25.00	9.31	95.54	30.40
Susan	94.00	74.60	21.60	23.33	7.79	96.81	27.50
Bahia	91.00	101.00	26.30	13.00	5.10	75.70	32.30
Bomba	92.00	128.30	25.30	20.33	7.79	87.19	27.80
Montsianejj	92.00	78.30	26.00	27.66	5.19	69.81	31.70
Senia	93.00	82.00	21.30	17.33	5.30	86.10	27.60
Tebre	84.00	77.00	21.00	19.66	6.98	87.50	30.50
79004- TR4-4-2-1-1	92.00	111.00	27.00	25.33	8.09	89.03	31.10
79061- TR64-3-3-1-1	89.00	113.00	19.60	18.33	5.69	78.74	35.70
80110- TR 4-1-1	115.00	110.00	22.00	13.00	4.58	71.11	34.20
80116- TR 259-1-1	92.00	99.30	20.00	16.00	5.53	78.65	36.10
96066- TR 1805-5-1-1	95.00	102.60	18.60	10.00	2.88	67.09	30.10
Publa	96.00	98.00	27.30	11.66	3.91	67.16	23.30

Table 2 Continue

Hiipgran	92.00	106.00	19.30	18.30	4.11	88.88	32.80
Thaibonet	98.00	90.60	21.30	22.00	6.00	80.42	31.00
Puntal	103.00	95.00	25.00	25.00	7.47	90.90	20.70
LSD at 0.05	**2.50**	**2.90**	**2.30**	**2.55**	**0.70**	**5.00**	**2.20**

Table 3: Biotic stress reaction of the Delta-Med tested materials under Egyptian conditions, 2010 season.

No.	**Genotype**	**Blast Reaction (Leaf)**	**Blast Reaction (nick)**	**Stem Borer Reaction**
1	Giza 177	1	1	R
2	Giza 178	1	1	MR
3	Giza 181	1	1	R
4	Giza182	1	1	R
5	Sakha 101	4	4	S
6	Sakha 102	1	1	R
7	Sakha 103	1	1	R
8	Sakha 104	5	4	S
9	Bala	7	7	HS
10	Susan	7	7	S
11	Bahia	7	7	HS
12	Bomba	7	7	S
13	Montsianeji	7	7	HS
14	Senia	7	7	HS
15	Tebre	5	7	HS
16	79004-TR4-4-2-1-1	5	7	S
17	79061-TR64-3-3-1-1	7	7	S
18	79004-TR50-4-2-1-1	7	7	S
19	79060-TR64-3-3-1-1	5	5	HS
20	85040-TR853-4-1	5	5	S
21	Publa	7	7	S
22	Hispgran	5	7	S
23	Thaibonet	7	7	HS
24	Puntal	7	7	S

R= Resistant, MR= Moderate resistant ,
S= Susceptible and HS= Highly susceptible

The F1 and F2 crosses were subjected to pedigree method for selection in the segregating generations. This allows additive alleles to be accumulated in such complex traits. We had F4, F5 and F6 generations in 2010 which have been grown as F5, F6 and F7 in 2011 rice growing season. The data of each character of each F7 hybrid population (individuals) were analyzed separately by the analysis of variance, according to Panse and Sukhatme (1957). The genetic parameters i.e., phenotypic variance, genotypic variance, genetic coefficient of variation was computed according to the formula suggested by Burton (1952). Heritability in broad sense and genetic advance upon selection were computed according to Johanson et al. (1955).

RESULTS AND DISCUSSION

Results of the evaluation experiment are presented in Table (2). For the 3rd year of evaluation, the Egyptian varieties exceeded the Delta-Med entries in grain yield and its components except 1000 grain weight. All Egyptian varieties exceeded 10 tons / ha. Giza 181 and Sakha 101 recorded the highest grain yield (12.43 and 12.30 t/ ha, respectively). For Spanish and Delta med genotypes, grain yield were generally low and ranged between 6.57 tons for Tebre and 9.54 tons /ha for Publa.

The Delta- Med genotypes had generally shorter duration and higher 1000 grain weight (Table 2). 1000

Table 4: Summary of the pedigree generations of Delta-Med materials, 2010

Year	Generation	planted		Selected	
		Lines	Crosses	Lines	Crosses
2006	F1	-	24	-	24
	F2	323	24	286	10
2007	F1	-	16	-	16
	F2	500	8	75	7
	F3	263	10	212	10
2008	F2	380	16	158	15
	F3	204	7	106	7
	F4	230	10	115	10
2009	F3	148	14	102	10
	F4	96	6	134	6
	F5	110	9	100	8
2010	F4	101	10	85	9
	F5	128	6	66	3
	F6	75	3	45	3
2011	F5	85	9	30	9
	F6	66	3	25	3
	F7	45	3	6	3

Table 5 : Summary of the pedigree generations of Delta-Med materials, 2011.

Generation	Planted		Selected	
	Lines	Crosses	Lines	Crosses
F5	81	9	30	9
F6	43	3	25	3
F7	15	3	6	3
Total	**135**	**15**	**61**	**15**

grain weight for Delta med genotypes ranged from 22.70 in Puntal to 38.10 in 85040-TR853-4-1, while in case of Egyptian rice varieties, 1000 grain weight values ranged from 21.90 in Giza 178 to 28.80 in Sakha 101.

This variation detected among the Egyptian and Delta-Med genotypes will give a great opportunity to enhance the trait value for most of the studied traits by using conventional breeding to utilize such high level of variation among those genotypes.

As far as biotic stresses is concerned, Egyptian varieties exhibit also considerably higher level of resistance. The reaction of the tested materials to both blast and stem borer are presented in Table (3). Egyptian rice varieties showed higher level of resistance to blast at both leaf and nick infection except Sakha 101 and Sakha 104. These two varieties started to show a blast resistance breakdown during the last three years. Most of the Delta Med showed high level of susceptibility which may limit their use under such ecosystem.

Now we do have a pedigree breeding program specifically to the Delta Med materials we have reached up to F7 stage in 2011 rice season. The summary of the breeding program with Delta med materials are presented in (Table 4 and Table 5). A total of 45 F7 lines were selected according to their desirable characters such as high yielding ability, blast resistance, stem borer resistance, grain weight and grain quality characters. These lines will be promoted to be grown as yield trial experiments in 2012 rice season. One set of this F7 lines will be distributed to be gown in the different locations as a verification trials through technology transfer program and after that can be sent to the Delta Med countries for evaluation there.

Data from Table (6) shows that most of the selected lines have desirable values for various traits. The red color lines were superior for most of the studied traits especially for yield and its components .These lines exceeded their parental lines .In addition to its higher yield they were earlier in heading and growth duration around 130 days, heavier in grain weight, high fertility percentage. So, we have succeeded to combine Egyptian and Delta-Med desirable traits in one line. These were promoted to be grown as F7 generation in 2011 rice growing season under normal conditions

Table 6 : The best selected lines (15 lines) from F6 generation ,2010.

No.	Crosses	D.H (day)	P.H (cm)	P.L (cm)	No.till./plant	G.y (t/ha)	Fert. (%)	1000-g-w (g)
7	Bomba x Giza182	99.00	93.00	20.00	21.00	7.90	87.00	23.00
18		102.00	91.00	19.00	25.00	10.58	88.00	25.00
21		100.00	102.00	20.00	22.00	10.45	90.00	26.00
25		100.00	100.00	19.00	19.00	8.89	91.00	26.00
26		99.00	95.00	21.00	26.00	10.87	93.00	26.00
27		99.00	110.00	23.00	19.00	9.19	89.00	25.00
28		100.00	88.00	22.00	20.00	8.02	86.00	25.00
29		101.00	97.00	27.00	30.00	11.22	92.00	27.00
30		100.00	105.00	25.00	29.00	11.38	94.00	28.00
39		100.00	100.00	26.00	22.00	8.49	87.00	26.00
44		100.00	90.00	28.00	28.00	11.00	92.00	29.00
53	Bomba x IR6554-22-2-3	100.00	93.00	25.00	24.00	10.75	94.00	27.00
54		99.00	98.00	24.00	31.00	11.14	91.00	28.00
56		98.00	105.00	23.00	30.00	11.03	90.00	27.00
65	Susan x Giza182	99.00	100.00	22.00	18.00	7.90	88.00	25.00

DH= Days to heading, P.H= Plant height, P.L= Panicle length, No.till.=No. productive tillers/plant, G.y= Grain yield(t/ha), Fert.= Fertility % and 1000-g-w= 1000 grain weight.

Table 7: Correlation coefficients among the traits studied of the selected lines from F7 generation.

Characters	Days to heading	Plant height	Panicle length	No. Panicles/ plant	Fertility%	1000 grain weight	Grain yield
Days to heading		0.230	0.310	0.520**	0.220*	0.180	0.300
Plant height			0.780**	0.110	-0.220	0.250	0.280
Panicle length				0.150	0.310	0.230	0.550*
No. panicles					0.475*	0.210	0.780**
Fertility%						0.225	0.650**
1000grain weight							0.850**
Grain yield/plant							-

*Significant and ** highly significant

besides the Egyptian rice varieties for comparison. The Selection has been made for yield and its components as well as blast and stem borer resistance.

Phenotypic correlation coefficients

Phenotypic correlation coefficients among the traits studied are shown in Table (7). Days to heading is significantly and highly significantly and positively associated with no. panicles/plant and fertility %. Plant height was positively and significantly associated with panicle length. Panicle length was highly significantly and positively correlated with grain yield per plant. No. panicles/plant was positively correlated with grain yield per plant and fertility %. One hundred grain weight and fertility percentage were significant and positively correlated with grain yield per plant. These results were in agreement with those reported by Singh et al. (1984), Singh (1990), Banzinger et al., 2000, Laftte and and Pontuwan, 2001.

Genetic components

In general, the phenotypic coefficient of variation (PCV), Table (8) was high for fertility % (110.00), number of panicles per plant (100.00), and plant height (98.00), while it was low for panicle length (40.00), days to heading (50.00) and grain yield/plant (55.00). Genotypic coefficient of variation GCV showed the same trend but the corresponding values were lower thereby implying the influence of environment on the genotypes. Heritability estimates, in general, were moderate to high for all characters studied, the values ranged from 62.00% to 76.53%. Reasonable values of

Table 8: Genetic parameters of variation for some characters studied in the promising lines.

Characters	Genotypic variance (%)	Phenotypic variance (%)	Heritability in broad sense (%)	Genetic advance
Days to heading(day)	35.00	50.00	70.00	10.19
Plant height(cm)	75.00	98.00	76.53	15.50
Panicle length(cm)	25.00	40.00	62.50	8.07
No. panicles/plant	68.10	100.00	68.00	14.00
100 grain weight(gram)	66.00	86.00	76.74	14.51
Fertility (%)	85.00	110.00	77.27	16.63
Grain yield(t/ha)	38.00	55.00	69.00	10.54

Table (9): The best selected lines (5 lines) from F7 generatio,2011,season.

No.	Crosses	D.H (day)	P.H (cm)	P.L (cm)	No.till./plant	G.y (t/ha)	Fert. (%)	1000-g-w (g)
26	**Bomba x Giza182**	100.00	98.00	22.00	24.00	10.71	90.00	26.00
29		103.00	100.00	25.00	27.00	11.18	90.00	27.00
30		98.00	107.00	23.00	28.00	11.00	91.00	28.00
44		100.00	93.00	26.00	25.00	10.60	92.00	29.00
53	**Bomba x IR6554-22-2-3**	102.00	90.00	25.00	22.00	10.50	92.00	27.00
56		95.00	100.00	23.00	28.00	11.00	90.00	27.00

DH= Days to heading, P.H= Plant height, P.L= Panicle length,
No.till.=No. productive tillers/plant, G.y= Grain yield(t/ha),
Fert.= Fertility % and 1000-g-w= 1000 grain weight.

genetic advance were found for all traits studied; implying that higher proportion of genotypic variance was attributed to additive genetic variance, and therefore, selection would be effective and useful for these traits from the progenies which will be produced. Jacob (2006) and Boonjung and Fukai (1996) reported the same results with the other varieties.

The best five lines are presented in Table (9).These lines can be distributed at the different rice growing areas in Egypt as well as can be tested at the Delta-Med conditions to be used as a donor parents in rice breeding program or as a new rice varieties directly possess high yielding ability, good grain quality characters and blast and stem borer resistance.

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