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Evaluation of Induced Mutants of Rice for Yield and Quality Characters

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Abstract: Fast neutrons (10 and 25 Gy) and gamma rays (150, 200, 250 and 300 Gy) were used to induce desirable mutations with regard to yield and quality characteristics in IR6 (non-aromatic) and Basmati-370, Jajai-77 and Sonar Sugdasi (aromatic) varieties of *indica* rice. Six stable mutants of non-aromatic varieties viz., IR6-252, IR6-25-1, IR6-30-1, IR6-1.0-2, IR6-1.5-2 and IR6-2.5-2 and six mutants of aromatic varieties viz., Basmati-2.5, Basmati-15-14, Basmati-20-1, Basmati-30-2, Jajai-77-2 and Sonahri Sugdasi-20-1 were evaluated in zonal trials over 9 different locations in the Province of Sindh and Balochistan. All the non-aromatic mutants except IR6-2.5-2 were significantly ($P \leq 0.05$) superior in yield to the parent IR6. The mutant IR6-252 had the highest paddy yield. Similarly, all the aromatic mutants except Basmati-2.5 were significantly ($P \leq 0.05$) superior to their respective parents and check variety. The mutant Basmati-20-1 had the highest paddy yield followed by mutant Basmati –15-14. All the mutants maintained their superiority in grain quality characters over their respective parents.

Key words: Induced mutations, rice mutants, yield, quality

Introduction

Rice is grown over an area of 2.5 million hectares with an annual production of about 5.15 million tones (Anonymous, 2000). The average grain yield is about 2.10 t ha^{-1}, which is one of the lowest in the world. Pakistan is one of the major rice exporting countries of the world. Both aromatic and non-aromatic types of rice are exported. Continuous efforts are needed by the Plant Breeders to evolve the high yielding varieties of rice to meet the local as well as export requirements for earning foreign exchange (18 – 22%). Significant achievements have been made in developing new rice varieties with desirable characteristics traits through mutation breeding. (McKenize and Rutger, 1986; Micke *et al.*, 1987; Maluszynski *et al.*, 1991; Qayoom *et al.*, 2000; Baloch *et al.*, 2002).

Many new strains of rice (aromatic as well as non-aromatic) have been developed by Nuclear Institute of Agriculture, Tandojam through induced mutations by using gamma rays and fast neutrons. The results with regard to yield and grain quality characteristics of promising mutant strains evaluated in zonal trials are discussed in this paper.

Materials and Methods

Seeds of non-aromatic rice (IR6) and aromatic (Basmati-370, Jajai-77 and Sonahri Sugdasi) were treated with 150, 200, 250 and 300 Gy of gamma rays and 10,15 and 25 Gy of fast neutrons. M_1 generation was grown with single seedling per hill at a distance of 20 cm between plant-to-plant as well as row-to-row. Mutants were selected on the basis of short stature and high yield potential in M_2 generation and confirmed in M_3 generation. Replicated trails were conducted in M_4 generation and mutants with high paddy yield were selected in M_5 generation for further evaluation in yield trails. The experimental layout for zonal varietal trails in both the groups of rice was Randomized Complete Block Design. One month old seedlings were transplanted at a distance of 20 cm from plant to plant as well as row to row and plot size of each genotype was 5 x 3 m^2. Two to three seedlings per hill were placed in order to avoid the chance of mortality. The fertilizer in IRRI group of rice was applied at the rate of 120 N + 60 P_2O_5 + 0 K_2O kg ha^{-1} whereas in aromatic group at the rate of 80 N + 40 P_2O_5 + 0 K_2O kg ha^{-1}. Multi location trails were conducted over 9 sites of different ecological zones of Sindh and Balochistan Province. The paddy yield (kg $plot^{-1}$) was recorded after the harvest of crop. The quality characters such as size (length) and shape (length/width) classification i.e., quality index (length/width x thickness) of rice kernels was carries out according to Khush *et al.* (1979), Sagar *et al.* (1998), Kawai and Amano (1991) and Singh (1997).

Results and Discussion

The data of selected mutants therefore were analyzed and results of ANOVA for non-aromatic rice indicated significant ($P \leq 0.05$) differences amongst the

Table 1: Mean paddy yield (kg ha^{-1}) of non-aromatic mutants in zonal varietal trails over 9 different locations in Sindh and Balochistan

	Mutants/Varieties								
Locations	IR6-25-1	IR6-252	IR6-30-1	IR6-1.0-2	IR61.5-2	IR62.5-2	IR6 parent	Shadab (check)	Site mean
NIA, Tandojam	7824b	8211a	5936e	6377d	5663e	6650cd	6903c	6657cd	6778
Khipro	6557a	6701a	6643a	6043b	6510a	5996b	5950b	6603a	6376
Daro (Thatta)	7237b	7991a	7877a	7210b	7851a	6490c	6817c	7904a	7422
Talhar (Badin)	7857b	8664a	8598a	7357cd	8518a	7164d	7284d	7590c	7879
Shikarpur	7797a	7971a	7824a	6530c	6543c	7210b	6723c	7317b	7239
Jacobabad	8498a	8671a	8558a	7871b	7237c	6677d	7884b	8478a	7984
RRI Dokri	8011d	7858e	9231a	8691b	8064d	8324c	8017d	8151cd	8293
K. N. Shah (Dadu)	7824c	9218a	7904c	7304d	7230d	7077d	7717d	8471b	7843
Jamali Farm (Balochistan)	8024b	8558a	8151b	7891b	8091b	6470d	7250c	7877b	7789
Average yield (kg ha^{-1}) over all sites	7737c	8431a	7857b	7257d	7304d	6897f	7110e	7671c	---
Rank	3	1	2	6	5	8	7	4	---

Means followed by the same letters are not significantly different from each other at 5% level.

Table 2: Mean paddy yield (kg ha^{-1}) of aromatic mutants in zonal varietal trails over 9 different locations in Sindh and Balochistan

	Mutants/Varieties									
Locations	Basmati1 5-14	Basmati 20-1	Basmati 30-2	Basmati 2.5-5	Jajai 77-2	Sonahri Sugdasi 20-1	Basmati (parent)	Jajai 77 (parent)	Sonehri sugdasi (parent)	Basmati 385 (check)
NIA, Tandojam	3909b	4095a	2848d	2888d	4135a	3442c	2515e	2461e	2541e	2895d
Khipro	3335bc	3815a	3162cd	2701e	3355ab	2968de	1748g	2081f	1594f	2988cd
Daro (Thatta)	3342b	4402a	2821d	2715d	3288b	3282b	1948e	1701f	1474f	3022c
Talhar (Badin)	3989b	4582a	3168d	3308cd	3408c	3328cd	1961e	1814e	1574e	3508c
Shikarpur	3315bc	3995a	3075d	2701c	3455b	3228c	2068f	1928f	1374f	2781e
Jacobabad	3955bc	4639a	3075e	3342d	3729d	3535bc	1894cd	1974f	1988f	2955f
RRI Dokri	3922b	4035a	3415c	3264b	3755b	3255a	1941b	2001d	1908d	2908c
K.N.Shah (Dadu)	3362b	3755a	2062c	3248bc	3095bc	3188bc	2068d	1401e	1454e	3048c
Jamali Farm (Balochistan)	3048b	3568a	3308a	3035ab	3288ab	2881a	1833ab	1334ab	1874ab	3022c
Average yield (kg ha^{-1}) over all sites	3575b	4057a	3102d	3022d	3522d	3242c	2141e	1854e	1754f	3015d
Rank	2	1	5	6	3	4	8	9	10	7

Means followed by the same letters are not significantly different from each other at 5% level.

Table 3: Physical dimensions of non-aromatic and aromatic mutants of rice

Mutants/ Varieties	Length (mm)	Width (mm)	Thickness (mm)	Length/width ratio	Quality index
Non-aromatic rice					
IR6-25-1	7.26	2.20	1.60	3.30	2.06
IR6-252	7.50	2.10	1.60	3.57	2.23
IR6-30-1	7.40	1.90	1.56	3.89	2.50
IR6-1.0-2	7.20	2.03	1.50	3.55	2.36
IR6-1.5-2	7.50	2.00	1.55	3.75	2.42
IR6-2.5-2	7.50	2.10	1.60	3.57	2.23
IR6 (parent)	7.20	2.21	1.80	3.27	1.82
Shadab (check)	7.50	2.00	1.70	3.75	2.21
Mean	7.383	2.068	1.6138	3.561	2.229
SD	0.1309	0.0991	0.8845	0.2029	0.2010
C.V. %	1.7734	4.7927	5.4809	5.6672	9.0186
Aromatic rice					
Basmati 15-14	6.70	1.60	1.40	4.19	2.99
Basmati 20-1	7.50	1.70	1.50	4.41	2.94
Basmati 30-2	7.90	1.80	1.63	4.39	2.70
Basmati 2.5-5	7.97	2.10	1.97	3.79	1.93
Jajai 77-2	7.40	1.90	1.60	3.89	2.43
S.S 20-1	7.20	2.06	1.80	3.49	1.94
Basmati 370 (P)	7.00	1.80	1.50	3.89	2.59
Jajai 77 (P)	6.70	2.10	1.60	3.19	1.99
S.S. (P)	7.10	2.06	1.80	3.45	1.91
Basmati 385 (Ch)	6.80	1.80	1.60	3.78	2.36
Mean	7.229	1.892	1.60	3.847	2.378
SD	0.4377	0.1705	0.1618	0.3818	0.4005
C.V. %	6.0565	9.0094	9.8659	9.9243	16.8419

mutants of non-aromatic as well as aromatic groups in grain yield (Table 1 and 2). The mutant IR6-252 gave statistically ($P \leq 0.05$) the highest paddy grain 9218 kg ha^{-1}) at K.N.Shah (Dadu) followed by 8671 kg ha^{-1} at Jacobabad and 8664 kg ha^{-1} at Talhar (Badin). The mutant IR6-30-1 gave the highest paddy yield (9231 kg ha^{-1}) at RRI, Dokri, followed by 8598 kg ha^{-1} at Talhar (Badin) and 8558 kg ha^{-1} at Jacobabad. On the basis of overall performance (mean of 9 different locations) the mutant IR6-252 (8431 kg ha^{-1}), IR6-30-1 (7857 kg ha^{-1}) and IR6-25-1 (7737 kg ha^{-1}) ranked first, second and third, respectively. The former two mutants showed 15 and 9% increase over the parent IR6 and 9 and 2% increase over the check variety Shadab, respectively.

In aromatic group, the mutant Basmati-20-1, gave statistically ($P \leq 0.05$) the highest paddy yield (4639 kg ha^{-1}) at Jacobabad followed by 4582 kg ha^{-1} at Talhar (Badin), 4402 kg ha^{-1} at Daro (Thatta). Another mutant Basmati-15-14, gave the highest paddy yield (3989 kg ha^{-1}) at Talhar (Badin), followed by 3955 kg ha^{-1} at Jacobabad and 3922 kg ha^{-1} at rice research Institute, Dokri, Sindh.

The average yield of mutant Basmati-20-1 (4075 kg ha^{-1}) and Basmati-15-14 (3575 kg ha^{-1}) were significantly ($P \leq 0.05$) higher than the parent Basmati-370 (2141 kg ha^{-1}) and check Basmati-385 (3915 kg ha^{-}) at almost all sites, indicating their excellent performance over all environments. Theses mutants ranked first and second when averaged over all sites. The yield of mutant Basmati-20-1 was 47 and 40% higher than the parent Basmati-370 while 26 and 15% higher than check variety Basmati-385.

Grains of all the rice genotypes were long (6.61 to 7.50 mm) and slender except of Basmati-2.5-5 (7.97 mm) and Basmati-30-2 (7.90 mm), which exhibited extra long size (Table 3). Most of the genotypes fall under the category of fine because, the quality index was more than 2. However, quality index was less than 2 in case of Sonahri Sugdasi (parent and mutant), Jajai (parent), Basmati-2.5-5 (mutant) and IR6 (parent) rice grains. Most of the mutants showed improvement in size, shape and quality index over their respective parents in both aromatic and non-aromatic rices. Awan *et al.* (1982) reported short stature and better grain quality mutants in rice variety Basmati-370.

Our results are in agreement with Awan *et al.* (1982), Bari *et al.* (1981), Baloch *et al.* (1999), Baloch *et al.* (2001), Baloch *et al.* (2001), kawai (1991), Khush *et al.* (1979), Maluszynski *et al.* (1991), McKenzie and Rutger (1986), Micke *et al.* (1986), Sagar *et al.* (1988), Singh (1977) and Wen and Qw (1996), who have used induced mutations to evolve high yielding and good quality mutant varieties of rice.

On the basis of over all performances, it was recorded that 3 mutants of non-aromatic varieties viz., IR6-252, IR6-30-1, IR6-25-1 and 3 mutants of aromatic varieties viz., Basmati-20-1, Basmati-15-14, Jajai-77-2 showed higher yield than their respective parents and checks. All the mutants maintained their superiority in grain quality characters on their respective parents.

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