

MUTAGENESIS FOR REDUCED PLANT HEIGHT AND HIGH GRAIN YIELD IN JAJAI 77, AN AROMATIC RICE (*ORYZA SATIVA* L.) VARIETY

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Abstract

Ionizing radiation was successfully utilized to develop the mutant variety Jajai 77-30 with reduced plant height and high grain yield from a commercially grown aromatic variety Jajai 77. About 22% reduction in plant height was recorded in the mutant variety Jajai 77-30 compared with its parent variety. The data of zonal and national trials indicated that the mutant variety Jajai 77-30 had significantly higher ($P \leq 0.05$) grain yield than the commercial varieties viz., Jajai 77, Basmati 370 and Basmati 385. The mutant variety Jajai 77-30 yielded 3781 kg/ha during 1990 and 4232 kg/ha during 1991 in the National Uniform Rice Yield Trials, securing second and first positions, respectively. This mutant has been named as "KHUSHBOO 95" and also released as a rice variety in 1996 for general cultivation in the province of Sindh.

Introduction

Rice has been a popular subject to mutagenesis because it is the world's leading food crop. The crop is diploid and highly self-pollinated. Induced mutations have played a significant role for the improvement of rice by developing a large number of semi-dwarf and high yielding varieties in a number of countries (Maluszynski *et al.*, 1986). Recently Wen & Qu (1996) have reported that 102 rice varieties were developed through induced mutations during the period of 1966-1993 in China. The main objective of the present study was to create useful genetic variability through induced mutation for the development of semi-dwarf and high yielding mutants from a commercially grown aromatic local cultivar Jajai 77. Besides having an excellent grain quality, it grows tall and because of weak stem lodges at the reproductive stage resulting in reduced grain yield.

Materials and Methods

The pure and homogenous seeds of Jajai 77 (500 seeds for each dose) were irradiated with different doses of gamma rays (150, 200, 250 and 300 Gy of ^{60}Co source). The irradiated seeds were sown in nursery beds along with non-irradiated (control) seeds during 1981. One month old seedlings were subsequently transplanted in a plot (5 m x 4m) at a uniform distance of 20 cm between hills and rows. At maturity, 3 panicles were harvested from each M_1 plant of the treated population and the control. The M_2 generation of the above material was grown of each panicle

Table 1. Performance of mutant strains/varieties of rice for different quantitative traits.

Mutant strains/ varieties	Plant height (cm)	No. of panicles per hill	Panicle length (cm)	Grain yield per hill (g)	Fertile grains per panicle	1000 grain weight (g)
Bas. P	162 b	11.00 c	30.93 b	18.50 f	42.00 c	21.58 d
Bas-32	131 c	14.05 b	26.53 e	31.18 c	62.75 b	22.28 c
Jajai. P	167 a	10.68 c	30.63 bc	19.43 f	45.00 c	21.43 d
Jajai-30	130 c	15.45 a	31.18 a	41.15 a	81.75 a	23.13 a
SS.P	164 b	10.33 c	30.15 d	21.75 c	48.25 c	21.38 d
SS-6	127 d	14.32 b	26.05 f	32.55 b	67.75 b	22.43 c
Bas.385	129 c	14.23 b	30.33 cd	29.43 d	66.25 b	22.25 c
LSD1	1.80	0.71	0.41	0.91	7.18	0.31
LSD2	2.47	0.98	0.57	1.25	9.84	0.42

separately during 1982. A high yielding mutant plant with short stature (Jajai 77-30) was selected from the M_2 population of 200 Gy. The mutated traits of the Jajai 77-30 were confirmed in M_3 and M_4 generations. During the years 1986 and 1987, this mutant was tested and further confirmed along with other cultivars in local yield trials. After thorough testing in local trials, the mutant strain Jajai 77-30 alongwith other genotypes/checks was evaluated in zonal trials (1988-89) and National Uniform Rice Yield Trials (1990-91) over different sites in Sindh and Balochistan provinces. The experimental design of both zonal and national trials were RCB with four and three replications at each site and each year. The plot size was 5mx3m. All other agronomical and cultural operations were followed as per recommendations. At maturity, data on plant height (cm), number of productive tillers per hill, panicle length (cm), grain yield per hill (g), fertile grains per panicle and 1000 grain weight (g) were recorded at Tando Jam site, whereas the data for grain yield per plot (kg/ha) were recorded for all sites in zonal and national trials. ANOVA of the data of grain yield and other characters were performed to determine the significant differences among the genotypes included in the trials.

Results and Discussion

The mean values at Tando Jam site of the characters for plant height, number of productive tillers per panicle, panicle length, grain yield per hill, fertile grains per panicle and 1000 grain weight were significant at 5% and 1% level (Table 1). The data of mean values of these characters revealed that mutant strain Jajai 77-30 was 37 cm shorter than its mother variety Jajai 77, 32 cm and 34 cm shorter than Basmati 370 and Sonahri Sugdasi respectively. The mutant strain Jajai 77-30 produced significantly (P

Table 2. Paddy yield (kg/ha) of aromatic rice mutants/varieties conducted in zonal trial during Kharif 1988.

Varieties/ Mutants	NIA	Badin	Thatta	B.S.K. (Hyd)	MPB	Jamali (Jaf)	Raja (Jacob)	Sh pur	Larkana	Dadu	Ave.	Rank
Bas.P	2307c	2780e	2520d	2467e	2453f	2500d	2260de	2513f	3660d	3007d	2647d	5
Bas-32	2967b	3487c	2740b	3120c	3160c	3127c	2827bc	2853d	4480c	3593c	3233c	4
Jajai.P	2193c	2800e	2857c	2760d	2447f	2507d	2140e	2560ef	3280d	2647de	2613d	7
Jajai-30	4120a	5477a	5413a	5620a	4600a	4527a	4433a	4867a	5820a	4337a	4920b	1
SS.P	2253c	3133d	2167f	2780d	2800e	2367e	2373d	2613e	3287d	2695e	2647d	6
SS-6	3247b	3440c	2280e	3080c	3040d	3220bc	2780c	3220c	5013b	3767bc	3307bc	3
B.385	3127b	3733b	2613c	3227b	3420b	3260b	3020b	3380b	5507a	3907b	3520b	2

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

Table 3. Paddy yield (kg/ha) of aromatic rice mutants/varieties conducted in zonal trial during Kharif 1989.

Varieties/ Mutants	NIA	Tando Bago (Badin)	Ansari Farm (Badin)	MPB (Thatta)	Shah Bandar (Thatta)	Larkana	Shaypur	Raja Farm (Jacob.)	Dadu	Jamali Farm (Jaf)	Ave.	Rank
Bas-7	4075b	5049c	4309d	3709d	3468c	4529d	5049c	5069c	4996c	4876c	4509d	4
Bas-32	3941b	4389b	4255d	3635d	3542c	4536d	4822b	4922c	4522d	4182d	4275e	5
Jajai.P	2314c	2338b	1539e	2578e	2991e	2678e	2797e	2839d	2656e	2176e	2491f	6
Jajai-2	4496b	5156c	5543d	4249c	4015b	5056c	5623b	5616b	5723b	5123b	5063c	3
Jajai-30	5623a	5976a	6370a	5643a	4336a	6090a	6216a	6336a	6096a	5923a	5863a	1
B.385	4129b	5790b	5910b	5102b	4069b	5596b	5649b	5589b	5623b	5049b	5256b	2

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

≤ 0.05) higher mean values for the different characters viz., number of panicles per hill (15.45), panicle length (31.18), grain yield per hill (41.15 g), number of fertile grains per panicle (81.75) and 1000 grain weight (23.13 g) as compared with the parent and other genotypes (Table 1).

The results of zonal trials (1988) indicated that the mutant strain Jajai 77-30 maintained consistently higher average yield over all sites and ranked first (Table 2). It gave average yield of 4920 kg/ha compared with parent and check varieties, Jajai 77 (2613 kg/ha), Basmati 370 (2647 kg/ha), Sonahri Sugdasi (2647 kg/ha) and Basmati 385 (3520 kg/ha) respectively. The result of zonal trials (1989) showed that mutant strain Jajai 77-30 also produced significantly higher average yield (5863 kg/ha) than the parent Jajai 77 (2491 kg/ha) and check variety Basmati 385 (5256 kg/ha) as shown in Table 3. The average yield of mutant Jajai 77-30 increased by 135.36% and 11.55% higher than its parent Jajai 77 and check variety Basmati 385, respectively. The site mean yields of zonal trials (1988 and 1989) revealed that the mutant strain Jajai 77-30 also ranked first at each site and was significantly superior in paddy yield than its parent and check varieties.

The grain yields (kg/ha) of mutant strain Jajai 77-30 along with other strains/varieties were tested over ten sites during 1990 (Table 4) and over eight sites during 1991 (Table 5) in National Uniform Rice Yield Trials (NURYT). The average yield of National Uniform Rice Yield Trial (NURYT) during 1990 revealed that the mutant Jajai 77-30 secured second position out of six genotypes on Pakistan basis. The mutant Jajai 77-30 gave 36% higher average yield than a check variety Basmati 370 (Table 4). Furthermore it was also superior in grain yield than another check variety Basmati Pak. While studying grain yields at individual sites, the mutant strain Jajai 77-30 also maintained its superiority over the check varieties Basmati 370 and Basmati Pak at six out of ten sites. The results of average yield of National Uniform Rice Yield Trials (NURYT) during 1991 indicated that mutant strain Jajai 77-30 secured first position out of nine genotypes on Pakistan as well as Sindh basis (Table 5). The mutant strain Jajai 77-30 produced 3% and 27% higher average yields than the Basmati 385 on Pakistan and Sindh basis, respectively. The data at individual sites revealed that mutant strain Jajai 77-30 produced higher grain yields than check variety Basmati 370 at five out of eight sites (Table 5).

In rice crop, significant improvement through the use of induced mutations have been reported for high yield (Futsuhara *et al.*, 1967; Soja & Simon, 1976; Bari *et al.*, 1981; Rutger & Peterson, 1981; Shu *et al.*, 1997) and for short stature (Hu, 1973; Rutger & Peterson, 1981; Okuno & Kawai, 1977; Mackill & Rutger, 1979; Sato, 1982; Rutger, 1982; Rutger, 1983; Takamure & Kinoshita, 1985; Mckenzie & Rutger, 1986; Clement & Poisson, 1988; Hu, 1991; Kawai & Amano, 1991). Present studies have confirmed the improvement for reduced plant height and high grain yield by mutation breeding. Such high yielding results were achieved due to reduction in plant height leading to lodging resistance.

Table 4. Paddy yield (kg/ha) of candidate rice varieties tested in National Uniform Rice Yield Trials at different locations during Kharif 1990.

Varieties/ KSK	Gujran Wala	Sheikhu Pura	NIAB	R.R.I Dokri	Govt. Farm Jamra	NIA	Thatta	D.I. Khan	Swat	Ave. over all Pak	Rank
DM-25	3583	3479	4196	5666	3375	3979	750	6633	3450	3815	1
Jajai-30	4262	3909	4062	5388	3750	4758	1000	3733	3929	3781	2
4048	4365	4229	3941	4611	4250	3944	1500	2866	---	3760	3
Bas. Pak	2185	2875	2866	5544	3875	4002	1825	4700	---	3364	5
Bas. 370	2392	2708	2387	4011	3625	3081	750	2533	2284	2769	6
Bas.385	3760	3344	3876	3722	3500	3706	1650	4333	4752	3662	4

Table 5. Paddy yield (kg/ha) of candidate rice varieties tested in National Uniform Rice Yield Trials at different locations during Kharif 1991.

Varieties/ KSK	Gujran Wala	Sheikhu Pura	NIAB	R.R.I Dokri	Govt. Farm Jamra	NIA	Thatta	Ave. over all sites Pak.	Rank over all Pak.	Ave. Sindh basis all Sindh	Rank over Sindh
DM-25	1609	4125	5238	3130	4979	4066	2000	3659	6	3544	3
DM15-30	1620	3667	4708	4050	3416	3200	1500	3451	8	3042	8
Jajai-30	1294	3944	5125	3780	5250	7200	1700	4232	1	4483	1
Jajai-2	1225	4667	4457	4639	4166	5933	2100	3955	3	4210	2
S. Bas	2393	4667	4937	3779	5666	2267	2300	3833	5	3503	5
TF 4	2732	4292	4042	2945	5287	3333	2300	3911	4	3466	6
Bas.385	2822	4958	6042	3269	5646	2733	2500	4100	2	3537	4
Bs.6129	779	2792	3750	3125	3771	2869	2200	2715	9	2991	9
Bas.370	2412	4167	4000	3038	3291	4400	2000	3516	7	3182	7

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