Pak. J. Bot., 39(7): 2463-2466, 2007.

IMPROVEM ENT OF GRAIN YIELD IN RICE VARIETY BASMATI-370 (*ORYZA SATIVA* L.), THROUGH MUTAGENESIS

H.R. BUGHIO, I.A. ODHANO, M.A. ASAD AND M.S. BUGHIO

Nuclear Institute of Agriculture (NIA),
Tando Jam, Sindh, Pakistan
niatjam@hyd.paknet.com.pk, bilal06_003@yahoo.com

Abstract

A high yielding rice mutant variety Mehak has been developed from a fine aromatic variety Basmati-370, through gamma rays (150 Gy). The mutant variety Mehak was found significantly better than its mother variety Basmati-370 in respect of yield and yield contributing traits. It has shown consistency in better paddy yield than all the mutant lines including its parent and local check in various micro, preliminary and advanced yield trials at Nuclear Institute of Agriculture, Tando Jam for three years. On the basis of three years yield it has shown 80% increase in paddy yield over its parent Basmati-370 and 40% yield increase than check variety Super Basmati. The mutant variety is also inherited with excellent aroma and other physico-chemical properties of check varieties Super Basmati and Basmati-2000.

Introduction

Rice has been a popular subject to mutagenesis because it is the world's leading food crop and of its diploid nature. 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 many countries (Maluszynski *et al*., 1986, Baloch *et al*., 1999, 2001a, 2001b, 2002, 2003). Recently IAEA/FAO has reported that 443 rice varieties have been developed through induced mutations (Anon., 2004) during the period of 1966-2004. 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 Basmati-370. Besides having an excellent grain quality, it grows tall and because of weak stems lodges at the reproductive stage resulting in reduced grain yield.

Materials and Methods

The pure and homogenous seeds of Basmati-370 (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 1992. One month old seedlings were subseqently transplanted in a plot, at a uniform distance of 20 cm between hills and rows.

At maturity, 2 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 separately during 1993. A high yielding mutant plant with short stature (Bas-15-2) was selected from the M_2 population of 150 Gy. The mutated traits of the Bas-15-2 were confirmed in M_3 and M_4 generations during the years 1994 and 1995. This mutant was further tested to confirm along with other cultivars in Micro Yield Trials, Preliminary

Yield Trials and Station Varietal Trials during 1996-1998. The experimental design of trials was RCB in each year. Fertilizer was applied at the rate of 100N: 60P: 0K kg/ha. 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, 1000 grain weight (g) and grain yield per plot (kg/ha) were recorded for all 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 Bas-15-2 was 32 cm shorter than its mother variety Basmati-370 (Clement and Poisson, 1988). The mutant strain Bas-15-2 produced significantly ($P \leq 0.05$) higher mean values for the different characters viz., number of panicles per hill (16.7) panicle length (29.5 cm), grain yield per hill (28.36 g) and number of fertile grains per panicle (89) as compared with the parent and other genotypes (Table 1).

In the micro yield trail (Table 2) the mutant variety Bas-15-2 (Mehak) gave significantly higher paddy yield (2813 kg/ha) than all the strains including parent Basmati-370 (1952 kg/ha) and check variety Super Basmati (2382 kg/ha). The mutant variety Bas-15-2 (Mehak) expressed an increase of 44% and 18% over parent Basmati-370 and check variety Super Basmati, respectively.

In the preliminary yield trial (Table 2) the mutant variety Bas-15-2 (Mehak) produced significantly higher paddy yield 2925 kg/ha than all the entries in the trial. It was 160 % and 40 % higher than the parent Basmati-370 and check Super Basmati, respectively.

In the station varietal trial comprising eight entries of aromatic rice group was conducted at Tando Jam during Kharif 1998. Significant differences were observed amongst the entries for paddy yield (Table 2). The mutant variety Bas-15-2 (Mehak) produced the highest paddy yield (3850 kg/ha) with an increase of 71 % and 63 % over its parent Basmati-370 and check variety Super Basmati, respectively.

The results of three years indicated that the mutant variety Bas-15-2 (Mehak) maintained its superiority in paddy yield over all other mutants. It gave average yield of 3196 kg/ha as compared with parent Basmati-370 (1776 kg/ha) and check variety Super Basmati (2280 kg/ha).This yield was 80 % and 40 % higher than parent variety Basmati-370 and check variety Super Basmati.

In rice crop, significant improvements through the use of induced mutations have been reported for high yield (Bari *et al.*, 1981; Rutger & Peterson, 1981; Shu *et al.*, 1997; Wen & QW, 1996) and for short stature (Rutger, 1982; Sato, 1982, Rutger, 1983; Takamure & Kinoshita, 1985; Mckenizie & Rutger, 1986; 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 1. Agronomical characters of Bas-15-2 (Mehak) and other rice genotypes in M_3 and M_4

Strains/ varieties	Heading date (50%)	Plant height (cm)	No. of panicles per hill	Panicle length (cm)	Fertile grains per panicle	Fertility %per panicle	1000 grain weight (g)	Grain yield per hill (g)
Bas-15-2	96 c	130 d	16.7 a	29.5 ab	149 a	89 a	21.9 bc	28.3 a
Bas-15-1	107 b	131 d	14.5 cd	27.4 c	70 e	67 d	23.2 b	17.5 d
Bas-15-14	94 c	109 e	16.1 ab	28.8 b	134 b	81 bc	18.9 d	26.8 a
Bas-30-2	113 ab	151 b	13.8 d	27.4 c	72 de	84 abc	22.2 bc	13.6 e
Bas-2.0	110 ab	128 d	14.8 bcd	29.0 b	88 d	78 c	18.6 d	18.6 cd
Jajai-77 (P)	111 ab	156 b	16.1 ab	28.9 b	87 d	67 d	22.2 bc	20.8 bc
Jajai-15/B	105 b	137 c	15.2 bc	30.0 a	113 c	87 ab	25.3 a	21.1 b
Bas-370 (P)	118 a	162 a	14.0 cd	27.8 c	68 e	63 d	19.5 d	14.3 e
S. Bas (check)	104 b	130 d	15.9 ab	28.9 b	77 de	81 bc	21.4 c	19.2 bcd

DMR test (0.05): means followed by the same letters are not significantly different from each other. (Av. of two years)

Table 2. Performance of mutant strains/varieties of rice for paddy yield (kg/ha) in different varietal trials conducted during 1996, 1997 and 1998

Varieties/ mutants	Micro yield trial 1996	Preliminary yield trial 1997	Station varietal trial 1998	Average over three years	% Increase over other genotypes
Bas-15-2	**2813 a**	**2925 a**	**3850 a**	**3196 a**	**--**
Bas-15-3	2052 cd	1808 e	1812 e	1891 e	69
Bas-30-4	2553 b	2058 c	2208 d	2273 c	41
Jajai-15/A	2132 cd	1917 d	3108 c	2386 c	34
Jajai-15/B	2212 c	1867 de	2208 d	2096 d	52
Jajai-15-2	2082 cd	2275 b	3166 c	2508 b	27
Jajai-77-P	1872 e	1292 f	1891 e	1685 f	90
Bas-370-P	1952 e	1125 f	2250 d	1776 ef	80
Super Bas (check)	2382 bc	2092 c	2366 d	2280 c	40

DMR test (0.05) means followed by the same letters are not significantly different from each other.

Table 3. Physico-chemical properties of mutant variety Bas-15-2 (Mehak).

Physico chemical traits	Bas-15-2 (Mehak)	Bas – 2000	Super Bas
Alkali Spreading	4.5	5.0	5.0
Gelatinization temperature	Intermediate	Intermediate	Intermediate
Amylose (%)	21.94	19.03	20.58
Aroma	2.0	2.0	1.0
Paddy weight	200	200	200
Brown rice	79	86.25	77.25
Total milled rice	72	74	67.5
Broken rice	7	12.25	9.75
Total head rice	62.75	54.25	57.75
Bran plish	9.25	19.75	9.75
Husk	21	13.75	22.75

References

Anonymous, 2004. IAEA/FAO leaflet 2004.

Baloch, A.W., A.M. Soomro, G. Mustafa, M.S. Bughio and H.R. Bughio. 1999. Mutagenesis for reduced plant height and high grain yield in Jajia 77, an aromatic rice (*Oryza sativa* L.) variety. *Pak. J. Bot*., 31: 469-474.

Baloch, A.W., A.M. Soomro, M.A. Javed and M.S. Bughio. 2001. Use of induced mutations for yield and quality improvement in aromatic rice. *Pak. J. Bio. Sci*., 1: 78-79.

Baloch, A.W., A.M. Soomro, M.A. Javed, H.R. Bughio, S.M. Alam, M.S. Bughio, T. Mohammed and N.N. Mastoi. 2003. Induction of salt tolerance in rice, through mutation breeding. *Asi. J. Plant Sci*., 2(3): 273-276.

Baloch, A.W., A.M. Soomro, M.A. Javed, M. Ahmed, H.R. Bughio, M.S. Bughio and N.N. Mastoi. 2002. Optimum plant density for high yield in rice (*Oryza sativa* L.). *Asi. J. Plant Sci*., 2: 114-116.

Baloch, A.W., A.M. Soomro, M.A. Javed, M.S. Bughio and H.R. Bughio. 2001. Genetic improvement in rice (*Oryza sativa* L.) through mutagenesis. *Pak. J. Bio. Sci*., 1:18-19.

Bari, G., G. Mustafa, A.M. Soomro and A.W. Baloch. 1981. Studies on the yield performance and grain quality of mutant strains of rice. *Pak. J. Sot*., 13: 189-194.

Clement, G. and C. Poisson. 1988. Genetic determinants of semi-dwarf characters induced in *Oryza sativa* for upland rice cultivation. *Mutation Breeding News letter*, 31: 5.

Hu, C.H. 1991. Use of induced semi-dwarfing gene to alter the rice plant type and cultural breeding practices for sustainable agriculture. In: *Plant Mutation Breeding for Crop Improvement*. IAEA, Vienna, pp. 167-172.

Kawai, T. and E. Amano. 1991. Mutation breeding in Japan. In: *Plant Mutation Breeding/or Crop Improvement*. Vol.1 IAEA, Vienna, p. 47-66.

Maluszynski, M., A. Micke and B. Donini. 1986. Genes for semi-dwarfism in rice induced by mutagenesis. In: *Rice Genetics*, IRRI, Manila, pp.729-737.

McKenzie, K.S. and J.N. Rutger. 1986. A new semi-dwarf mutant in a long grain rice cultivar. *Crop Sci*., 26: 81-84.

Rutger, J.N. 1982. Use of induced and spontaneous mutants in rice genetics and breeding First Coordinated Research Programme on Evaluation of Mutant Stocks for semi-dwarf Plant Type as Cross Breeding Materials in Cereals. 1981, Vienna, Austria, IAEA-TECDOC-268, Vienna (1982) 105.

Rutger, J.N. 1983. Applications of induced and spontaneous mutation in rice breeding and genetics. *Advances in Agronomy*, 36: 383-413.

Rutger, J.N. and M.L. Peterson. 1981. Research tool uses of rice mutants for increasing crop productivity. In: *Induced Mutations-A Tool in Plant Breeding, Austria* p. 457-468.

Sato, H. 1982. Since Reimei, rice variety: Its use for rice breeding. *Gamma Field Smposia*, 21: 1-6.

Shu, Q., D. Wu and Y. XIA. 1997. The most widely cultivated rice mutant variety 'Zhefu 802' in China and its genealogy. Mutt. Breed. Newsletter, 43: 3-6.

Takamure, I. and T. Kinoshita. 1985. Inheritance and expression of reduced culm number character in rice. *Japan. J. Breed*, 35: 17-24.

Wen, X. and L.QW. 1996. Crop improvement through mutation techniques in Chinese agriculture. *Mutt. Breed. Newsletter*, 42: 3-6.

(Received for publication 14 February 2006)