Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Sciences
Volume 1 Number 1: 39-40, 2002

Impact of Reduced Culm Length on Yield and Yield Parameters in Rice

A. W. Baloch, A. M. Soomro, M. A. Javed, M. S. Bughio and N. N. Mastoi
Nuclear Institute of Agriculture, Tandojam-70060, Sindh, Pakistan

Abstract: Three short statured rice mutants (B-370-32, J-77-30 and SS-6) were developed through mutation breeding from three aromatic, fine grained, but tall and low yielding local varieties (Basmati-370, Jajai-77 and Sonahri Sugdasi, respectively). The mutants exhibited superiority in grain yield and quality over their parents. The number of panicles per hill, grain weight per hill and fertile grains per panicle made significant contribution to grain yield per unit area. Among the mutants, the grain yield of J-77-30 was significantly higher as compared to its parent/check varieties.

Key word: Mutation breeding, rice, yield parameters

Introduction

Rice (*Oryza sativa* L.) is grown on 2.42 million hectares in Pakistan, covering approximate 1.22 million hectares under aromatic and 1.20 million hectares under non-aromatic cultivars (Anonymous, 1998-99). The excellent grain quality of aromatic rice cultivars such as Basmati-370, Jajai-77 and Sonahri Sugdasi fetch two to three times higher than those of the coarse grain varieties in the national and international markets. However, the major drawback of these local aromatic cultivars is that they grow very tall and consequently lodge on fertile soils at the time of grain formation resulting in serious yield losses. The use of induced mutation has been considered as an appropriate approach for developing short statured mutants accompanied by high yield and excellent grain quality. (Bari *et al*., 1981; Micke *et al*., 1990; Hu, 1991; Maluszynske *et al*., 1991; Baloch *et al*., 1999).

Materials and Methods

Seeds of three varieties of rice viz; Basmati-370, Jajai-77 and Sonahri Sugdasi were treated with 150, 200 and 250 Gy of gamma rays from 60Co and 15, 20 and 25 Gy of neutrons fast, to raise M1 generation. Selection was carried out in M2 generation which was raised from the seeds of first formed panicle of each plant in each treatment. M3 generation was raised to confirm the mutated traits selected from M2 generation. These mutant lines, after subsequent morphogenetic evaluation, were tested for yield performance in replicated yield trial in M4 generation at Experimental Farm, Tandojam. A high yielding variety Basmati-385 was also included in the trial as a check for comparison.

The yield trial was laid out in Randomized Complete Block Design. The size of the plot was 3 x 4 m^2. The seedlings were transplanted at a distance of 20 cm between rows and hills with three seedlings per hill. The fertilizer was applied at the rate of 80N:40P (kg/ha) in the form of urea and triple super phosphate. The basal dose of fertilizer 40N: 40P (kg/ha) was applied before transplanting and the remaining quantity of nitrogen fertilizer was applied as top dressing after 40 days of transplanting. The paddy yield and yield components were recorded at the time of harvesting, except days to heading date, which was recorded from seedling transplantation to 50 % flowering and data were analyzed following Gomez and Gomez (1984).

Results

The data of M3 generation revealed that the mutants B-370-32, J-77-30 and SS-6 were about 22 to 32 days earlier and had 20 to 43 cm short culm length than their respective parents. These mutants had 6 to 7 more panicles per hill, 14 to 21 more fertile grains per panicle and 242 to 543 grams higher grain yield per m2 than their parents (Table 1). The mean values for all the traits were significantly different from each other in M4 generation. Variations categorically were observed within parameters and sparse ranges existed from 94 to 131 days for seeding to 50 % flowering, 127 to 167 cm for plant height, 10.33 to 15.45 for number of panicles per hill, 18.5 to 41.15 gm for grain yield per hill, 85 to 109 for total grains per panicle, 42 to 81.75 for fertile grains per panicle, 21.43 to 24.43 (gm) for 1000 grain weight and 2.42 to 4.78 (kg) for grain yield per plot. The less heading days were 94 in B-370-32

Table 1: Performance of promising mutants for yield and yield components in M3 generation

Mutants/varieties	Days to 50 % heading	Plant height (cm)	No. of penicles Per hill	Fertile grains perx pencile	Grain yield per hill (g)	Grain yield per m^2 (g)
Basmati 370(P)	117.5	149.7	14.2	90	19.48	412
B-370-32	85.2	129.2	20.2	104	32.16	729
Jajai 77(P)	118	150.4	14.6	93	20.41	435
J-77-30	95	106.7	22.3	114	42.15	978
Sonahri Sugdasi (P)	116.5	148.5	14.4	93	22.70	492
S. S-6	94.2	116.5	21.7	107	33.55	764
Basmati-385 (check)	106.5	124.0	6.4	101	30.41	685

Table 2: Performance of promising mutants for yield and yield components in M4 generation

varieties/mutant strains	Days to 50 % headings	Plant height (cm)	No. of panicles per hill	Grain yield per hill (g)	Total grains per panicles	Fertile grains per panicles	1000 grains weight (g)	Grain yield per plot ($12m^2$) (kg)
Basmati 370(P)	113c	162b	11.00c	18.50f	85b	42.00c	21.58d	2.85d
B-370-32	94d	131c	14.05b	31.18c	99a	62.75b	22.28c	3.8bc
Jajai 77(P)	126b	167a	10.68c	19.43f	88b	45.00c	21.43d	2.42e
J-77-30	96d	130c	15.45a	41.15a	109a	81.75a	23.13a	4.78a
Sonahri Sugdasi (P)	131a	164b	10.33c	21.75e	88b	48.25c	24.38a	2.93d
S. S-6	95d	127d	14.32b	32.55b	102a	66.75b	24.43a	4.02b
Basmati-385 (check)	94d	129c	14.23b	29.43d	96a	66.25b	22.25c	3.92bc

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

and Basmati-385 as compared to 131 days in Sonahri Sugdasi. Plant height was lowest in mutant strain SS-6 (127 cm) whereas, it was highest in a parent variety Jajai-77 (167 cm). The mutant strain J-77-30 produced higher number of viable panicles per hill (15.45), higher grain yield per hill (41.15gm), more grains per panicle (109), more fertile grains per panicle (81.75) and higher grain yield per plot (4.78 kg). Whereas, these parameters were consistently lower in other entries of the experiment. Comparatively, number of viable panicles were low in variety Sonahri Sugdasi (10.33), while variety Basmati-370 exhibited low grain yield per hill (18.5gm), low number of grain per panicle (85) and low fertile grains per panicle (42). Variables of 1000 grains (21.43gm) and grain yield per plot (2.42 kg) were low in variety Jajai-77 (Table 2).

Discussion

The results eventually impart that mutagen have induced changes providing classical criteria for isolation of useful mutants. In three mutants, there was a substantial decrease in plant height, while an increase in other quantative parameters in accordance with a shift in the mean away from the direction from the previous selection (Brock, 1965). Presently, it is a universally recognized fact that plant architecture has evolutionary significance and practically reduced plant height has contributed a lot in numerous crops to potentiate the grain yields. Therefore, the increased plant yield of our mutants may be linked to the altered plant morphology associated with increased grain yield per hill, total grains per panicle, fertile grains per panicle and 1000 grain weight. The plant morphology accompanying with such modifications in quantitative traits has achieved great importance to make the plants fit in the mathematical models for increasing the plant yield. It is identified that reduced plant height in rice has a positive relation ship with increased yield due to increased response to higher doses of fertilizer associated with increased lodging resistance and increased panicle number per unit area (Dat *et al.*, 1978) and increased spikelets per unit area (Takeda *et al.*, 1984). Semi-dwarfism has been reported to give 15 to 25 % more grain yield (Rutger, 1983). In the context of the improved quantitative characters, it is observed that the plot yield of all semi-dwarf mutants was significantly higher as compared to their parents. The mutant J-77-30 produced significantly highest grain yield (4.78 kg/plot) followed by SS-6 (4.02 kg/plot).

Acknowledgment

We are indebted to Mr. Muhammad Afzal Arain, PSO NIA, Tandojam for the critical review of manuscript and valuable comments.

References

Anonymous, 1998-99. Agricultural Statistics of Pakistan. pp: 13-17.

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 Jajai 77, an aromatic rice (*Oryza sativa* L.) Variety. Pak. J. Bot., 31: 469-474.

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

Brock, R. D., 1965. Induced mutation affecting quantitative characters. In: The use of Induced Mutations in Plant Breeding. Supplements to Radiation Botany, 5: 451-464.

Dat, T. V., M. L. Peterson and J. N. Rutger, 1978. Performance of rice composite dimorphic for plant height and for pubescence. Crop Sci., 18, 1-4.

Gomez, K. and A. Gomez, 1984. Statistical Procedures for Agricultural Research, pp: 1-68.

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.

Maluszynske, M., B. Sigurbjornsson, E. Amano, L. Sitch and O. Lamro, 1991. Mutant varieties data bank, FAO/IAEA data base MBNL, 38: 16-21.

Micke, A., B. Donini and M. Maluszynski, 1990. Induced mutations for crop improvement Breeding Review, No. 7.

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

Takeda, T., M. Oka and W. Agata, 1984. Characteristics of dry matter and grain production of rice cultivars in the warmer part of Japan IV. Comparison between grain production of Japanese and new Korean cultivars. Japan J. Crop Sci., 53: 28-34.