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The Induction and Evaluation of Productive Semidwarf Mutants of Basmati-370

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ABSTRAK

Biji benih Basmati 370 yang kering dan seragam, dengan kandungan kelembapan lebih kurang 14% telah didedahkan kepada pancaran sinar gamma (dari sumber 60 Co) dosnya 0, 15, 20 dan 25 kR. Dua puluh satu muatan separuh kerdil telah dipilih dari 36,000 tumbuhan M2 yang berasal daripada lebih kurang 12,000 tumbuhan M1. Perilaku pembaikbiak mutan-mutan tersebut telah dipilih di peringkat M3 dan kesudahannya 6 mutan telah dipilih. Ujian kadar hasil perbandingan mutan-mutan tersebut dengan induk kultivar Basmati–370, telah menunjukkan yang jenis mutan berpotensi mengeluarkan hasil yang tinggi dan mempunyai bentuk separuh kerdil. Sifat-sifat lain dan juga trait fizikokimia mutan-mutan tersebut dan kultivar induk telah juga dibincangkan.

ABSTRACT

Dry, uniform seeds of Basmati 370 with about 14% moisture content were exposed to 0, 15, 20 and 25kR doses of gamma rays (60Co source). Twenty one semi-dwarf mutants were selected from 36,000 M2 plants originating from about 12,000 M1 plants. The breeding behaviour of these mutants was studied in M3 and consequently 6 mutants were selected. The comparative yield test of mutants with mother cultivar Basmati-370, established the high yield potential and semi-dwarf plant posture of mutant strains. The other plant attributes as well as physico-chemical traits of the mutants and parent cultivar are also presented.

INTRODUCTION

Basmati rices have been prized for their good cooking quality and aroma in the sub-continent of Indo-Pak from time immemorial. From these Basmati rices, Basmati 370 was isolated from the local germplasm and is currently cultivated predominantly in the province of Punjab.

Though the cultivar is matchless in cooking quality and aroma, it possesses two detrimental aspects which are: (i) tall growing habit and (ii) weak straw. Both these attributes make the cultivar incapable of responding to fertilizer or withstanding lodging. The importance of short culm length and maximum yield potential is now readily recognized.

But the hybridization with the world famous Dee-Gee-Woo-Gen dwarfing gene source may not accomplish the arduous task of rectifying the two set-backs inherent in basmati rice. The mutagenesis approach may be the pragmatic approach to accomplish the job successfully. The technique may provide an alternative as it is a less disruptive approach inducing fresh variability into a well adapted local germplasm of basmati rices.

The earlier strifes have been fruitful in the induction of short stature (Malik, 1982; Marie, 1981; Misra, 1979 and Sajjad, 1984), lodging resistance (Rutger *et al.*, 1977) with high yield potential (Sajjad, 1984 and Rutger, 1982) and maintaining the original aroma of Basmati 370 (Ready *et al.*, 1975).

A large number of cultivars has already been developed using induced mutants as gene donors for desireable traits. A high frequency of recovering the semidwarf progenies resulting from hybridizing the induced semidwarf mutant lines

have also been reported (Marie, 1981 and Reddy, 1975) which illustrates the even greater potential of mutants as parent for hybridization.

In 1980, the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, Pakistan embarked on this study to induce semi-dwarf mutants of Basmati 370.

MATERIALS AND METHODS

Healthy and uniform seeds of Basmati 370 with moisture contents of about 14% were exposed to 9, 15, 20 & 25 kR doses of gamma rays from a Co source of NIAB 1979-80. The 15, 20 & 25 kR treatments consisted of 5000 seeds each. The transplantation was accomplished by using single seedling per hill, at a ear to row distance of 15 cm. On maturity of the crop, first three emerging panicles per plant were harvested and bulked dose wise. M_2 generation was grown at a plant to row distance of 20 cm using a single seedling per hill during 1981-82. The plants of Basmati 370, grown from unirradiated seed as control, were transplanted after every 20th row of M_2 plants. Some semi-dwarf mutants (DM) were selected and their breeding behaviour was studied during 1982-83. The true breeding mutants were selected and yield tested in a micro yield trial (Gross plot size $8m^2$/entry) during 1983-84. The micro yield trial was conducted using a randomized complete block design with four replications. Single seedling per hill was transplanted with a plant to row distance of 20 cm. The crop was fertilized at the rate of 80:40:0, N:P:K, kg/ha respectively. The physico-chemical traits were studied and the data were statistically analysed.

EXPERIMENTAL RESULTS

The breeding behaviour of the mutants selected from M_2 generation was studied in M_3 during 1982-83. The results are presented in Table 1. It is evident from the data that all the mutants were significantly shorter than the parent cultivar Basmati 370 by about 16% to 19%. The performance of these semi-dwarf mutants for number of productive tillers per plant, number of days to flowering, panicle length, panicle fertility and yield per plant was not significantly different from that of Basmati 370. For Basmati 370, DM18, DM20, DM22, DM24 and DM25, number of grains per panicle was significantly higher than the rest of the mutants.

TABLE 1
Performance of semidwarf mutants and parent cultivar Basmati-370 in M_3 (1982–83)

Name of mutant variety	Plant height reduction (%) over Bas. 370	No. of productive tillers/ plant	No. of grains/ panicle	Panicle fertility (%)	Yield plant (g)
Basmati 370	–	11.7a	127.1a	93.4a	21.2a
DM18 (15kR)	16.0	11.6a	124.0ab	95.3a	20.8a
DM20 (15kR)	16.3	11.4a	120.6abc	95.0a	19.9a
DM22 (15kR)	16.4	11.3a	119.9abc	94.5a	19.5a
DM24 (20kR)	17.1	11.2a	118.4abcd	94.9a	19.3a
DM25 (20kR)	17.3	11.0a	116.4abcd	95.0a	19.3a
DM38 (25kR)	18.6	10.0a	110.3cd	93.8a	18.0a

Figures followed by different letters are significant at 5% level of significance according to DMRT.

TABLE 2
Performance of semi-dwarf mutants and parent variety Basmati-370 in a micro yield trial

Name of mutant/ variety	Plant height (cm)	No. of productive tillers/ plant	No. of grains/ panicle	Panicle fertility %	Yield (kg/ha)
Basmati 370	177.0a	9.3b	112.3a	85.3a	3564.0b
DM18 (15kR)	132.8b	10.9a	121.6a	89.1a	4464.0a
DM20 (15kR)	133.2b	11.8a	119.5a	88.9a	5085.0a
DM22 (15kR)	134.1b	11.3a	127.3a	89.1a	5154.0a
DM24 (20kR)	132.8b	11.8a	127.4a	89.6a	5373.0a
DM25 (20kR)	131.5b	11.3a	124.3a	89.5a	5245.0a
DM38 (25kR)	131.8b	12.0a	118.0a	89.3a	5250.0a

Figures followed by different letters are significant at 5% level of significance according to DMRT.

TABLE 3
Physico-chemical traits of rice mutants variety

Variety/ mutant	Length (mm)	Width (mm)	Length width	Quality Index	Elongation ratio	Amylose %	Aroma
Basmati-370	6.9	1.8	3.8	2.3	1.8	22.8	3.2
DM-18	6.7	1.7	3.9	2.4	1.8	23.3	3.0
DM-20	6.7	1.7	3.9	2.3	1.9	22.9	3.0
DM-22	6.7	1.7	3.9	2.3	1.8	23.1	3.0
DM-24	6.8	1.8	3.8	2.3	1.9	23.5	3.5
DM-25	6.6	1.7	3.9	2.4	1.9	22.8	3.4
DM-38	6.6	1.7	3.9	2.4	1.8	23.2	3.0

The results of micro yield trial conducted during 1983-84 are presented in Table 2. It is evident from the data that all mutant lines were significantly shorter in height than Basmati 370. They were 24% to 26% shorter and had significantly higher number of productive tillers per plant. The performance of mutant strains for the plant attributes of panicle length and thousand grain weight was significantly inferior to that of parent. The mutant strains were similar in performance for the plant attributes of number of grains per panicle and panicle fertility percent. The mutant strains surpassed Basmati 370 in yield potential by about 25-51%. The plant attributes which

have enhanced the yield potential of mutant lines seem to be a higher number of productive tillers per plant. Such results have also been reported in rice, (Sajjad, 1984; Dat, 1978 and Rangaswamy, 1983) . The results of physico-chemical traits of mutants and parent indicate (Tabel 3) that some characteristics of the mutants were at par while others were superior to those of the parent variety, Basmati-370. For instance, the mutants DM-24 and 25 had a stronger aroma than the parent.

It may safely be concluded from the present study that all the mutants exhibited the property of semi-dwarf plant posture along with a higher yielding capability. They may be used as gene sources for short culm for basmati rices.

The emphasis in future studies will be to isolate the number of mutants to avoid the potential risk of genetic vulnerability of semi-dwarf mutants and to use these as gene source for stem shortening of Basmati 370.

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