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RADIATION INDUCED SHORT STATURE, EARLY MATURING MUTANTS IN BASMATI RICE (*ORYZA SATIVA* L.)

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Seeds of two indica rice cultivars viz Basmati 370 and Basmati 198 were irradiated with different dosages of gamma rays to induce short stature and earliness. A large number of early flowering and short stature mutants were selected in M2 generation. Most of the mutants segregated for earliness and plant height in M3 generation. Four short statured mutants of Basmati 370 viz. DM16-5-1, DM16-5-2, DM-2 and DM107-4 and an early flowering mutant of Basmati 198 namely EF-76-1 were finally selected. These mutants were further studied for their agronomic characteristics in M4. Reduction in plant height ranged from 18-43 % in the short stature mutants. While the early flowering mutant flowered three weeks earlier than the parent variety Basmati 198.

Key words: Rice, Mutations, Earliness and Short stature.

INTRODUCTION

Interest in the development of short stature and early maturing varieties of crop plant is a common objective in many countries of the world. This objective has been emphasized in the rice breeding programme in Pakistan mainly because the indigenous Basmati varieties are tall, late maturing, sensitive to photoperiod, and are less responsive to nitrogenous fertilizer. Late maturing habit of these cultivars do not leave sufficient time for timely sowing of wheat crop in the rice fields. So far, the rice breeders in Pakistan have been using the conventional breeding methods for attaining these goals.

The induction of large number of semidwarf and early maturing mutants of rice have been documented [1-7] but very few tries have been done to induce early maturing [1] and semidwarf [8,9,10] mutants of Basmati rices. The induction of larger number of such mutants of Basmati rice may be emphasized to avoid genetic vulnerability of the mutants to insect pests and diseases epidemics. These mutants may also be used as gene sources for early maturity and stem shortening of Basmati 370 rice through hybridization.

This prompted the present study and the results are discussed in the paper.

MATERIALS AND METHODS

Uniform seeds of two indica rice (*Oryza sativa* L.) cultivars Basmati 370 and Basmati 198 were irradiated with the gamma rays (^{60}Co) doses 0,15,25 and 30 kR. One thousand seeds in each treatment were used. Moisture content of the seed at the time of exposure was adjusted to 14 %. After the treatment, the seeds were sown in the nursery beds. Thirty days old seedlings were planted in the main plot as M_i generation at a spacing distance of 11 centimeters in order to supress tillering. At maturity, the first formed three panicles of each M_1 plant were harvested in bulk. The bulk harvested M_1 seed,9000 seeds in each treatment were transplanted as single seedling per hill to grow M_2 about 27,000 plants, with a plant-to-row distance of 22cm. Every 10th row was planted with the check variety. At panicle emergence stage, early plants were marked by red tags while short stature plants were isolated at maturity. A total of 81 useful variants were selected from M_2 of Basmati 370 population, and 12 mutants from Basmati 198 population.

In M_3 generation, most of the plant progenies segregated for earliness and plant height. Finally, four semidwarf mutants namely DM16-5-1, DM16-5-2, DM-2 and DM107-4 from Basmati 370 and an early flowering mutant i.e. EF-76-1 from Basmati 198 were selected from 25 and 15 kR respectively, while 30 kR dose did not resulted in useful mutation. These mutants alongwith the parent varieties were transplanted (plot size 1.10 m x 1.54 m) with single seedling per hill at a spacing of 22 x 22 cm and detailed study of their agronomic characters was made. In order to avoid lodging in Basmati 370 chemical fertilizer was not applied at any stage during the course of these studies. The design of the experiment was a randomized complete block with three replications.

Data with respect to number of days from seedling to flowering, plant height, peduncle length, internode length, tillers per plant, distance between flag leaf collar to panicle neck node, panicle length, fertility percentage, 500 grain weight, grain yield per plant and harvest index were recorded. Data were statistically analysed and mean differences were determined by L.S.D.

RESULTS AND DISCUSSION

Basmati 370 mutants DM16-5-1, DM16-5-2, DM-2 and DM107-4 were selected for short stature and it is clear from Table 1 that the plant height in these mutants has been significantly reduced i.e. about 18-43 % as compared to the parent variety. Our results agree with Samoto [7], Rutger and Peterson [11], who also reported short statured mutants derived from japonica rice cultivars. In the mutants DM16-5-1 and DM16-5-2, the distance between flag leaf collar to panicle neck node was also reduced due to which, flag leaf in these mutants appears high in the canopy. However the distance was not as much reduced as in other short stature tropical varieties, IR-6 and IR-8. Erect flag leaf is a desirable trait for efficient sunlight utilization in photosynthesis. Duncan [12] advocated the importance of leaf angle for canopy photosynthesis. Rutger *et al.* [5] also reported a mutant D-7 with high canopy appearance, capable of giving high yield.

Mean values for days to heading (Table 1) show that all the short stature mutants have almost the same flowering period as that of Basmati 370 except DM-2 which flowers four days later than Basmati 370. An early flowering mutant namely EF-76-1 derived from a late maturing variety Basmati 198 flowers three weeks earlier than Basmati 198. The mutant is also relatively shorter in height than the parent variety. Early flowering useful mutants in rice have been reported by several workers [1,4,5].

The peduncle length, length of each of upper 6 internodes, panicle length, 500 grain weight of DM16-5-1, DM16-5-2, DM-2 and DM107-4 (Table 2) have been significantly reduced as compared to Basmati 370, while the 7th internode was absent in DM107-4 due to 43 % reduction in plant height (Table 1). The fertility percentage in case of DM16-5-1 and DM16-5-2 and tillers per plant in DM-2 and DM-107-4 has been increased significantly than those of Basmati 370. Apparently tillers per plant and fertility percentage have compensated each other in all the four mutants with the result that a non significant difference in grain yield per plant among the four mutants of Basmati 370 was obtained (Table 2).

Maximum reduction in plant height and an increase in number of tillers per plant was observed in DM107-4 which has the potential to respond positively to higher doses of fertilizer. A semidwarf high yielding and good quality PAU mutant of Basmati 370 has been reported by Saini *et al.* [6] which is 72 cm shorter, 10 days earlier and 83.7 % high yielding than the parent variety.

Harvest index of all the mutants (Table 1 and 2) increased significantly than the parent varieties viz. Basmati-370 and Basmati 198. Increase in the harvest index of these mutants is an indication of the high yielding potential of the mutants. Many workers suggested that yield may be

Table 1. Origin and characteristics of five agronomically promising mutants selected from Basmati 370 and Basmati 198.

Genotype	Irradiation dosage (kR)	Days to heading	Height (cm)	Percent reduction over control	Flag leaf collar to panicle neck neck node (cm)	Desirable attributes
Basmati 370 selections						
DM16-5-1	25	113.33	144.10	18.72	3.24	Short stature
DM16-5-2	25	111.76	126.67	28.55	3.37	Short stature
DM-2	25	117.00	136.90	22.78	4.05	Short stature
DM107-4	25	112.02	100.76	43.16	5.09	Short stature
Basmati 370 (control)	–	112.85	177.28	–	5.01	–
Basmati 198 selections						
EF76-1	15	94.75	128.00	5.26	5.23	Earliness
Basmati 198(control)	–	114.52	135.10	–	4.23	–
LSD 5 %		1.78	3.47		N.S	–
1 %		2.51	4.89		N.S	–

Table 2. Agronomic characteristics and yield components of semi-dwarf mutants.

Genotype	Plant height (cm)	Peduncle length (cm)	Internode length (cm) 1	2	3	4	5	6	Panicle length (cm)	Tillers per plant	Fertility %	500 grain weight (gms)	Harvest index	Yield per plant (gms)
DM16-5-1	144.10	38.07	22.99	21.71	14.08	10.40	6.75	2.3	29.09	11.48	94.36	9.99	33.50	20.89
DM16-5-2	126.67	36.81	21.35	18.74	10.71	8.08	4.6	1.74	28.16	11.9	94.65	9.20	29.58	17.33
DM-2	136.90	38.43	19.84	20.18	11.78	9.37	5.41	1.73	27.13	14.26	86.87	10.15	27.28	18.94
DM107-4	100.76	36.43	19.48	13.03	3.60	2.13	1.38	–	26.23	16.33	82.41	9.42	31.43	18.58
Basmati-370 (control)	177.28	44.34	23.51	24.25	19.28	16.79	12.56	4.06	32.09	12.76	87.14	10.17	25.87	21.56
LSD 5 %	3.38	1.69	1.12	1.12	1.45	0.97	0.93	1.06	1.43	2.91	5.24	0.24	4.71	–
1 %	4.92	2.46	1.63	1.63	2.11	1.47	1.36	1.59	2.08	–	7.62	0.35	–	–

Table 3. Total plant height and yield components of Basmati 198 and an early flowering mutant EF-76-1.

Genotype	Plant height (cm)	Panicle length (cm)	Tillers/plant	Fertility percent	500 grain weight (gms)	Yield per plant (gms)	Harvest index
EF-76-1	128.00	27.51	12.52	91.62	10.15	22.67	37.36
Basmati 198 (control)	135.10	26.38	12.00	86.03	10.35	19.30	28.29
LSD 5 %	–	N.S	N.S	3.67	N.S	N.S	3.08
1 %	–	–	–	N.S	–	–	7.10

improved by higher grain yield combined with higher harvest index values [5,12,13]. High yielding semidwarf mutants have also been reported by Gangadharan *et al.* [14] and Nagraju *et al.* [15].

Table 3 depicts some important characteristics of the mutant EF-76-1 and the parent variety Basmati 198. There is not significant difference in plant height, panicle length, tillers per plant, 500 grain weight and yield per plant. However, a slight increase in yield per plant of EF-76-1 can be attributed to a significant increase in the fertility percentage as compared to the parent variety. Mikaelsen *et al.* [4] reported an early flowering mutant *Early cessriot* which headed 28 days earlier while the other characters in the mutant showed no difference from the parent variety. Induced earliness in rice has also been reported by Awan and Cheema [1] and Gangadharan *et al.* [14].

From the present study it may be concluded that Basmati rices may be improved for maturity period and plant height through induced mutations and these induced mutations may serve an alternate source of dwarfism and early maturity in the basmati background for hybridization.

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