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Short Communication

Gamma rays induced mutations in Basmati rice (*Oryza sativa* L.)

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The important objectives in improving Basmati rice are to develop short statured, high yielding, early maturing and disease resistant varieties. Mutation breeding is relatively a quicker method for the improvement of crops [1]. Many physical and chemical mutagens have been used for induction of useful mutants in rice [2]. The present article deals with the observation on seedling growth injury and spikelet sterility in M_1 generation and chlorophyll and morphological mutations in M_2 generation in Basmati rice (*Oryza sativa* L.) induced by gamma rays.

The dry seeds (moisture, 12%) of the two varieties of rice, namely, Taraori Basmati and Pusa Basmati 1 were used for mutagenic treatments. Two hundred seeds were taken for each treatment of gamma rays in both the varieties for mutagenic treatment. The seeds were sealed in polythene bags and exposed to 50, 100, 150, 200, 250 and 300 Gy doses of gamma rays (^{60}Co source) at Gamma Cell, IARI, New Delhi. In M_1 generation, the 100 seeds from each treatment of gamma rays along with the respective control of both the varieties were grown in Petridishes in laboratory condition for recording observations on seedling growth injury (7 days after germination). The remaining 100 seeds were sown in the nursery bed for transplanting in M_1 generation.

For spikelet sterility, ten plants from each replication of each treatment along with the controls of both the varieties were randomly selected and tagged. The percentage of spikelet sterility was determined by counting the number of completely unfilled spikelets out of the total number of spikelets of the main panicle. For raising the M_2 generation, seeds of the selected M_1 plants in all the treatments were sown and 21-day-old seedlings were transplanted in three replications using a spacing of 20 × 15 cm. All the recommended cultural practices were followed.

The chlorophyll mutation frequency was calculated dose-wise per 100 M_2 plants. The mutagenic efficiency and effectiveness were estimated following the method of Konzak *et al.* [3]. The frequency and spectrum of different types of morphological mutants were scored as per procedure at various developmental stages, particularly from flowering to maturity period [4].

Extensive studies to alter the spectrum of mutations and to achieve some degree of mutagen specificity in higher plants have been carried out with the chlorophyll deficient mutations because of their ease in detection and frequent appearance following mutagenic treatment. The mutagenic efficiency is a measure of the proportion of mutations in relation to undesirable changes (factor mutations/sterility) like sterility, injury, survival, etc. Maximum mutagenic efficiency was observed maximum in Taraori Basmati at 300 Gy gamma rays (Table 1) on growth injury and sterility basis both, whereas it was found in Pusa Basmati 1 at 100 Gy gamma rays. However, 50 Gy dose of gamma ray was found least efficient on growth injury and sterility in both the varieties. Mutagenic effectiveness denotes the frequency of mutations induced by a unit dose of mutagen (factor mutations/dose). The 100 Gy dose of gamma rays was found to be most effective in both the varieties of Basmati rice (Table 1). Kumar and Mani [5] found that a highly efficient mutagen may not be the highly effective one. Awan *et al.* [6] were of the opinion that lower doses might be effective for inducing chlorophyll mutations if appropriate pre-germinated treatments had been employed.

A total of 15 types of morphological mutants in Taraori Basmati and 13 types in Pusa Basmati 1 were identified. These mutants were dwarf, semi-dwarf, tall, early maturing, late maturing, high tillering, large panicle, partial sterile, complete sterile, bushy, pigmented pericarp, red kernel, large grain, awned, awnless, pigmented awn, and high yielding. The mutation spectrum of important and useful mutants observed in M_2 generation is given in Table 2. No relationship between treatment doses and mutation spectrum could be established. It is evident from the findings (Table 2) that the morphological mutants showed independent dose relationship with the mutagenic treatments as they occurred at random. The frequency of morphological mutants per 100 M_2 plants in case of Taraori Basmati was highest at 200 Gy gamma rays (1.64 per cent) and in Pusa Basmati 1 at 300 Gy gamma rays (1.57 per cent). In case of dwarf mutants (short statured

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Table 1. Efficiency and effectiveness of different doses of gamma rays in Basmati rice

Mutagenic treatment	Taraori Basmati						Pusa Basmati 1					
	M_1 seedling growth injury (%)	M_1 spikelet sterility (%)	Mutation frequency on M_2 seedling basis (%)	Mutagenic efficiency		Mutagenic effectiveness	M_1 seedling growth injury (%)	M_1 spikelet sterility (%)	Mutation frequency on M_2 seedling basis (%)	Mutagenic efficiency		Mutagenic effectiveness
	I	S	Msd	Msd/I	Msd/S		I	S	Msd	Msd/I	Msd/S	
Control	0	0	0	0	0	0	0	0	0	0	0	0
Gamma rays												
50 Gy	9.85	13.37	1.41	0.143	0.105	0.282	17.44	11.40	1.51	0.086	0.132	0.302
100 Gy	14.82	29.44	5.08	0.343	0.172	0.508	23.34	17.38	4.68	0.200	0.269	0.468
150 Gy	20.55	28.11	4.74	0.230	0.168	0.316	33.25	21.43	5.44	0.163	0.253	0.362
200 Gy	27.06	37.29	6.00	0.222	0.161	0.300	35.60	23.59	5.77	0.162	0.244	0.288
250 Gy	28.60	43.11	7.46	0.260	0.173	0.298	42.38	37.87	8.47	0.199	0.223	0.338
300 Gy	30.42	45.81	10.54	0.346	0.230	0.351	44.07	53.77	7.44	0.168	0.138	0.248

Table 2. Spectrum and frequency of morphological mutations per 100 M_2 plants in Basmati rice induced by gamma rays

Mutagenic treatment	Taraori Basmati									Pusa Basmati 1								
	Total plants	Total morpho logical mutant	Mutation frequency (%)	Mutation spectrum (number of events)						Total plants	Total morpho logical mutant	Mutation frequency (%)	Mutation spectrum (number of events)					
				Dwarf	Semi-dwarf	Tall	Early maturing	Sterile	High yielding				Dwarf	Semi-dwarf	Tall	Early	Sterile	High yielding
Control	1500	-	-	-	-	-	-	-	-	1500	-	-	-	-	-	-	-	-
Gamma rays																		
50 Gy	1400	2	0.14	-	1	-	1	-	-	1405	3	0.21	-	1	-	1	-	-
100 Gy	1398	8	0.57	-	2	-	1	-	2	1398	8	0.57	1	-	-	3	1	-
150 Gy	1400	14	1.00	1	3	-	1	-	1	1392	12	0.86	2	-	1	3	-	-
200 Gy	1399	23	1.64	1	5	1	1	-	2	1396	19	1.36	-	2	-	2	-	3
250 Gy	1399	17	1.21	2	3	-	2	1	1	1399	14	1.00	-	3	-	3	1	-
300 Gy	1397	18	1.29	-	4	1	4	-	2	1397	22	1.57	2	2	-	3	2	6

plants) there was a proportional decrease in leaf length. They possessed smaller panicle coupled with the reduction in the length of the last internode. Semi-dwarf mutants with medium statured plants were isolated from many treatments in both the varieties Tall mutants having long statured plants were taller at least by 10 cm than their parents. Early maturing mutants, (phenotypically alike parents) which matured 10 to 15 days earlier than their parents, were found in both the varieties of Basmati rice. It was found that the high yield of the mutants was not due to only one trait but due to a cumulative effect of all yield attributing traits. Induction of useful mutants like dwarf, semi-dwarf, earliness and high yielding derived from both the varieties could be of immense significance for the Basmati rice improvement programme.

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