Plant Archives Volume 21, No 1, 2021 pp. 900-903 *e-ISSN:2581-6063 (online), ISSN:0972-5210*

Plant Archives

Journal home page: www.plantarchives.org

DOI Url: https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no1.123

SELECTION OF SHORT STATURE AND EARLY MATURING BADSHAH BHOG IN M_2 FROM GAMMA RAY IRRADIATION

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(Date of Receiving-07-12-2020; Date of Acceptance-19-03-2021)

ABSTRACT

Badshah Bhog is a non basmati aromatic traditional rice cultivar. which is not widely cultivated due to some unfavourable traits which were relatively high plant height, late maturity and low average yield. By the utilization of gamma ray irradiation in plant breeding attempted to overcome such problems in crops. The objective of this research is to observe and select M_2 mutants of Badshah Bhog from gamma ray irradiation and obtain early maturing short stature plants. The research was conducted by Line sowing method. Established experimental plots for every irradiation doses and comparing the treatment result with the control to identify the effect of irradiation on the growth of Badshah Bhog. The result showed that there have been several plants with potential mutant traits supported the positive and negative character of every individual. The irradiated dose of 300 Grays has the shortest maturity duration of 131 days with the highest productive tiller of 6.67 but very low as compared to control. The irradiated dose of 400 Grays has the shortest Plant height of 97.8 cm. The plant yield of mutant lines in the present study was not affected significantly in any direction which could due to occurrence of polygenic mutations with ‘plus’ and ‘minus’ effect equally distributed. Together with short stature plants also plants bearing double spikelet at tip and mid region of panicle observed.

***Keywords*:** Aromatic rice, Mutation, Gamma rays, early maturing, short stature

INTRODUCTION

The aromatic rice is praised for its unique quality, a nature’s gift to Indian subcontinent. Now a day farmers are interested to cultivate these varieties due to excellent grain quality, aroma, and high premium market price. Badshah Bhog is a non basmati aromatic traditional rice cultivar. Like most of the local rice cultivar, this cultivar has also some weaknesses. This rice has a relatively long life cycle of about 5 months with a low average yield of 2.5-3 tonnes/ha. The main problem of traditional aromatic rice cultivars are low yield potential, late maturity and lodging susceptible. To obtain more beneficial plants traits for a purpose, The plant breeding have to create the genetic makeup of individual and plant population (Sobrizal, 2016). One method to overcome the problem of Badshah Bhog cultivar was through mutation breeding. It is stated that mutation breeding is highly beneficial for the repair of some traits by not changing most of the original properties of the plant (Warman *et al.,* 2015). Gamma ray irradiation is predicted to be one among the solutions in improving unfavourable traits and to realize profitable end in an attempt to extend the productivity and welfare of the farmers. Mutations breeding can be useful for the improvement of some plant properties that most of the original plant trait are not changed. The experiment was targeted to observe and selectM_2 mutants of Badshah Bhog from gamma ray irradiation for early maturing and short stature plants, but we also observed double spikelet at tip and mid region of panicle. Which is positive relation with plant yield.

MATERIALS AND METHODS

This research was conducted in Agricultural Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati, Sriniketan during two kharif seasons (June-November) 2016 and 2017 respectively. The materials used in this research were Badshah Bhog a non-basmati aromatic traditional rice cultivar (untreated) as control and seeds of all four doses of M_2 (the result of M_1 selection of gamma ray irradiation with 250 Gyh^{-1}, 300 Gyh^{-1}, 350 Gyh^{-1} and 400 Gyh^{-1}). The experiment was conducted by making experimental plots of line sowing. Observations were conducted on all irradiated treated plants and compared with control plants in order to identify the difference and the effect of irradiation on growth of Badshah Bhog. The data obtained were analyzed descriptively by comparing each individual plant in each dose of irradiation with control average and select individuals suspected of mutation.

RESULT AND DISCUSSION

Early maturing and short stature plants achievement

The development of new rice variety was expected to increase the productivity of rice production. The reduction in plant height enhances lodging resistance, and improves harvest index (grain/grain plus straw) and biomass production in rice (Khush GS, 1999). The dwarf mutants have many agronomic importance due to which it takes important place in plant species. Recessive major gene mutations are mainly responsible for dwarfness (Mikaelsen, 1980). Based on data of Table-1 following results are obtained:

Table-1. Mean and range of selected mutant plants bearing early maturing and short stature in M_2 generation

Characters	Control			250 Gy			300 Gy			350 Gy			400Gy		
	Mean	Range		Mean	Range		Mean	Range		Mean	Range		Mean	Range	
		Min.	Max.		Min.	Max.		Min.	Max.		Min.	Max.		Min.	Max.
50% Flowering	121	119	126	93.25	89	103	91	90	92	93	90	95	91.4	89	93
Days to maturity	151.5	147	156	133	129	142	131	130	132	133	130	135	131.4	129	133
Plant height	156.86	141	177	100	93	107	101	94	108	103.75	97	107	97.8	92	104
Total tiller	14.32	8	25	8.25	6	13	8.84	7	11	8	7	11	7.6	5	9
Productive tiller	12.62	7	19	6	4	10	6.67	4	9	5.25	4	8	5.4	3	7
Flag leaf area	17.08	7.5	28.88	20.25	18.9	21.6	19.8	18	21.6	20.85	19.5	21.6	20.22	18.9	21.6
Panicle length	27.28	23.2	30.5	16.25	12	19	15.5	12	20	15.5	13	19	14.8	11	21
Primary Branch per panicle	8.30	4.67	10.67	7.5	7	8	6.17	5	8	6.5	6	7	7	5	9
Secondary Branch per panicle	29.14	9	46.67	13	11	15	13	10	16	13.75	13	15	15.8	9	26
Total Grain per panicle	135.65	63.34	205.34	63.25	37	95	62.34	52	78	76.25	56	116	71	45	112
Filled Grain per panicle	96.58	47.67	167.33	31.5	21	54	20.67	12	25	48.84	19	92.34	39.2	21	72
Spikelet Fertilty(%)	72.12	55.95	90	49.32	36.84	56.84	33.33	23.08	43.64	59.00	33.93	80.82	53.30	46.03	64.29
Yield per panicle	1.51	0.96	2.26	0.78	0.33	1.58	0.59	0.40	1.62	0. 63	0.32	1.4	0.71	0.36	1.43

Table-2. Mean and range of double spikelet at tip and mid region of panicle

Characters	Control			250 Gy			300 Gy			400 Gy		
	Mean	Range		Mean	Range		Mean	Range		Mean	Range	
		Min.	Max.		Min.	Max.		Min.	Max.		Min.	Max.
50% Flowering	121	119	126	114	113	115	113	113	113	114.5	113	116
Days to maturity	160	155	165	152.5	149	156	150.5	149	152	151.5	149	154
Plant height	156.86	141	177	154	152	156	158	156	160	152.5	152	153
Total tiller	14.32	8	25	10	9	11	21.5	20	23	11	9	13
Productive tiller	12.62	7	19	8.5	7	10	17.5	17	18	9.5	8	11
Flag leaf area	17.08	7.5	28.88	22.5	21	24	28.05	23.93	32.18	26.63	26.25	27
Panicle length	27.28	23.2	30.5	24.5	22	27	27	26	28	29.5	27	32
Primary Branch per panicle	8.30	4.67	10.67	16.16	8.67	23.67	10.84	10.34	11.34	9.17	7.67	10.67
Secondary Branch per panicle	29.14	9	46.67	18	13.34	22.67	24.67	23.34	26	28.34	23.67	33
Total Grain per panicle	135.65	63.34	205.34	101.67	80	123.34	124.34	113.67	135	122.5	99	146
Filled Grain per panicle	96.58	47.67	167.33	79.5	65.34	93.67	87.34	81	93.67	100.34	79.67	121
Spikelet Fertilty(%)	72.12	55.95	90	78.80	75.95	81.67	71.20	60.00	82.40	81.67	80.47	82.87
Yield per panicle	1.51	0.96	2.26	3.14	3.05	3.23	2.36	1.28	3.43	3.54	3.17	3.90

50% flowering- The duration of 50% flowering is reduced up to 20-25 days as compared to control. The mean value was maximum at 250 Gy (93.25) and minimum at 300 Gy (91).

Days to maturity- The maturity duration of dwarf plant also reduced up to 15-20 days as compared to control. The mean for maturity was maximum at 250 Gy (133) and 350 Gy (133) and minimum at 300 Gy (131.4). These type of early mutants had been also identified by Mahadevappa *et al.,* (1983), Hakim *et al.,* (1985) and Sharma (1985) in rice.

Plant height- The plant height of the selected population of this group reduced 50 to 60 cm compared with the height of parent. Maximum and minimum plant height was observed at 300 Gy (103.75) and at 400 Gy (97.8) respectively. The plant height was significantly reduced in irradiated plants observed by Naeem *et al.,* (2015). Wattoo *et al.,* (2012) observed that gamma radiation intensity (15-25 kR) and plant height has inversely proportional relation.

Total tiller and productive tiller- The mean value for total tiller was maximum at 300 Gy (8.84) and minimum at 400 Gy (7.6). The mean value for productive tiller was maximum at 300 Gy (6.67) and minimum at 350 Gy (5.25). It is less as compared to control. The mutants had a tendency to produce less tillers at the maturity stage.

Total grain per panicle, filled grain per panicle and spikelet fertility (%): All these characters showed wide range. The no. of total grain was maximum at 400 Gy (71) and minimum at 300 Gy (62.3). The maximum number of filled grain was at 350 Gy (48.84) and the minimum was at 350 Gy (20.64). The spikelet fertility % was maximum at 350 Gy (59.00) and minimum at 300 Gy (33.33). The numbers of filled grain of all doses are lower than parent indicates effect of radiation for filled grain which correlates with total grain per panicle and spikelet fertility (%).

Yield per panicle: The yield per panicle is decreased in all the treatments as compared to parent. The weight of grain per plant tillers is influenced by the number of tillers, number of grain per tillers and percentage of filled seed. If these components were in high value, it will produce high yields, most likely the yield of seeds per plant will also high. As Sugiono *et al.,* (2016) stated that the yield of seeds per plant is a correlation of yield component, including the number of panicles per clusters, the number of grains per panicle, the grain content appearance and test weight. A indirect correlation between days to maturity and yield was reported by Vyas and Chauhan (1994) in Vigna radiate. Gottschalk and Wolff (1983) suggested that the mutant gene may act as a kind of foreign element within the genome, disturbing its genetic balance which results in a reduced vitality or seed production of the plants. The plant yield of mutant lines in the present study was not affected significantly in any direction which could due to occurrence of polygenic mutations with 'plus' and 'minus' effect equally distributed. Changes in flowering time, plant height, number of productive tillers per plant, panicle length and single plant yield, grain shape and size as observed suggested the existence of pleotropic gene action, which was earlier reported by Reddy and Reddy (1974).

Plants bearing double spikelet at tip and mid region of panicle: Yield in rice (Oryza sativa) is decided by three major components: panicle number per plant, grain weight and grain/spikelet number per panicle (Zhou *et al.,* 2018). Grain number per panicle is one among the most targets and mainly results from the amount of spikelets. Traditionally, rice breeders have focused on the improvement of spikelet number per panicle and rarely focused on the number of florets because a normal rice spikelet has one fertile floret and produces one seed. In rice with a determinate spikelet, the spikelet meristems produced the fixed floral meristems, resulting in the formation of one floret. The observation for double spikelet at mid and tip region of panicle are presented in Table-2. The double spikelet at mid and tip region of panicle were observed in all mutagens except 350 Gy. The mean value of important agronomical characters such as 50% flowering, days to maturity, total tiller, productive tiller, flag leaf area and total grain did not show remarkable changes with parent at all four doses. Higher amount of yield per panicle was obtained in all selected mutants belonging to each dose. The parent has one fertile floret that is flanked by one pair of glumes, which are generated from the spikelet meristem, and one floret per spikelet is strictly regulated in the Oryza genus. The floret contains five parts, those are lemma, palea, lodicule, stamen and pistil. At maturity, the seed setting rate, grain size and weight of the double spikelet were comparable with those in the normal type. These results suggested that mutagens have the potential for increasing the grain number per panicle and yield. Changes in flowering time, plant height, number of productive tillers per plant, panicle length and single plant yield, grain shape and size as observed suggested the existence of pleotropic gene action, which is in much agreement with the earlier contention of Reddy and Reddy (1974).

CONCLUSION

There are some differences in agronomic characters of M_2 plants (gamma ray irradiatedby various doses)and control plants (Badshah Bhog) such as plant height, number of productive tillers, number of seeds per panicle, maturity duration and yield of seeds per panicle. This experiment acknowledge the importance of gamma rays in rice crop to generate genetic variability. The responsible gene for dwarfism and early maturity in non-basmati aromatic rice have important aspects to develop short stature rice cultivar with retaining original quality.

ACKNOWLEDGEMENT

The authors are thankful to the Department of Genetics and Plant Breeding, Visva-Bharati University, Sriniketan for providing the facilities to carry out the work. [Note; we have no conflicts of interest to disclose this manuscript.]

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