Breeding behaviour of induced mutants in intra-crosses of aromatic rice

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ABSTRACT

Breeding behaviour of mutant characters in five true breeding gamma-ray induced mutants of a tall aromatic rice cultivar Gobindabhog was studied in crosses of mutants among themselves and with their mother cultivar Gobindabhog. Wide range of variation was observed in crosses of Mutant x Mutant than in Mutant X Parent. Height mutations were independent of panicle mutations. Mutations for high panicle density, less test weight and gold hull colour in one mutant was independent of each other. Awn was found to appear in some segregants in one Mutant X Mutant cross where none of the cross-parents including mother cultivar Gobindabhog had awned grain.

Key words: *Aromatic rice, breeding behaviour, induced mutants*

The utilization of useful mutants in cross-breeding programme is an important aspect of mutation breeding. A great majority of induced mutations in well-adapted economically important genotype is accompanied by one or several negative traits. Such undesirable effects can be due to either true pleiotropic action of mutant gene or mutational events in closely linked genes. The present investigation aims at studying the breeding behaviour of mutant characters in true breeding gamma-ray induced mutants in crosses among themselves and with their mother cultivar Gobindabhog.

The experimental materials comprised F_2 populations of five crosses viz., Mut 2 X Gobindabhog, Mut 5 X Gobindabhog, Mut 1 X Mut 4, Mut 2 X Mut 5 and Mut 3 X Mut 5. Gobindabhog is a popular aromatic variety of Gangetic West Bengal while the rest five parents are gamma-ray induced true breeding mutants. The above 5 crosses were selected based on the results of general combining ability effects (Table 1) from the analysis of 6 x 6 half diallel crosses following the Method II of Model 1 (Griffing, 1956). The mutants retained the characteristic aroma of mother cultivar and were morphologically distinct from each other (Ghosh, 1993). The important mutant characters along with the characteristics of Gobindabhog are as follows:

Gobindabhog	: tall, susceptible to lodging, semispreading culm, droopy leaves
Mut 1 [42(12)12]	: dwarf, very sturdy culm, spreading tiller, incomplete panicle exertion, high sterility and grain shattering, late flowering
Mut 2 [21(6)3]	: slender culm, high tillering, high panicle density, high sterility and grain shattering, gold hull colour, low seed weight and grain yield
Mut 3 [42(1)1]	: thick and stiff culm, semispreading tiller, panicle compact and low panicle density with higher seed weight
Mut 4 [124(17)4]	: high yielding mutant with slightly less test weight, flag leaves erect and broad with slow leaf senescence
Mut 5 [184(17)10]	: incomplete panicle exertion, slightly less seed weight and grain yield

Table 1. General combining ability effects of mutants and Gobindabhog

Parent	Plant height	Days to flower	Panicle exsertion	Panicle length	Panicle weight	No. of grains panicle^{-1}	Spikelet fertility %	Test weight	Harvest index	Grain yield plant $^{-1}$	Overall rank
Mut 1	H(+1)	L(-1)	L (-1)	M(0)	L(-1)	M(0)	L(-1)	H(+1)	L(-1)	L(-1)	L(-4)
Mut 2	H(+1)	L(-1)	L (-1)	L(-1)	L(-1)	L(-1)	L(-1)	L(-1)	L(-1)	L(-1)	L(-8)
Mut 3	M(0)	L(-1)	M (0)	M(0)	M(0)	L(-1)	H(+1)	H(+1)	L(-1)	M(0)	L(-1)
Mut 4	L(-1)	H(+1)	H (+1)	M(0)	H(+1)	H(+1)	M(0)	L(-1)	H(+1)	H(+1)	H(+4)
Mut 5	L(-1)	H(+1)	L (-1)	H(+1)	H(+1)	H(+1)	H(+1)	L(-1)	H(+1)	H(+1)	H(+4)
Gobindabhog	L(-1)	H(+1)	H (+1)	H(+1)	H(+1)	H(+1)	H(+1)	H(+1)	H(+1)	M(0)	H(+7)

H: Significant value in desirable direction, M: Nonsignificant value and L: Significant value in undesirable direction; Values in the parentheses indicate score for the purpose of assigning overall rank

Two thousand F_2 plants for each of the crosses bordered by their respective parents were grown during wet season 2002 with intra- and inter-row spacings of 20 and 30 cm. Standard cultural practices were followed to raise a good healthy crop. F_2 plants were carefully observed for recombination of mutant characters. Data were recorded on 200 F_2 plants from each of the crosses and 20 pants from each of the parents for plant height, panicle characters and grain yield.

Pattern of segregation for plant height, panicle characters and grain yield (Table 2) in two crosses of

Table 2. Range, mean and variation of some characters in F_2 generation of crosses of Mutant x Mutant and Mutant x Gobindabhog

Cross	Character	Range		Mean	CV%
		Min.	Max.		
Mut 2xMut 5	Plant height (cm)	97	140	122.32	11.24
	Panicle exertion	-4	15	6.51	10.37
	Panicle number plant^{-1}	11	46	20.37	25.34
	Panicle length (cm)	12	27	21.91	13.27
	Panicle weight (g)	0.42	1.72	1.21	27.15
	Yield plant^{-1}(g)	4.31	46.95	19.78	33.68
Mut 3xMut 5	Plant height (cm)	123	162	137.52	6.22
	Panicle exertion	-5	12	4.97	8.31
	Panicle number plant^{-1}	15	45	22.31	20.34
	Panicle length (cm)	18	28	22.91	8.63
	Panicle weight (g)	0.63	1.58	0.97	16.38
	Yield plant^{-1}(g)	6.71	56.93	16.73	26.57
Mut 1xMut 4	Plant height (cm)	95	175	135.32	22.73
	Panicle exertion	-2	17	7.21	12.31
	Panicle number plant^{-1}	6	38	22.31	28.75
	Panicle length (cm)	11	29	21.31	10.21
	Panicle weight (g)	0.46	2.32	1.37	32.37
	Yield plant^{-1}(g)	3.52	57.21	19.21	31.28
Mut 2x Gobindabhog	Plant height (cm)	83	170	137.07	12.05
	Panicle exertion	4	16	9.37	4.52
	Panicle number plant^{-1}	10	37	19.31	18.35
	Panicle length (cm)	12	26	20.31	9.58
	Panicle weight (g)	0.49	1.92	1.05	21.36
	Yield plant^{-1}(g)	5.17	42.35	18.31	25.89
Mut 5x Gobindabhog	Plant height (cm)	120	165	135.7	6.31
	Panicle exertion	-3	19	14.23	7.31
	Panicle number plant^{-1}	8	30	17.06	15.31
	Panicle length (cm)	21	28	24.32	7.46
	Panicle weight (g)	0.72	2.17	1.51	25.75
	Yield plant^{-1}(g)	8.36	43.47	20.21	22.45

induced mutants Mut 2 and Mut 5 with mother cultivar Gobindabhog indicated higher genetic diversity in Mut 2 as compared to Mut 5. Recombination for plant height of Mut 5 with panicle characters of Gobindabhog could not be obtained which indicated pleiotropic effect of mutant gene or mutations in closely linked genes. Failure to isolate such recombinants may be due to small population size. However, the possibility of pleiotropic effect was ruled out from the F_2 generation results of cross of Mut 3 X Mut 5 (plant # 1 and # 3), where recombination of panicle characters of Mut 3 with plant height of Mut 5 occurred (Table 3) indicating independent mutations for these characters. In Mut 2 X Gobindabhog, recombinants (plant # 4 and # 5) with higher panicle density of Mut 2 with better grain size of Gobindabhog could not surpass panicle weight of better parent Gobindabhog due to higher spikelet sterility transmitted from Mut 2.

Wide variation in F_2 populations of Mut 1 X Mut 4 and Mut 2 X Mut 5 for different characters indicated large genetic differences between mutants due to mutations at multiple loci. According to calculations of Hansel (1966) such multiple mutations seem to be the rule rather than exception. Separation of panicle characters from plant height of Mut 1 indicated that height mutation was independent of the mutations in panicle traits. Similarly panicle density, grain size and gold hull colour of Mut 2 were independent of each other as recombinants (like plant #1) were recovered. Appearance of awn in few grains of some segregants in Mut 1 X Mut 4, where none of the parents including Gobindabhog had awned grain, may be due to genic interaction. Gaul *et al.* (1968) observed that a completely new pleiotropic character occurred in a changed genetic background- a character, which was not present in the original mutant.

Table 3. Performance of a few F_2 selects from crosses of Mutant x Mutant and Mutant x Gobindabhog

Parents/F_2 segregants		Plant height (cm)	Panicle exsertion (cm)	Panicle No.	Panicle length (cm)	Panicle weight (g)	Yield plant^{-1}(g)
Mut 1		99.7	1.92	22.5	21.43	1.15	17.40
Mut 2		108.7	9.87	28.3	18.97	1.13	15.17
Mut 3		133.7	9.85	18.2	23.65	1.54	21.90
Mut 4		135.2	13.90	20.0	25.50	2.27	33.60
Mut 5		128.3	-0.40	21.5	24.31	1.41	28.90
Gobindabhog		154.3	17.80	22.4	27.27	1.85	30.00
Mut 1 x Mut 4	1	97.0	-2.00	20.0	23.0	1.26	20.33
	2	150.0	14.50	36.0	29.0	1.76	57.21
	3	150.0	16.00	21.0	27.0	2.29	41.75
	4	155.0	16.00	25.0	27.0	1.89	35.87
	5	163.0	16.00	29.0	29.0	1.73	40.32
Mut 2 x Mut 5	1	116.0	0.00	38.0	25.0	1.46	45.16
	2	118.0	1.50	46.0	22.0	0.88	34.17
	3	129.0	13.50	24.0	23.5	1.26	25.90
	4	130.0	3.50	27.0	23.0	1.53	36.08
	5	147.0	13.00	33.0	27.0	1.62	46.95
Mut 3x Mut 5	1	116.0	-4.00	27.0	27.0	1.53	35.38
	2	120.0	4.00	40.0	25.0	1.13	36.90
	3	126.0	0.00	28.0	27.5	1.51	34.94
	4	130.0	6.00	32.0	25.0	1.17	31.11
	5	152.0	9.00	41.0	27.0	1.53	56.97
Mut 2 x Gobindabhog	1	118.0	11.00	28.0	22.0	1.35	32.76
	2	118.0	10.00	21.0	22.0	1.18	22.19
	3	130.0	13.00	33.0	25.0	1.29	36.97
	4	133.0	13.00	22.0	24.0	1.69	28.37
	5	138.0	15.00	28.0	25.0	1.74	42.35
Mut 5 x Gobindabhog	1	126.1	1.00	27.0	26.1	1.41	33.43
	2	126.3	1.50	26.0	26.3	1.35	30.78
	3	132.8	0.00	18.0	25.8	1.54	24.49
	4	142.0	11.00	22.0	26.2	1.79	39.21
	5	152.0	17.00	23.0	26.7	2.09	43.47

Undesirable characteristics *viz.*, high sterility of Mut 2 and grain shattering behaviour of Mut 2 and Mut 1 were reduced in some segregants. Positive transgressive segregants for grain yield in Mut 1 X Mut 4 were associated with tall plant height, which would be susceptible to lodging.

The results of general combining ability (Table 1) indicated that Mut 4, Mut 5 and Gobindabhog were overall high general combiners, while the remaining three mutants were low general combiners. Therefore, out of the five crosses four were in the category of H X L and one in H X H. Langham (1961) suggested the possibility of transgressive segregation by crossing the parent with high and low expression of a trait. High yielding plants coupled with shorter plant height were recovered in population of Mut 2 X Mut 5. Therefore, this cross might be productive for isolation of promising short height high yielding lines.

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