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GENETICS OF EMS INDUCED RECESSIVE TALL MUTATION IN RICE

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ABSTRACT

A local variety, Japan Violet, treated with aqueous solution of EMS (0.75% – 12 h) after presoaking in 0.01% vitamin C solution for 12 h produced a monogenic recessive tall mutant in M_2, the inheritance of which was confirmed in M_3 and in the progenies of the cross Japan Violet x tall mutant. The feasibility of utilizing the tall mutant in hybrid rice breeding programme is discussed.

Key words: Recessive tall, rice, mutant, inheritance.

One of the major constraints in hybrid seed production in self-pollinated crops like rice/wheat is insufficient pollen-transfer to female stigmatic lobes. Appropriate height of the pollen parent could enhance the rate of pollination by wind and gravity [1]. Mostly tall habit is dominant over short and is undesirable due to its low production potential. However, recessive talls in rice with elongated lowermost or uppermost internodes have been reported to be monogenic [1–3]. The tall mutant of rice (Fig. 1) in the present study differs in several respects from the types reported earlier. Genetics of the mutant and the feasibility of its use as an effective pollen parent in hybrid seed production are described.

MATERIALS AND METHODS

One hundred uniform pure seeds of cv. Japan Violet, a local semidwarf rice variety with all parts purple except junctura back, junctura front and node, were presoaked in 0.01% vitamin C solution for 12 h and treated with 0.75% aqueous ethyl methane sulphonate (EMS) solution for 12 h. The treated seeds were thoroughly washed in running tap water and sown in Petri dishes along with control for germination. One-week-old seedlings were planted in

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shallow pans and one-month-old seedlings were transplanted, five plants each, in 23 cm pots for studying the M_1 population along with control. In subsequent seasons, M_2, M_3 populations with their controls were also raised and screened for mutations. One of the M_2 lines showed segregation for the tall mutant (Fig. 1) which was characterized and studied for inheritance and confirmation in M_3 generation. A cross, Japan Violet x tall mutant, was also studied up to F_3 generation to confirm the inheritance pattern.

Fig. 1. Plants of the parent variety Japan Violet (a), and its recessive tall mutant (b).

RESULTS AND DISCUSSION

The mutant showed elongation of 1st, 2nd, 3rd and 4th internodes (top to bottom) with 77.4%, 142.0%, 60.7% and 66.7% increase, respectively, over the corresponding internodes of the normal parent (Table 1) in contrast to the early reports on elongation of first (uppermost) [3, 4] and/or last (lowermost) [1, 2] internodes. The recessive tall mutant obtained in this study is different from the earlier internodal mutants [1, 2] showing a mean increase of 86.7% per node over the control (Table 1). Besides the difference in internodal elongation pattern, panicle and spikelets also showed significant increase in length, while spikelet sterility decreased significantly in the mutant over the control. Total number of tillers and ear bearing tillers remained almost unchanged (Table 2). The panicle in the mutant emerged 8–12 cm above the flag leaf unlike the sheathed panicle character of the control, wherein the panicle base (nodal region) remains concealed in the sheath, on an average, by 2.97 cm.

The M_1 plants appeared normal like the parent variety Japan Violet. One out of 69 M_2 progenies of the EMS treated material segregated into 22 short : 4 tall plants giving a good fit to 3 : 1 with $\chi^2 = 1.28$ ($P = 0.30 - 0.20$), showing monogenic recessive nature of tallness. The breeding behaviour of 22 M_3 families out of the 26 M_2 plants (4 lines were rejected due to fewer number of plants) confirmed the M_2 ratio, as 6 M_3 progenies bred true for normal,

Table 1. Rate of increase in length of different internodes in recessive tall mutant over the control cv. Japan Violet

Control or mutant		Length of different internodes (cm)				Increase per node (%)
		1	2	3	4	
Japan Violet	Range	28.0–33.0	10.0–13.5	1.5–4.0	0.5–2.0	
	Mean	29.6	11.2	2.8	1.2	
Recessive tall mutant	Range	46.0–57.0	21.0–30.0	2.0–6.0	1.0–3.0	
	Mean	52.5	27.1	4.5	2.0	
Increase over control, %		77.4	142.0	60.7	66.7	86.7

12 segregated in 3:1 ratio, and 4 bred true for tall recessive in conformity with the expected ratio 1:2:1 with $\chi^2 = 0.30$ (P = 0.90–0.80). The F_1 of the cross appeared normal with 82 cm height and F_2 segregated into 172 short : 64 tall, again giving 3:1 ratio with $\chi^2 = 0.56$ (P = 0.50–0.30). The breeding behaviour of 30 F_3 families again confirmed the F_2 ratio, as 10 bred true for normal : 12 segregated in 3:1 ratio, and 8 bred true for recessive tall, with $\chi^2 = 1.5$ (P = 0.50–0.30), fitting the expected ratio 1:2:1.

Table 2. Morphometric description of the recessive tall mutant and the source parent variety Japan Violet of rice

Character	Japan Violet		Recessive tall mutant	
	range	mean	range	mean
Plant height, cm**	71.0–89.0	82.2	100.0–116.0	108.1*
Culm length, cm	38.5–51.5	44.8	78.0–94.0	86.1*
Total No. of tillers	7.0–16.0	10.9	7.0–15.0	9.4
Total No. of productive tillers	6.0–12.0	9.2	7.0–12.0	8.7
Productive tillers, %	62.5–100.0	82.7	72.0–100.0	92.2
Panicle length, cm	17.5–22.0	19.3	21.3–24.0	22.7
No. of spikelets/panicle	75.5–120.5	105.0	86.0–121.0	97.2
No. of sterile spikelets/panicle	9.5–32.0	21.2	6.0–26.0	18.1*
Sterility %	8.4–35.6	22.6	6.9–29.7	18.2*
Panicle density, spikelets/cm	3.8–6.2	5.1	3.3–5.1	5.0
Grain length, cm	0.8–0.9	0.8	0.9–1.1	1.0*

*Significant at 5% level.

**Either from base to leaf tip, or to panicle tip, as the case may be.

Genetic analysis showed that internode elongation in respect of all the four internodes in the mutant described above is controlled by a recessive gene, which could be designated as ein (elongated internode) in the present case, unlike the early reported eui gene [3, 4] for elongation of the uppermost internode. The eui gene has been incorporated into cms plants to increase panicle exertion [5, 6]. However, the present recessive tall mutation is more appropriate for hybrid rice technology, as it helps to enhance the chances of outcrossing as a pollen shedder. The mutational approach appears to be equally effective in enhancing outcrossing efficacy of the female plants also. Besides cms maintainers and restorers, which are essential for hybrid seed production, the recessive tall male plant resulting from incorporation of eui or ein gene into the male (fertility maintaining) parents, would be of great advantage in the production of semidwarf F_1 plants for hybrid seed production in rice and the phenomenon could be applied to similar situations in such cereals.

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