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Mutagenic Effect of Gamma Rays (γ—Ray) on Growth Yield and Composition of Oil in Patchouli (*Pogostemon patchouli* Pellet.)

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Abstract

Mutagenic effect of different doses of gamma rays was investigated to develop a high yielding mutant in patchouli. The *in vitro* grown plantlets were exposed with 3, 5, 6, 8, 9 and 10 kR dose of gamma rays. The plants raised from these treatments were screened in field for their quantitative and qualitative traits. The study resulted in isolation of several economically useful mutant showing variation in agronomic and essential oil characteristic. Herb yield shows inverse relationship with dose rate ; as dose rate increases, herb yield get decreases. However, high frequency of alternation in oil content and oil yield was noticed in several treatments, especially in plant exposed with 8 kR, which exhibited pronounced effect in enhancing oil content (2.4 to 3.45%) and oil yield (68.34 to 84.06 l/ha per year).
Key words : Mutagenic effect, Gamma rays, Patchouli, Growth, Yield.

Patchouli *Pogostemon cablin* (Blanco) Benth. = *P. patchuli* Pelleto var. *sauvis* Hook.f. believed to be a native of the Philippines, is now cultivated in tropical regions for its essential oil. Patchouli oil is one of the most important naturally occurring base materials used in perfumery (1). There is no synthetic substitute for patchouli oil which further enhances its prominent position in the perfume industry. In addition, patchouli oil also possesses antifungal and bacteriostatic proprieties attributes to a number of dehydroacetic acid (1, 2). Patchouli being a vegetatively propagated crop, virtually there is no scope for generating the variability as the available genetic variation in this crop is also very narrow. Traditional breeding methods tried for breaking yield barriers were not successful as the plant rarely flowers and does not set seed. Possibility of obtaining high yielding clone / genotype through mutation breeding in patchouli was therefore considered an alternative to conventional breeding technique. Therefore present study was designed for the induction of mutation using gamma irradiation for genetic variability so as to improve the quantitative and qualitative traits.

Methods

In vitro raised plantlets were irradiated with different doses of gamma rays (3, 5, 6, 8, 9, 10, 12, 15 and 20 kR) using 60 Co source at Rashmi irradiation center Kidwai, Bangalore. Immediately after irradiation the plantlets were transferred to the culture room. Dose response curve were first established and LD_{50} were determined. The irradiated plantlets along with control plants were transplanted in the field at 60 cm × 60 cm spacing under uniform field condition. Cultural operations are carried out at timely interval. Observation on five agronomic traits viz., plant height, number of branches, leaf area, herb yield. Oil content and

Table 1. Plant height, number of branches and leaf area as influenced by gamma rays in the plantlets of patchouli (*Pogostemon patchouli* Pellet.).

	Treatments	Plant height (cm)	No. of branches/ plant	Leaf area/ plant (cm^2)
T_1	Control	82.5	35.7	4555.7
T_2	3 kR	80.5	35.0	4446.0
T_3	5 kR	78.7	33.7	4254.2
T_4	6 kR	71.2	30.5	4087.2
T_5	8 kR	68.7	27.7	3773.7
T_6	9 kR	65.7	24.7	3667.0
T_7	10 kR	60.7	22.7	3149.2
	Mean	72.6	30.0	3990.4
	F-test	*	*	*
	SE ±	1.3	1.13	14.10
	CD 5%	4.1	3.36	41.90

Table 2. Herb yield, oil content and oil yield as influenced by gamma rays in the plantlets of Patchouli (*Pogostemon patchouli* Pellet.).

	Treat-ments	Herb yield/ har-vest/ ha (t)	Herb yield/ ha/ yr (t)	Oil con-tent (%)	Oil yield/ har-vest/ ha (l)	Oil yield/ ha/yr (l)
T_1	Control	0.90	2.70	2.40	22.78	68.34
T_2	3 kR	0.90	2.85	2.37	21.43	64.29
T_3	5 kR	0.87	2.61	2.42	22.23	66.69
T_4	6 kR	0.86	2.58	2.72	23.49	70.47
T_5	8 kR	0.84	2.52	3.45	28.02	84.06
T_6	9 kR	0.83	2.49	3.02	24.91	74.73
T_7	10 kR	0.81	2.43	3.02	24.65	73.95
	Mean	0.86	–	2.7	23.93	–
	F-test	*	–	*	*	–
	SE ±	0.007	–	0.07	0.65	–
	CD 5%	0.02	–	0.22	1.93	–

oil yields were recorded at the time of harvesting.

Oil estimation of dry herb was done by hydrodistillation using clevanger's apparatus. The percentage of oil was calculated on moisture free basis. The quality of oil was assessed with the help of gas chromatographs. The mean values for all the economic traits were subjected to statistical analysis (randomized complete block design) for different characters pairs at different doses.

Results and Discussion

The treatment of plant cells and tissue in *in vitro* with physical mutagens enhance the spectrum and frequency of variations. In the present investigation, the plantlets exposed with different dose of γ— rays showed wide variability in both quantitative and qualitative traits.

Growth Parameters

The growth parameters like plant height, number of branches and leaf area showed significant difference among the treatments (Table 1). The maximum plant height (82.5 cm) number of branches (35.7/ plants) and leaf area (4,555.7 cm^2) was recorded in the control treatment, whereas minimum plant height (60.7 cm), number of branches (22.7/plant) and leaf area (3,149.2 cm^2) was recorded in plantlets exposed with higher dose of gamma rays (10 kR), it is the maximum dose rate where we observed 50 per cent of surivality (LD_{50}). By the results we observed that, as the dose rate increases, the vegetative growth decreases. This might be due to the reason that the increased dose rate of gamma rays may effects the vital mutation in the genotypes of patchouli. These results in line with results found by Lal et al. (3) in citronella and Mishra et al. (4, 5) in muskdana where they reported that enzyme activity associated with biosynthesis of primary metabolic traits like plant height, number of branches, leaf area, was recorded with increased dose rate gamma rays.

Yield Parameters

Herbage yield found to be influenced by different doses of gamma rays (Table 2). The non-irradiated plants recorded maximum herb yield (2.7 t/ha) whereas, the plant exposed with 10 kR dose, recorded minimum herb yield (2.43 t/ha). From the table it was observed that, as the dose rate increases, herb yield get decreases. Regarding oil content, the plant exposed with 8 kR dose of gamma rays recorded maximum oil content (3.45%) whereas minimum oil content (2.37%) was recorded in plant treated with 3 kR dose of gamma rays which was on par with the control (2.4%). But any increase in the dose rate, behind the 8 kR, the oil content get decreases. This is because the synthesis of secondary metabolite like, essential oil, alkaloids, etc., follows a definite, biosynthetic pathway catalysed by specific enzyme involved in each step. In this sequential enzymatic activation, it is possible to hit the specific enzyme at specific step or activate them all by gamma irradiation by changing or enhancing the rate of biosynthesis. The 8kR dose of gamma rays might favorably activate the enzyme which associated with biosynthesis of essential oil in patchouli could cause the enhancing the rate of biosynthesis leading to higher oil content. This result is in conformity with results found by Mishra et al. (5) in palmrosa, Sharma et al. (6) in Black Henbane, Kak and Kaul (7) in *Mentha citrata* etc. Regarding oil yield the maximum oil yield (84.06 l/ha per year) was recorded in plants exposed with 8 kR dose of gamma rays and minimum oil yield (64.29 l/ha per year) was recorded in plant exposed with the lesser dose (3 kR) of gamma rays.

In conclusion, considerable progress has been made in the application of induced mutation in vegetative propagated plants. In seeds or vegetative propagated aromatic plants, ionizing radiations have been successfully used to enhance their industrial utility. In present study, plant exposed with 8kR dose of gamma rays may be selected as mutant clone which has higher oil content and oil yield. Further evaluation of these clones need to known there consistency. The mutation breeding offers considerable scope for altering both qualitative and quantitative characters in patchouli in a desirable direction. Only through careful screening and selection, the range of variability induced by gamma rays can be widened and which can be further exploited by recombinant breeding.

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