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RADIATION INDUCED MACROMUTATION IN SESAME (*SESAMUM INDICUM* L.)

SANDIPAN CHOWDHURY and ANIMESH K. DATTA*
Department of Botany, Genetics and Plant Breeding Section, Kalyani University, Kalyani – 741235, India.
*email : dattaanimesh@gmail.com

Twenty viable mutants namely *chloroxantha, narrow leaf, elongated leaf, thick leaf, ovate leaf, ternate, long petiole, fasciated stem, thick stem, lax branching, bushy, unbranched stem, dwarf, early flowering, late flowering, white flower, small flower, round fruit* and *black seed* were isolated at M_2 following gamma (50, 100, 200 and 300Gyre) and X-ray (50, 100, 200 and 300Gyre) irradiations to dry seeds (moisture content: 9.56%) of sesame (*Sesamum indicum* L. var.B-67; family: Pedaliaceae). Over the M_2 population the mutants occurred in the following order : *narrow leaf > thick leaf > early flowering > late flowering > dwarf > fasciated stem > black seed > elongated leaf = lax branching > small flower = white flower = thick stem > pigmented flower = unbranched stem > ternate = bushy = round fruit > long petiole = chloroxantha = ovate leaf.* Mutation frequency was noted to be higher in X-irradiation (10.71%) than gamma irradiation (6.56%). Estimated total mutation frequency over M_2 population was 8.37%. Maximum frequency of mutation was recorded following 300Gy X-ray treatment. Spectrum of mutation varied among the doses of irradiations (gamma rays: 19, range: 2-14; X-rays: 15, range: 2-12).

Keywords : Gamma rays; Macromutation; Sesame; X-rays.

Introduction

Induction of mutation forms an important part of breeding programme aiming at the improvement of crop plants through creation of genetic variability[1] and the methodology has been successfully administered in different plant species to raise 'plant type' mutants[2]. However, reports on plant type mutants in sesame (*Sesamum indicum* L.) are rather meagre[3-9] , although it has significant commercial importance for oil yielding property and therapeutic uses. With a view to develop superior 'plant type' mutants in sesame which closely correspond with the ideotype being look for in the crop, a research project on radiation induced mutagenesis in *Sesamum indicum* L. has been initiated and the present communication reports on the frequency and the types of macromutants induced (gamma rays and X-rays) at M_2.

Material and Methods

Dry seeds (moisture content : 9.56 %) of *Sesamum indicum* L. var. B-67 (obtained from Pulses and Oil Seed Research Station, Berhampur, West Bengal) were treated with gamma rays (doses: 50, 100, 200 and 300 Gyre; source ^{60}Co at the rate of 1.3Gy per minute; irradiation at Saha Institute of Nuclear Physics, Salt Lake, Kolkata) and X–rays (doses: 50, 100, 200 and 300 Gyre; source to distance 10 cm.; at the rate of 20.16Gy per minute; irradiation at CRIJAF, Nilgang). Control and treated seeds were sown (50 seeds in each lot) in the experimental field of Kalyani University (spacing of 15 cm between plants and 40 cm between lines) to raise M_1 and subsequently M_2 generation (plant to row) during rain-fed seasons of 2005 and 2006, respectively. M_2 population was carefully screened for macromutations and the mutant frequency was estimated in per cent. Flower and seed colours of normal and mutants (of identical maturity) were confirmed from Horticultural Colour Chart I and II and Munsell Soil Colour Chart.

Results and Discussion

Twenty different macromutant types (mutant traits confirmed at M_3 from selfed segregation) were spotted at M_2 population and their frequencies were presented in Table 1. Mutation seems to have brought about gross morphological changes (Table 2) in affecting seedling colour (*chloroxantha*), branching pattern (*lax branching, bushy,* and *unbranched*), stem structure (*thick stem* and *fascinated stem*), growth habit (*dwarf*), leaf morphology (*narrow leaf, elongated leaf, thick leaf, ovate leaf, ternate* and *long petiole*), flower (*early flowering, late flowering, small flower, pigmented flower* and *white flower*) and seed (*black seed*) characteristics and pod shape (*round fruit*). Leaf and flower mutations were predominant.

Table 1. Types and frequency of macromutations in *S. indicum*.

Doses (Gyre)	No. of plants scored	Mutation frequency(%)										
		Chloroxantha	*Narrow leaf*	*Elongated leaf*	*Thick leaf*	*Ovate leaf*	*Ternate*	*Long petiole*	*Fasciated stem*	*Thick stem*	*Lax branching*	*Bushy*
Gamma – rays												
50	64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	4.68	0.00
100	672	0.15	0.60	0.15	1.79	0.15	0.30	0.00	0.30	0.15	0.74	0.00
200	503	0.00	1.59	0.00	0.99	0.00	0.00	0.00	0.99	0.20	0.00	0.59
300	317	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.63	0.32	0.32	0.00
Total	1556	0.06	0.77	0.06	1.16	0.06	0.13	0.00	0.64	0.19	0.58	0.19
X – rays												
50	84	0.00	13.00	0.00	0.00	0.00	0.00	0.00	1.19	0.00	0.00	0.00
100	585	0.00	0.51	1.37	3.25	0.00	0.00	0.17	0.68	0.17	0.17	0.00
200	558	0.00	0.54	0.18	0.90	0.00	0.18	0.00	0.00	0.00	0.00	0.00
300	347	0.00	5.48	0.00	1.15	0.00	0.00	0.00	0.00	0.58	0.00	0.00
Total	1574	0.00	2.28	0.57	1.78	0.00	0.06	0.06	0.32	0.19	0.06	0.00
Grand total	3130	0.03	1.53	0.32	1.47	0.03	0.10	0.03	0.48	0.19	0.32	0.10
Gamma – rays												
50	64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2	6.25
100	672	0.00	0.15	0.30	0.00	0.00	0.15	0.00	0.45	0.30	14	5.65
200	503	0.99	0.20	0.00	0.00	0.00	0.00	0.20	0.00	1.59	9	7.36
300	317	0.00	0.63	2.52	2.20	0.32	0.00	0.00	0.00	0.00	8	7.26
Total	1556	0.32	0.51	0.64	0.45	0.06	0.06	0.06	0.19	0.64	19	6.56
X – rays												
50	84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2	14.28
100	585	0.00	0.51	1.20	0.68	0.34	0.34	0.00	0.00	0.00	12	9.40
200	558	0.00	0.90	1.08	0.90	0.54	0.36	0.54	0.00	0.18	11	6.27
300	347	0.00	2.31	3.46	3.17	0.00	0.00	0.58	0.00	0.00	7	16.71
Total	1574	0.00	1.02	1.59	1.27	0.32	0.25	0.32	0.00	0.06	15	10.71
Grand total	3130	0.16	0.77	1.12	0.86	0.19	0.16	0.19	0.10	0.35	20	8.37

Table 2. Mutation frequency estimated for different morphological traits in sesame.

Mutation affecting	Mutation frequency (%)	
	Gamma – rays	X - rays
Seedling character	0.06	0.00
Breeding pattern	1.09	0.06
Stem structure	0.84	0.51
Growth habit	0.51	1.02
Nature of leaf	2.19	4.76
Flower characteristics	1.29	3.75
Pod shape	0.19	0.00
Seed colour	0.64	0.06
Total plants scored	1556	1574

A brief idea on the characteristics of the mutants (Table 1, Figs. 1-9) are presented below.

Narrow leaf : Narrow leaves (length: 15.5 cm ± 0.41; breadth: 6.13 cm ± 0.15) had smaller area (42.67 sq.cm ± 2.74) than leaves of control plants (87.2 sq.cm ± 4.19). Most predominant among the mutant types.

Elongated leaf : Elongated leaves (length: 17.83 cm ± 0.14; breadth: 11.1 cm ± 0.48) had broader area (106.67 sq.cm ± 4.25) than leaves of control plants. Frequency of this mutant was higher in X-ray (0.57%) than gamma (0.06 %) rays.

Thick leaf : Leaves were with leathery feeling. X-ray-100Gy yielded maximum *thick leaf* mutants.

Ovate leaf : Leaves ovate with serrated margins in comparison to lanceolate with entire margins in control plants. Ovate leaves were hairy on the upper surface and were with short and thick petioles. The mutant type could only be spotted in 100Gy gamma irradiation.

Ternate : Single node with 3 leaves in the main axis of the plant. Each axil of the leaves bear a fruit. This mutant type was recovered from 100Gy gamma and 200Gy X - irradiations. Estimated mutation frequency over the population has been 0.10%.

Long petiole : Leaves are with long petiole (19 cm – 22 cm; control: 7 cm – 9 cm) and those petioles were more or less right angle to the main axis. The mutant type was only identified from 100Gy X-irradiation.

Fasciated stem : Appeared in most doses (excepting 200 and 300Gyre X-rays) of irradiations (maximum frequency – 50Gy gamma rays). The fasciated mutant could easily be identified due to the presence of crown cluster of leaves at the apex. The fasciated region of the stem was broad, strap like flattened, ribbed and width of the flattened stem at broadest region varied between plants and ranges between 1.5 cm to 3.5 cm.

Thick stem : Mutant plants had thicker stem (2.2 cm to 2.5 cm) than control (1.2 cm to 1.5 cm). Mutation frequency over the population was noted to be 0.19%.

Lax branching : Branching pattern in this mutant type has been laxed natured and the angle of divergence of primary branches in relation to the main axis (average/ plants scored at maturity) was noted to be higher (32.35^0) than control (22.75^0). Attaining height of 126.58 cm ± 6.50 (98.0 cm to 150.0 cm) at maturity, the mutant produced higher number of primary branches per plant (6.0 ± 0.45) than control (3.83 ± 0.27).Maximum frequency of this mutant type was recorded from 50Gy gamma irradiation.

Bushy : Only spotted from 200Gy gamma irradiation. Bushiness was due to higher number of primary (7 to 9) and total (10 to 14) branches than control (primary branches: 5 to 6; total branches: 7 to 9).

Unbranched : This mutant type appeared only in 200Gy gamma irradiation. The mutant plants were erect and attained a height of 98 cm to 122 cm at maturity. Capsule yield on the main axis was more in the mutant (43.5) than control (28.5).

White flower : The colour of the mutant flowers (corolla tube and flaps) was noted to be completely white (8/2) as compared to *phlox purple* (632 to 632/3) colour in flaps and white colour of corolla tubes in control. Mutation frequency of *white flower* mutant in M_2 population was 0.19%.

Pigmented flower : The mutant plants possessed intensely pigmented flowers (mutant: corolla tube – *phlox purple* 632/3, flap - *phlox purple* 632/2; control: corolla tube and flap - *phlox purple* 631/1). The frequency of this mutant type was found to be higher in X-irradiations than gamma irradiations.

Small flower : The mutant plants were with small sized flowers (flower length: 2.83 cm ± 0.14, breadth: 1.53 cm ± 0.03) than control (length: 4.0 cm ± 0.01, breadth: 1.83 cm ± 0.03).

Round fruit : The mutant plants had round and ribbed fruits in comparison to elongated fruits in control. This mutant type was spotted only from 100Gy gamma irradiations.

Black seed : The mutant plants possessed black seeds (length: 3.1 mm ± 0.24, breadth: 2.03 mm ± 0.01) in comparison to *dark seed* – 3/6 seeds in control (length: 2.65 mm ± 0.13, breadth: 2.0 mm ± 0.05). Mutation frequency over the population was 0.35%.

X-irradiation has induced higher frequency

Figs.1-9. Plant types in sesame. 1. Control. 2. *Elongated* leaf mutant. 3. *Thick leaf* mutant. 4. *Ovate leaf* mutant. 5. *Ternate.* 6. *Fasciated stem* mutant (-->) showing zone of fasciation, intense fruiting and crown cluster of leaves at the apex); 7. *Lux branching,* mutant. 8. *Unbranched stem* mutant; 9. Pod shape (a. normal elongated fruit, b. *round fruit* in mutant).

(10.71%) of mutation than gamma irradiation (6.56%). Mutation frequency estimated over M_2 population was 8.37%. Maximum frequency of mutation has been recorded from 300Gy X-ray treatment. Spectrum of mutation was higher in gamma irradiations (19; range: 2-14) compared to X-ray doses (15; range: 2-12). Over the M_2 population the mutants occurred in the following order: *narrow leaf > thick leaf > early flowering > late flowering > dwarf > fasciated stem > black seed > elongated leaf = lax branching > small flower = white flower = thick stem > pigmented flower = unbranched stem > ternate = bushy = round fruit > long petiole = chloroxantha = ovate leaf.*

Induced mutation have affected various plant parts of sesame resulting into alteration of the plant ideotype. The mutants scored seem to have academic and/ or agronomic values. Further, leaf, flower colour, seed colour and fasciated stem mutants may be exploited as genetic markers in breeding experiments in sesame for improvement.

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