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FASCIATED MUTANT INDUCED BY THE COMBINED TREATMENT OF GAMMA RAYS AND SODIUM AZIDE (20 KR + 0.10% SA) IN *LINUM USITATISSIMUM* L.

ALKA* AND M.Y.K. ANSARI

Cytogenetics Lab, Department of Botany, Aligarh Muslim University, Aligarh-202002, U.P. INDIA.

ABSTRACT

The present investigation provides the effect of combined treatment of gamma rays and SA (Sodium Azide) on the morphology of *Linum usitatissimum*. Fasciated plants were obtained in M_2 and M_3 generation. Various widened and flattened organs were found such as fasciated stems, abnormal branches arising from fasciated stems, broad and abnormal leaves. The enhanced activity of apical meristem and cambium resulted in a significantly increased circumference of the stem resulting into increasing number of leaves, buds, flowers, fruits and seeds. Moreover the size of fruits and seeds were much bigger than control.

KEYWORDS: ***Linum usitatissimum*, gamma rays, SA, Fasciated mutant.**

ALKA
Cytogenetics Lab, Department of Botany, Aligarh Muslim University, Aligarh-202002, U.P. (INDIA)

INTRODUCTION

Fasciation (or cristation) is a variation that may occur in the morphology of plant organs and typically involves broadening of the shoot apical meristem, flattening of the stem and changes in leaf arrangement. The scientific knowledge on fasciation was reviewed by White (1948), Gorter (1965) and Clark et al. (1993). Fasciations have been reported to occur naturally in trees, shrubs, flowers and cacti in at least 107 plant families and are very common in the Rosaceae, Ranunculaceae, Liliaceae, Euphorbiaceae, Crassulaceae, Leguminosae, Onagraceae, Compositae and Cactaceae (Binggeli 1990). Physical and chemical mutagens provide a good scope for selection, as a tool for alteration in the genotype to enhance the variability of characters as obtained at present. Sodium Azide has been one of the most powerful mutagens in crop plants and its mutagenic potential has been reported in several screening assays. It is a well-known respiratory-catalase and per-oxidase inhibitor and shown to be a potent chemical mutagen in both higher and lower organisms (Nilan et al., 1973). Gamma rays are the form of electromagnetic energy. Gamma rays have the shortest wavelength in the electromagnetic spectrum, therefore have the greatest ability to penetrate through any gap, even a subatomic one, in what might otherwise be an effective shield. and has proven an adept means of encouraging the expression of recessive genes and producing new genetic variations (Schum, 2003; Song and Kang, 2003). Both these mutagens should yield a frequency of mutations higher than the total of two mutagens. The present mutation may be due to synergistic effects of combination treatments of mutagens on the morphology of *Linum usitatissimum*.

MATERIALS AND METHODS

Healthy and dried seeds of *Linum usitatissimum* L. were obtained from theAcharya Narendradev University of Agriculture and Technology, Kumarganj, Faizabad, U.P. For combination treatments, three samples of 100 seeds each were irradiated with gamma rays by 20 kR doses and then treated with in three combinations of SA (0.10%, 0.50% and 1.00%). The treated seeds were immediately sown at the rate of 100 seeds per plot in a randomized block design (RBD) with three replications at spacing of 15x30 cm within and between the rows. Morphological parameters were recorded at plant maturity in M_1, M_2 and M_3 generations.

RESULT

Out of 300 seeds sown, 5 fasciation mutants were obtained in M_2 and M_3 generations in 20 kR+0.10% SA only. Five mutants showing fasciated characters were obtained in M_2 generation and same characters were obtained in M_3 generation which showed that these mutants were true type. The most of the characters were superior than control plants such as average height, width of stem, thickness of stem, length and width of leaf, flower and seed morphology and yield parameters. Moreover the days to maturity decreased than control significantly. Increase number of capsules/plant, seed size and seeds weight (1000-seeds weight) are favorable in getting more oil yield/plant (Table.1) (Fig. A-H).

Table 1
Characters of fasciated mutants obtained in M_2 and M_3 generations.

Characters of Plant	Control Plant	Fasciated Mutant
Average height	78.60 cm.	97.40 cm.
Width of stem	5 mm.	4.2 cm.
Thickness of stem	5 mm.	8.0 mm.
Average length of leaf	3 cm.	3.5 cm.
Average width of leaf	3 mm.	1.6 cm.
Number of capsules/plant	69.50	80.00
Number of seeds/capsule	8.50	10.50
1000-seeds weight (g)	6.33	12.00
Days to maturity	120	100
Flower characters	Light blue with blue lining, Petals margin entire, petals apex: round, normal size anther	Purple with purple lining, petals margin wavy, petals apex: lobed, anther bigger in size
Seed characters	Brown, small, elliptical	Dark brown, broad, thick, elongated, bigger size, shining surface, seed tip beak like

Figure
A-H: Figures of Linum usitatissimum L. showing Control and Fasciated Mutant in M_2 generation.

A. ***Control plant.***
B. ***Fasciated stem, highly densed thicker and bigger leaves, increased number of flower buds.***
C. ***Control leaf***
D. ***Obovate, Bigger, thicker and broader mutant leaf***
E. ***Control flower***
F. ***Mutant flower, petals wavy margin, lobed apex***
G. ***Control seeds***
H. ***Mutant seeds***

DISCUSSION

Fasciations are widespread phenomena reported in more than 100 vascular plant species (Tang and Knap, 1998) affecting dicots and monocots in 39 plant families and 86 genera (Goethals et al., 2001). Fasciations may occur in woody plants, annuals and even cacti. There are many reasons for fasciations through bacterial infection by seedborne *Rhodococcus fascians* (Putnam and Miller, 2007). Crespi et al. (1992) reported fasciation due to bacterial infection was the result of the transmission of a linear plasmid (containing a gene that synthesizes cytokinin). Goethals et al. (2001), report the ability of *Rhodococcus fascians* to cause fasciations and other plant distortions, while involving a cytokinin-like compound, appears to involve other plant hormones as well. Many annual plants contain a gene responsible for the fasciation of vegetative parts and flowers. Gregor Mendel, the father of modern genetics, demonstrated that the gene for fasciation was a heritable trait in peas (Gottschalk, 1977). These inherited fasciations are meristematic mutations which impart tumor-like properties to the meristem (Tang and Knap, 1998). This support the present finding because the fasciated mutant obtained in M_2 generation were inherited in M_3 also. Moreover herbicides, insects and physical injury to the growing tip are reported to stimulate the occurrence of fasciations (Geneve, 1990). Spontaneous mutations may also cause fasciation (Gabillard and Pitrat, 1988).

Moreover the fasciation induced by a combination of gamma rays and SA found in the present study has also been reported to induce floral fasciation in *Gerbera jamesonii* by gamma rays (Singh et al. 2011), stem fasciation in sunflower by EMS (Lyakh et al. 2005; Soroka and Lyakh, 2009) and in *Cicer arietinum* var. ILC-3279 by EMS and gamma rays (Haq et al, 1994). As obtained the increased yield and seed size in *Linum* at present, Gorter (1965) and Tanskley (2004) have also reported significant increase in locule number and fruit size in tomato cultivar. This may be due to the synergistic effect of gamma rays and SA as supported by several other workers (Jana and Rao, 1975 in Black gram; Venkateswarlu *et al.,* 1988 in *Cartharanthus roseus,* Ignacimuthu and Babu 1989 in Black gram). It may be concluded that these increased growth causing fasciation may be due to the development of conditions favouring rapid growth following the hormonal actions of cytokinin and similar other hormones/ triggering of genes responsible for cytokinin production due to point mutations caused by SA and gamma rays.

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