Induced Mutagenic Variability in Saffron (*Crocus sativus* L.)

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Abstract

Saffron (*Crocus sativus* L.) is an iridaceous cormose geophyte. Its stigmatic lobes constitute saffron, which is used in flavouring food dishes and manufacturing perfumes, dyes and biomedicines. Flavour, fragrance, and colour and are attributed to the presence of some constituents like picrocrocin, a glycoside; safranal, an aglycone obtained from picrocrocin; and crocin and its hydrolysed product crocetin, respectively.

Kashmir is the only region producer of saffron in India. Kashmiri saffron is qualitatively superior to others, but its yield is minor in comparison with Spanish or Iranian strains. Low yield is mainly due to primitive agronomic practices but also partly due to non-availability of high yielding strains. All allies of genus *Crocus* are diploid but *C. sativus* is triploid in genetic makeup (2n=3x=24). Due to triploidy, meiosis in *C. sativus* is highly erratic and genetically unbalanced gametes are formed, which lead to formation of sterile gametes and ultimately no sexuality is involved that is essential phenomenon for seed formation.

Due to absence of sexuality in the existing strains, a non-conventional breeding programme at Govt. Fruit Research Centre Pithoragarh, located at 5,000 feet height from sea level in mid hills of Uttaranchal, where temperate climate is available, was carried out by irradiating *C. sativus* corms to develop putative mutants of economical use. Corms were subjected to different does of Co^{60} to induce variability. Six sets of saffron consisting of 100 uniform corms of 4-5 cm in diameter were irradiated with 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 krad doses of gamma rays. A set of 100 corms was planted as control. Variability with respect to sprouting time, plant height, induction of flowering, number of petals and shape of petals was noted. Corms of identified mutants were harvested separately and these mutant lines were advanced to next generations to bring them true to type.

Delayed sprouting and slow growth in higher doses (2.0, 2.5, and 3.0 krad) increase of plant height in lower doses (0.5 and 1.0 krad), decrease is higher doses (2.0, 2.5 and 3.0 krad), and induction of flowering in middle doses (1.0, 1.5, and 2.0 krad) was noted. On evaluating the variants, serrated petal mutants were found to be superior than parental strain and other mutants with respect to days of flowering (68 days), size of flower (4.87 cm), length of stigma (2.91 cm) and weight of 100 fresh stigmas (0.608 g)

Delayed sprouting, slow growth in higher doses, increase and decrease of plant height in lower and higher doses respectively is due to the amount of auxin synthesized during the course of sprouting. Development of serrated petal is the result of a somatic gene mutation, whereas fused petal is the result of inhibition of apical cell division of petal at initial stage of flower development, caused by irradiation.

INTRODUCTION

Saffron (*Crocus sativus* L.) is a cormose genotype. Its dried stigma is used in colour, flavour, perfume and biomedicine. Moreover, the cultivated saffron strain is triploid in genetic make up, therefore is incapable to produce seed. Propagation/cultivation

is made by a vegetative part called corm. Due to the involvement of large quantity of corms in its cultivation the cost of saffron farming is increased. Keeping in view the importance of the above referred, the present investigation was undertaken to induce the genetic variability in saffron using physical irradiation. The main objective of employing physical irradiation was to develop polyploid forms; tetrafid, pentafid or hexafid stigmatic plants; and colour mutants; and to study the radiosensitivity showed by various characteristics of saffron plant growth.

MATERIALS AND METHODS

The present investigation was conducted during 2000-2002 at Govt. Fruit Research Centre, Pithoragarh, India, located at 5000 feet height from sea level in mid hills of Uttaranchal. The cultivated strain of Kashmir known as Kashmira was used to perform the present study. Six sets of saffron corms, each set consisting of 100 uniform corms of 3-4 cm diameter were irradiated with 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 krad doses of Co60 gamma rays at NBRI, Lucknow. A set of 100 untreated corms was used as control. After irradiation, corms were planted in raised beds at 10 x 15 cm dimension and 8-10 cm depth. All cultural practices were made to raise the normal crop.

Observation on sprouting period, plant height, days to flowering, flower size, flower shape, flower colour, flowering percentage, weight of 100 stigmas, pollen fertility and corm yield per plant were taken into consideration. Individually all plants of VM1 generation were examined. The identified mutants (VM1) were separated and advanced to VM2 and VM3 generations for further study and trial. Morphological and yield study of identified mutants were made separately.

RESULTS AND DISCUSSION

Radiosensitivity study was made on the basis of various morphological characters of the plant. Induction of early sprouting in 0.5 krad, 1.0 krad and 1.5 krad and delayed sprouting in higher doses was noted. Induction of flowering and plant height in 0.5 krad and 1.0 krad and decrease in plant height in higher doses were also observed. Cent percent sprouting in the bulbs treated with 0.5, 1.0 and 1.5 krad and in higher doses reduction in sprouting was noted. Cent percentage survival in 0.5, 1.0 and 1.5 krad and reduction in survival percentage in higher doses was observed. Pollen fertility in control plant was less (10%) but in treated plants it was further reduced. Corm yield per plant was higher in 0.5 and 1.0 krad but reduced in higher doses. No polyploid forms, colour mutations and tetrafid stigma plants were obtained (Table 1).

On the examination of treated population of VM1 generation, 53 flowering plants from 0.5,1.0,1.5 krad, two serrated petal plants from 0.5 krad and two 3- petal plants from 1.0 krad were identified. Corms of these plants were harvested separately and these mutant lines were advanced to VM2 and VM3 generations to bring them true to type form and also to compare them with those of parental lines. All 53 flowering mutants failed to bloom in VM2 generation indicating reversible mutation/ loss of induction effect. Moreover, serrated petal mutant and 3-petal mutants remained in mutant condition in VM2/VM3 generations. LD50 was noted to be 2.5 krad. Normally saffron flower has six petals with smooth margin but serrated petal mutants appeared. The three petal mutant flower has three petals instead of 6. The mean of various vegetative and yield characters of mutants are presented here (Table 2).

Delayed sprouting, slow growth in higher doses, increase/decrease of plant height at lower and higher doses respectively, and induction of flowering in VM1 generation at lower doses, are due to auxin synthesis at lower doses; whereas at higher doses it is inhibited resulting into delayed and stunted growth. The present study is in conformity with other reports (Gordon, 1959). Stunted growth, reduction in survival and reduced fertility is also attributed to genetic loss due to chromosomal aberrations and gene

mutations (Sparrow et al., 1967; Datta and Gupta, 1980). Flower induction in VM1 generation is the result of mutations in the biochemical pathways, which assist the synthesis of flower inducing substance, leading to the formation of flower; whereas the same process is not inherited in the next generation resulting into flowerless plant.

Formation of serrated petal is due to the somatic gene mutation where as 3-petal mutant is the result of alternate inhibition of apical cell division of petal at initial stage of flower development due to induction effect.

Low corm yield in higher doses is due to damage in some bud cells of corm due to irradiation.

Literature Cited

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Tables

Table 1. Radiosensitivity study on different characters of saffron.

Characteristics	Control	0.5 Krad	1.0 Krad	1.5 Krad	2.0 Krad	2.5 Krad	3.0 Krad
Days to sprouting	45.± 1.80	41.0±1.50	42.01±1.25	44.0±1.65	62.0±3.90	75.0±1.80	80.0±2.0
Days to flowering	64.0±2.25	60.0±1.50	64.0±2.0	65.0±1.05	-	-	-
Plant height (cm)	11.85±1.90	14.60±2.0	16.0±1.75	12.0±2.0	10.85±1.00	9.65±1.05	9.20±0.85
Sprouted bulbs (%)	100	100	100	100	60.00	55.00	51.00
Survival plants (%)	100	100	100	100	54.00	47.00	20.00
Flowering plants (%)	13.0±0.5	15.0±2.25	20.0±1.80	18.0±1.50	-	-	-
Pollen fertility (%)	10.0±1.50	8.0±2.0	7.0±1.90	5.0±1.75	-	-	-
Corm yield (per plant)	5.50±1.75	5.85±2.00	6.0±1.95	5.25±2.0	4.75±1.85	4.35±1.65	3.45±1.65

Table 2. Performance of mutants in VM3 generations.

Variety/ mutants	Days to sprouting	Days to flowering	Plant height (cm.)	Flowering plants (%)	Flower diameter (cm)	Stigma length (cm)	100 stigma weight (g)	Corm yield (per plant)
Parental variety (Kashmira)	47.00	65.00	13.50	16.00	4.30	2.80	0.675	5.20
3-petal mutant	48.00	66.00	13.60	4.00	4.28	2.70	0.670	5.25
Serrated petal mutant	50.00	68.00	14.25	41.00	4.87	2.91	0.688	5.30