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Induced Mutation as a Tool for Improving Corm Multiplication in Saffron (*Crocus sativus* L.)

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Summary

An attempt was made to create new variants for increasing corm production per planting cycle through the induction of mutations using physical [Gamma rays in Kilo-Roentgen (kr)] and chemical (Ethyl Methane Sulphonate, Colchicine, Ethidium bromide) mutagens at different growth stages of saffron using fortnight treatments (Ist June, 15th June, Ist July, 15th July, Ist August, 15th August, Ist September, 15th September). Initially, 44 plants were selected on the basis of their higher yield performances. Further evaluation of those 44 selected mutagenic plants in M3 generation during the year 2010 identified the treatments D2T6 (15th June treatments of corms with 0.1% EMS) and D8T6 (15th June treatment of corms with Colchicine 0.05%) both producing highest number of daughter corms (15) per mother corm followed by D2T2 (15th June treatment of corms with 0.2kr gamma radiations) producing 12 daughter corms per mother corm, as compared to control (Natural Population) producing only 5 daughter corms per mother corm. Thus, 15th June is proposed as ideal time for treatment of saffron corms in order to induce increased number of daughter corms per mother corm. Further 0.2kr dose gamma radiation is having positive effect on increasing number of daughter corms per mother corm. Standardization of such technique could add to economic stability of farmers, make available considerable quantity of saffron corms for area expansion and by that add to the saffron area and production of our country.

Key Words: Mutagenesis, Variability, Corm Production, Corm Multiplication

Introduction

Saffron is triploid (2n=3X=24), sterile geophyte and is propagated solely vegetatively by means of corms. The autotriploid nature of this *Crocus sp.* renders chances of crop improvement through conventional means like hybridization very difficult [1]. The triploid condition in saffron only allows vegetative multiplication, but no regular sexual reproduction due to meiotic abnormalities which result in abnormal chromosome assortment and formation of an abnormal number of genetically unbalanced spores that vary in shape and size leading to complete sterility [2]. However, there have been efforts by different researchers to this effect using non-conventional breeding techniques [3-6]. Therefore, utilization of heterogenity in the natural population which is due to genetic and environmental factors offers a tremendous scope for saffron improvement. Mutation breeding technique is presently used for induction of genetic variability [7]. The use of mutagenesis could enhance the multiplication rate of saffron corms per planting cycle (4-5 years) in absence of sexuality and thus increase the scope of improvement of saffron through mutation breeding.

Materials and Methods

The corms of uniform weight (10 g) from natural saffron population were subjected to five dozes of Co^{60} gamma rays at Bhaba Atomic Research Centre, Srinagar during 2007 viz; 0.1 Kr, 0.2 Kr, 0.3 Kr, 0.4 Kr and 0.5 Kr and five doses of chemical mutagens viz., Ethyl Methane Sulphonate (0.1 and 0.2%), Ethidium Bromide (0.1 and 0.2%) and Colchicine (0.05%). Each treatment (T1 to T10) was subjected to 8 sets of 100 dormant saffron corms at regular interval of 15 days starting from 1st June to 15th September (D1 to D8). Treated corms were planted at the Saffron Research Sub-Station with a planting geometry of 20 x 10 cm^2. Data on number of corms per mother corm, total number of flowers per plot, average number of leaves per plant, average plant height (cm), average leaf width (mm), fresh flower weight (g), fresh pistil weight (g), dry pistil weight (g) and saffron yield kg/ ha were recorded for M3 generation.

Results and Discussion

Initially 44 plants were selected on the basis of their higher yield performances during M0 (2007), M1 (2008) and M2 (2009) generations. Further evaluation of those 44 selected mutagenic plants produced through physical and chemical mutagenesis applied at different growth stages of saffron in M3 generation during the year 2010 identified the treatments D2T6 (15th June treatments of corms with 0.1% EMS) and D8T6 (15th June treatment of corms with Colchicine 0.05%) both produced highest number of daughter corms (15) per mother corm followed by D2T2 (15th June treatment of corms with 0.2kr gamma radiations) producing 12 daughter corms per mother corm, as compared to control (Natural Population) producing

only 5 daughter corms per mother corm (Table 1). Thus, 15th June is proposed as ideal time for treatment of saffron corms in order to induce increased number of daughter corms per mother corm. Further 0.2kr dose gamma radiation is having positive effect on increasing number of daughter corms per mother corm. EMS has been reported to induce nuclear as well as cytoplasmic mutations in crop plants [8]. Further the effect of various doses and treatment durations of physical and chemical mutagens in inducing variability for economic traits in crop plants has also been reported [8, 9, 10, 11]. Data on traits other than yield attributing traits like average number of leaves per plant, average plant height (cm), average leaf width (mm) recorded during M3 generation identified 0.2kr treatment on 15th June and 15th July as promising. Stunted growth, reduction in survival and reduced fertility was attributed to genetic loss due to chromosomal aberrations and gene mutations [12, 13].

Conclusion

Standardization of technique of using induced mutagenesis for enhancing the rate of corm multiplication in saffron would add to economic stability of farmers, make available considerable quantity of saffron corms for area expansion and by that add to the saffron area and economize the saffron cultivation of our country.

Table 1. Evaluation of selections made from mutation breeding experiment (Plot size- 0.75 m^2)

S. No	Treatment	Mutant selections ¥	No. of corms per mother corm	Total Number of Flowers per plot	Number of leaves	Plant Height (cm)	Avg. Leaf width (mm)	Fresh Flower Weight (g)	Fresh Pistil Weight (g)	Dry Pistil Weight (g)	Yield Kg/ha
1	2	3	4	5	6	7	8	9	10	11	12
1	D1T1	R2P10	2	4	9	25	1.8	1.64	0.148	0.033	0.440
2		R3P10	6	8	10	17	0.8	3.28	0.295	0.065	0.866
3		R9P2	5	9	8	10	1.0	3.69	0.332	0.074	0.986
4		R6P5	3	5	24	20	1.0	2.05	0.185	0.041	0.547
5	D1T2	R9P4	4	7	10	27	1.0	2.87	0.258	0.057	0.760
6	D1T5	R5P6	2	6	8	16	1.0	2.46	0.221	0.049	0.653
7	D1T6	R7P10	2	5	8	19	1.1	2.05	0.185	0.041	0.547
8	D1T7	R3P1	4	7	32	12	0.6	2.87	0.258	0.057	0.760
9		R3P8	8	10	21	23	1.85	4.1	0.369	0.082	1.093
10	D1T9	R6P1	5	8	41	18	1.2	3.28	0.295	0.065	0.866
11		R4P9	4	7	23	20	0.9	2.87	0.258	0.057	0.760
12		R2P9	10	16	10	38	1.0	6.56	0.590	0.131	1.746
13	D1T10	R6P9	4	7	5	36	1.3	2.87	0.258	0.057	0.760
14	D2T2	R3P5	4	9	50	19.5	1.0	3.69	0.332	0.074	0.986
15		R2P3	12	17	7	30	1.0	6.97	0.627	0.139	1.853
16		R5P7	6	8	23	22	1.1	3.28	0.295	0.065	0.866
17		R4P10	10	13	12	29	0.7	5.33	0.480	0.107	1.426
18		R7P4	5	9	15	29	1.1	3.69	0.332	0.074	0.986
19	D2T6	R6P6	5	8	24	11	0.7	3.28	0.295	0.065	0.866
20		R10P4	15	22	33	14	0.8	9.02	0.812	0.180	2.399
21	D2T3	R2P3	5	7	21	20	0.9	2.87	0.258	0.057	0.760
22	D3T9	R3P6	9	13	19	18	0.7	5.33	0.480	0.107	1.426
23		R4P4	5	9	9	36	0.8	3.69	0.332	0.074	0.986
24	D3T7	R9P3	4	7	7	20	0.9	2.87	0.258	0.057	0.760
25	D3T10	R3P1	3	4	27	13.5	0.75	1.64	0.148	0.033	0.440
26	D4T2	R4P9	9	10	45	10.5	0.7	4.1	0.369	0.082	1.093
27	D4T5	R5P10	5	6	33	15	0.6	2.46	0.221	0.049	0.653
28	D5T2	R4P7	6	7	26	12	0.6	2.87	0.258	0.057	0.760
29	D5T6	R2P5	7	7	19	30	1.4	2.87	0.258	0.057	0.760
30	D6T2	R3P4	10	13	24	13	0.8	5.33	0.480	0.107	1.426
31	D6T7	R4P1	5	9	25	16	0.7	3.69	0.332	0.074	0.986
32	D6T10	R7P6	10	11	27	27	0.9	4.51	0.406	0.090	1.200
33	D7T8	R4P10	10	9	27	18	0.9	3.69	0.332	0.074	0.986
34		R4P9	3	5	38	18	1.0	2.05	0.185	0.041	0.547
35	D7T9	R3P4	10	12	22	26	1.0	4.92	0.443	0.098	1.306
36		R1P4	4	7	20	19	1.0	2.87	0.258	0.057	0.760
37		R10P8	10	11	18	30	1.2	4.51	0.406	0.090	1.200
38	D8T4	R6P1	7	8	11	15	0.8	3.28	0.295	0.065	0.866
39	D8T8	R1P1	5	7	19	27	1.2	2.87	0.258	0.057	0.760
40		R2P1	3	5	24	20	1.0	2.05	0.185	0.041	0.547
41	D8T1	R3P9	10	11	7	10	0.6	4.51	0.406	0.090	1.200
42	D8T6	R3P10	15	19	12	18	0.9	7.79	0.701	0.156	2.079
43		R5P6	5	8	19	17	1.0	3.28	0.295	0.065	0.866
44	D8T10	R6P5	14	16	28	15	0.8	6.56	0.590	0.131	1.746
45	Control	Natural Population	10	11	17	17	0.9	4.51	0.406	0.090	1.200

- 1st June to 15th September treatment (D1 to D8), Doses of physical and chemical mutagens (T1 to T10); ¥- R= row number, P= plant number selected

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