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EFFECT OF GAMMA RADIATION AND ETHYL METHANE SULPHONATE (EMS) ON MORPHOLOGICAL CHARACTERS OF GARDEN PEA (PISUM SATIVUM LINN) IN PLANTS OF M_2 GENERATION

Botany

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ABSTRACT

Background: Pisum sativum L. is a self pollinated pulse crop. This crop is an excellent source of essential nutrients, proteins, minerals, fibers, unsaturated fatty acids and β-carotene. **Aim:** To study the effectiveness and efficiency of different doses of Gamma radiation and Ethyl Methane Sulphonate on genetic variability of garden pea in the M2 and M3 generation. **Methods:** Seeds of garden pea were subjected to mutagenic induction by different doses of Gamma radiation and EMS. The plants in M2 generation which contained new useful mutants were harvested to raise individual plant progenies in the M2. For M3 generation, progeny from individual selected plants of M2 were grown. **Results:** The number of branches per plant, floral twigs, seeds per pod and the weight of 100 seeds in gm in garden pea was found to be higher in comparison to control plants. **Conclusions:** Exposure of Gamma radiation up to the dose of 15 kR or EMS at the concentration of 0.5% to 0.8% induced useful mutation in garden pea.

KEYWORDS

Pisum Sativum L. Gamma radiation, Ethyl Methane Sulphonate, Genetic variatio

INTRODUCTION

Garden pea Pisum sativum Linn.is a lianoid, annual, monocarpic, self fertilizing leguminous plant of family Papilionacea with a chromosome number of 2n = 24. South western Asia is the center of origin of this crop[1] (Nepolian et al., 2019). This crop is planted for its green pods which can be cooked as vegetable. The fruits and seeds are rich in starch, proteins, oil, galactolipids, alkaloids such as trigonelline and piplartine, as well as essential oil and soluble carbohydrates. High protein, starch, absorbable supplement content and low fiber content makes it as an excellent domestic feed.

The most economical external input and a critical input for agricultural productivity is seed[2,3] (Goyal et al., 2019 and Dhulgande et al., 2014). Gamma radiation and chemical mutagen like ethyl Methane Sulphonate are mutagenic agents used to produce beneficial mutations at a high rate. Mutations have been used to produce many cultivars with improved economic values [5](Turkan et al., 2006). Ethyl Methane Sulphonate (EMS) is a chemical mutagen has been reported to be the most effective and powerful mutagen which usually causes high frequency of gene mutations and low frequency of chromosome aberrations in plants[5] (Khatri et al., 2005). Gamma radiation is and energetic form of electromagnetic radiations is known for their ability to be popular mutagen due to its simple application, good penetration, reproducibility, high frequency of mutation and less disposal problems[6] (Ambavaane et al., 2015).

In the present investigation, the effectiveness and efficiency of different doses of Gamma radiation and Ethyl Methane Sulphonate (EMS) were studied on genetic variability of garden pea Pisum sativum L. in the M_2 and M_3 generation, and mutants exhibiting desirable morphological characters have been scored.

II. MATERIALS AND METHODS

Fresh and healthy seeds of garden pea were used for induction of mutation by physical and chemical mutagens. These were treated with Gamma radiation and Ethyl Methane Sulphonate (EMS). For this purpose, 30 seeds were plated in large Petri dishes in moist condition. The Petri dishes were incubated in the BOD incubator at 27±2^{0}C. Seeds were treated separately with five different doses gamma rays viz. 10 kR (100 Gy), 15 kR (150 Gy), 20 kR (200 Gy), 25 kR (250 Gy) and 30 kR (300 Gy) with radio isotope ^{60}Co in ^{60}Co source chamber. Similarly, the seeds were treated with six different concentrations of EMS viz. 0.5 %, 0.6 %, 0.7 %, 0.8 %, 0.9 % and 1.0 % for about six hours. The treated seeds were sown in plots of area 10 m X 15 m to raise M_1 generation. The seeds of the garden pea produced were collected separately after harvesting and grown in next growing season to obtain M_2 and M_3 generation. About 20 seeds from each M_1 were harvested separately to raise the M_2progeny rows. All the plants in M_2 rows which contained new useful mutants were harvested separately to raise individual plant progenies in the M_2. For M_3 generation, progeny rows from individual selected plants were grown. Mutant M_3 rows were harvested in bulk for a preliminary yield trial in M_4. The results obtained have been presented in Table-1 and 2.

Table-1: Effect Of Different Doses Of Gamma Radiation On Quantitative Characteristics Of Garden Pea

Doses of Gamma radiation	Vegetative characters					
	Plant height in cm	Number of branche s/plant	Number of floral twigs/pl ant	Number of pods /plant	Number of seeds/ pod	Weight of one hundred seeds in gm
	Garden Pea Pisum sativum Linn.					
Control	52.7 ±0.35	15.55 ±0.61	11.50 ±0.31	32.25 ±1.35	3.50 ±0.15	24.55 ±0.67
10 kR	53.65 ±0.31	16.55 ±0.37	11.75 ±0.32	33.65 ±1.27	4.45 ±0.17	25.60 ±0.37
15 kR	55.45 ±0.28	18.65 ±0.42	12.55 ±0.27	35.75 ±1.26	5.65 ±0.19	28.55 ±0.35
20 kR	51.45 ±0.70	13.35 ±0.47	10.47 ±0.29	30.27 ±1.37	3.05 ±0.08	22.75 ±0.67
25 kR	49.55 ±0.67	11.25 ±0.28	8.45 ±0.18	24.35 ±0.75	2.17 ±0.06	18.65 ±0.48
30 kR	46.35 ±0.65	10.17 ±0.21	6.47 ±0.21	21.45 ±0.67	1.50 ±0.31	16.25 ±0.21

Table-2: Effect Of Different Concentrations Of EMS On Quantitative Characteristics Of Garden Pea Pisum Sativum Linn.

Concentration of EMS in Percent (%)	Vegetative characters					
	Plant height in cm	Number of branche s/plant	Number of floral twigs/pl ant	Number of pods /plant	Number of seeds/ pod	Weight of one hundred seeds in gm
	Garden pea Pisum sativum Linn.					
Control	52.70 ±0.35	15.55 ±0.61	11.50 ±0.31	32.25 ±1.35	3.50 ±0.15	24.55 ±0.67
0.5	53.45 ±0.45	16.65 ±0.56	12.75 ±0.35	33.75 ±10.76	4.15 ±0.17	25.45 ±0.18
0.6	55.65 ±0.27	18.37 ±0.18	13.85 ±0.36	35.65 ±0.75	4.65 ±0.19	27.35 ±0.25
0.7	56.75 ±0.26	20.25 ±0.21	14.65 ±0.45	37.55 ±0.60	5.35 ±0.16	28.87 ±0.17
0.8	58.45 ±0.38	22.45 ±0.26	16.47 ±0.41	39.27 ±0.51	5.85 ±0.21	30.86 ±0.16
0.9	54.25 ±0.39	18.45 ±0.21	12.65 ±0.27	29.47 ±0.47	3.15 ±0.22	26.65 ±0.18
1.0	50.17 ±0.46	13.65 ±0.25	10.55 ±0.16	26.35 ±0.35	2.16 ±0.18	21.55 ±0.20

III. RESULTS

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The mean plant height of garden pea in control experiment was 55.70 ±0.35. The number of branches per plant in pea was 15.55 ±0.61. The number of floral twigs (fertile branches) was 11.50 ±0.31. Similarly, the number of pods per plant was 32.25 ±1.35. The number of seeds per pod and the weight of 100 gm seeds was 3.50 ±0.15 and 5.00 ±0.21(Table-1).

Pea plants when treated with Gamma radiation showed useful and harmful mutation in M2 generation. When treated with Gamma radiation up to the dose 15 kR plants showed significant increase in their height. At 10 kR dose of Gamma radiation, garden pea showed an increase in their height to 53.65 ±0.31. 10 kR to 15 kR doses of Gamma radiation may be considered as useful radiation dose for inducing mutation. Above 20 kR dose of Gamma radiation plants showed a significant decline in their height (Table-1).

The number of branches per plant in control experiments was 15.55 ±0.61. The number of branches increased significantly in garden pea when exposed to Gamma radiation up to 15 kR. This means that the radiation dose of 10 kR and 15 kR induced favorable growth of garden pea plants. On exposure to15 kR Gamma radiation, pea plants showed an increase in their number of branches to 18.65 ±0.42 (Table-1). The number of fertile branches (floral twigs) per plant increased on exposure to at the dose of 15 kR in comparison to control which was 11.50 ±0.31 (Table-1). The number of pods per plant, seeds per pod and the weight of 100 seeds in gm showed a more or less similar trend of mutagenic response of Gamma radiation of dose 10 kR to 30 kR. In control experiments, the number of pods per plant was 32.25 ±1.35. Exposure of Gamma radiation up to the dose of 15 kR caused increase in the number of pods per plant which was 35.75 ±1.26. The number of seeds per pods also increased to 5.65 ±0.19 in pea pods when exposed to a radiation dose of 15 kR in comparison to control. Above 15 kR of radiation dose the number of seeds per pod significantly declined. Similarly, the EMS at the concentration of 0.5% to 0.8% induced useful mutation in garden pea. At 0.5% EMS the plant height of was 53.45 ±0.45 in comparison to control. Up to 0.8% EMS exposure the plant height increased to 58.45 ±0.38. Beyond this concentration of EMS the plant height of garden pea declined. To 0.5% to 0.8 % concentration of EMS was therefore found to induce usable mutation (Table-2).

IV. DISCUSSION

Garden pea, several mutants in M_2 generation were observed in terms of growth habit, size and height of plants, number of vegetative and floral branches, pods per plant, seeds per pod and weight of seeds. The present observations also gain support from the work of several worker[7-12] (Tokers(Laskar et al., 2015; Gaur et al., 2001; Toker, 2009; Khan et al., 2009; Khan et al., 2004; Tyagi and Gupta, 1991). It has been observed that every individual gene responsible for agronomic trait can mutate, and therefore, a wide spectrum of viable morphological mutants can be expected in mutation experiments[13] (Tyagi and Gupta, 1991). Enhancement of frequency of induced morphological mutations towards desired agronomic traits is important key in mutation breeding programme for crop improvement. The pleiotropic effects of mutated genes or chromosomal aberrations or gene mutations might be responsible for such mutants [14](Wani, 2009)

V. CONCLUSIONS

It can be concluded that Exposure of Gamma radiation up to the dose of 15 kR and EMS at the concentration of 0.5% to 0.8% induced useful mutation in garden pea Pisum sativum Linn..

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