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IMPACT OF GAMMA RADIATION AND ETHYL METHANE SULPHONATE (EMS) ON MORPHOLOGICAL CHARACTERS OF DESI AND KABULI CHICKPEA (CICER ARIETINUM L.) IN PLANTS OF M_2 GENERATION

Botany

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ABSTRACT

Background: *Cecer arietinum* 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 Desi and Kabuli chickpea in the M_2 and M_3 generation. **Methods:** Seeds of Desi and Kabuli chickpea were subjected to mutagenic induction by different doses of Gamma radiation and EMS. The plants in M_2 generation which contained new useful mutants were harvested to raise individual plant progenies in the M_2. For M_3 generation, progeny from individual selected plants of M_2 were grown. **Results:** The number of branches per plant, floral twigs, seeds per pod and the weight of 100 seeds in gm in both Desi and Kabuli chickpea 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 both Desi and Kabuli chickpea.

KEYWORDS

Cicer arietinum L. Gamma radiation, Ethyl Methane Sulphonate, Genetic variations

INTRODUCTION

Cicer arietinum L. (Chickpea) is a self pollinated, diploid (2n=14 or 2n=16), annual leguminous pulse crop, and its global production is estimated to about 11 million tonnes and India is the major producer of this crop[1].

Two broad categories of chickpea are grown in India viz. Desi (Microsperma) and Kabuli (Macrosperma). Desi chickpea is relatively smaller in size. Chickpea is an excellent source of essential nutrients, proteins, minerals, fiber, unsaturated fatty acids and β-carotene[2,3]

Chickpea is a small plant growing to about 70 cm in height. Its lateral roots develop symbiotic nodules containing nitrogen fixing bacteria *Rhizobium* sp. Their leaves are imparipinnate. The entire surface of plant is covered by glandular trichomes that contain malic acid, citric acid and oxalic acid[4, 5]. Flowers are solitary and borne in an axillary raceme. The pods contain up to 3 seeds.

Cicer arietinum is an autogamous plant whose genome size is 738.09Mb[6]. Mutation breeding is the most reliable method for the improvement of genotype[7]. The quality of Chickpea can be significantly improved through induced mutagenesis[8-13].

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 Desi and Kabuli chickpea in the M_2 and M_3 generation, and mutants exhibiting desirable morphological characters have been scored.

MATERIALS AND METHODS

Fresh and healthy seeds of Desi and Kabuli chickpea 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 each of the two varieties of chickpea were plated separately in large Petri dishes in moist condition. The Petri dishes were incubated in the BOD incubator at 27±2^{0}C. Seeds of each of the two varieties of chickpea 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 two varieties 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_2 progeny 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 Desi And Kabuli Chickpea

Doses of Gamma radiation	Vegetative characters											
	Plant height in cm		Number of branches/plant		Number of floral twigs/plant		Number of pods /plant		Number of seeds/pod		Weight of one hundred seeds in gm	
	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli
Control	52.7 ±0.35	53.50 ±0.46	15.55 ±0.61	17.65 ±0.75	11.50 ±0.31	13.70 ±0.37	32.25 ±1.35	34.27 ±0.28	3.50 ±0.15	5.00 ±0.21	24.55 ±0.67	28.65 ±0.75
10 kR	53.65 ±0.31	55.75 ±0.48	16.55 ±0.37	17.85 ±0.41	11.75 ±0.32	13.85 ±0.35	33.65 ±1.27	35.35 ±0.17	4.45 ±0.17	5.76 ±0.27	25.60 ±0.37	30.65 ±0.67
15 kR	55.45 ±0.28	57.85 ±0.65	18.65 ±0.42	19.75 ±0.57	12.55 ±0.27	15.80 ±0.43	35.75 ±1.26	37.45 ±1.37	5.65 ±0.19	6.37 ±0.31	28.55 ±0.35	30.75 ±0.68
20 kR	51.45 ±0.70	52.65 ±0.67	13.35 ±0.47	15.45 ±0.55	10.47 ±0.29	11.65 ±0.70	30.27 ±1.37	31.25 ±1.25	3.05 ±0.08	4.15 ±0.18	22.75 ±0.67	25.85 ±0.73
25 kR	49.55 ±0.67	50.45 ±0.65	11.25 ±0.28	13.37 ±0.48	8.45 ±0.18	9.35 ±0.47	24.35 ±0.75	26.37 ±1.19	2.17 ±0.06	3.25 ±0.26	18.65 ±0.48	22.75 ±0.53
30 kR	46.35 ±0.65	48.45 ±0.62	10.17 ±0.21	11.45 ±0.51	6.47 ±0.21	7.26 ±0.30	21.45 ±0.67	22.48 ±0.35	1.50 ±0.31	2.25 ±0.09	16.25 ±0.21	19.45 ±0.45

Table-2: Effect Of Different Concentrations Of EMS On Quantitative Characteristics Of Desi And Kabuli Chickpea

Concentration of EMS in Percent (%)	Vegetative characters											
	Plant height in cm		Number of branches/plant		Number of floral twigs/plant		Number of pods /plant		Number of seeds/pod		Weight of one hundred seeds in gm	
	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli	Desi	Kabuli
Control	52.70 ±0.35	53.50 ±0.46	15.55 ±0.61	17.65 ±0.75	11.50 ±0.31	13.70 ±0.37	32.25 ±1.35	34.27 ±0.28	3.50 ±0.15	5.00 ±0.21	24.55 ±0.67	28.65 ±0.75
0.5	53.45 ±0.45	54.65 ±0.47	16.65 ±0.56	18.75 ±0.61	12.75 ±0.35	14.85 ±0.26	33.75 ±10.76	35.35 ±0.18	4.15 ±0.17	5.65 ±0.19	25.45 ±0.18	28.55 ±0.61
0.6	55.65 ±0.27	56.75 ±0.38	18.37 ±0.18	20.76 ±0.60	13.85 ±0.36	15.95 ±0.25	35.65 ±0.75	37.47 ±0.19	4.65 ±0.19	6.25 ±0.21	27.35 ±0.25	30.65 ±0.60
0.7	56.75 ±0.26	57.55 ±0.35	20.25 ±0.21	22.75 ±0.57	14.65 ±0.45	16.34 ±0.24	37.55 ±0.60	39.65 ±0.28	5.35 ±0.16	6.87 ±0.23	28.87 ±0.17	32.25 ±0.48
0.8	58.45 ±0.38	59.65 ±0.31	22.45 ±0.26	24.65 ±0.48	16.47 ±0.41	18.35 ±0.21	39.27 ±0.51	40.16 ±0.31	5.85 ±0.21	7.65 ±0.24	30.86 ±0.16	34.35 ±0.43
0.9	54.25 ±0.39	53.27 ±0.29	18.45 ±0.21	19.35 ±0.38	12.65 ±0.27	13.45 ±0.20	29.47 ±0.47	30.55 ±0.35	3.15 ±0.22	3.17 ±0.26	26.65 ±0.18	24.35 ±0.18
1.0	50.17 ±0.46	49.55 ±0.25	13.65 ±0.25	12.55 ±0.35	10.55 ±0.16	9.65 ±0.17	26.35 ±0.35	21.57 ±0.45	2.16 ±0.18	3.13 ±0.30	21.55 ±0.20	20.55 ±0.21

RESULTS

The mean plant height of Desi and Kabuli chickpea in control experiment was 55.70 ±0.35 and 53.50 ±0.46 cm respectively. The number of branches per plant in Desi and Kabuli chickpea was 15.55 ±0.61 and 17.65 ±0.75 respectively. The number of floral twigs (fertile branches) was 11.50 ±0.31 and 13.70 ±0.37 respectively. Similarly, the number of pods per plant in Desi and Kabuli chickpea was 32.25 ±1.35 and 34.27 ±0.28 respectively. The number of seeds per pod and the weight of 100 gm seeds in Desi and Kabuli chickpea was 3.50 ±0.15 and 5.00 ±0.21, and 24.55 ±0.67 gm and 28.65 ±0.75 gm respectively (Table-1).

Chickpea 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, the Desi and Kabuli chickpea showed an increase in their height to 53.65 ±0.31 and 55.75 ±0.48 cm respectively. 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 of both the chickpea varieties showed a significant decline in their height (Table-1).

The number of branches per plant in control experiments was 15.55 ±0.61 and 17.65 ±0.75 in Desi and Kabuli chickpea respectively. The number of branches increased significantly in both Desi and Kabuli chickpea 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 both chickpea varieties. On exposure to15 kR Gamma dariation, Desi and Kabuli chickpea showed an increase in their number of branches to 18.65 ±0.42 and 19.75 ±0.57 respectively (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 were 11.50 ±0.31 and 13.70 ±0.37 respectively (Table-1). The number of pods per plant, seeds per pod and the weight of 100 seeds in gm in both the chickpea varieties 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 and 34.27 ±0.28 respectively in Desi and Kabuli chickpea. Exposure of Gamma radiation up to the dose of 15 kR caused increase in the number of pods per plant in both Desi and Kabuli chickpea which were 35.75 ±1.26 and 37.45 ±1.37 respectively. The number of seeds per pods also increased to 5.65 ±0.19 and 6.37 ±0.31 in Desi and Kabuli chickpea 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 both Desi and Kabuli chickpea. At 0.5% EMS the plant height of Desi chickpea and Kabuli chickpea was 53.45 ±0.45 and 54.65 ±0.47 cm respectively in comparison to control. Up to 0.8% EMS exposure the plant height increased to 58.45 ±0.38 and 59.65 ±0.31 cm respectively. Beyond this concentration of EMS the plant height of both the chickpea varieties declined. 0.5% to 0.8 % concentration of EMS was therefore found to induce usable mutation (Table-2).

DISCUSSION

In Chickpea, 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 workers[14-20]. 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[20]. 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[21].

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 both Desi and Kabuli chickpea.

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