



RESEARCH ARTICLE

MUTAGENIC EFFECTIVENESS AND EFFICIENCY OF GAMMA RAYS AND EMS ON CHICK PEA

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ABSTRACT

The present study was undertaken in order to find out the effectiveness and efficiency of gamma rays and EMS in chickpea. Seeds of Co-4 variety of chickpea (*Cicerarietinum L.*) were treated with gamma rays (20kR to 60kR) and EMS (10mM to 50mM). The biological damage was calculated in M1 generation based on seedling injury (I), pollen sterility (S) and mitotic aberrations (M). The M2 population was carefully screened for various chlorophyll mutations. Mutagenic effectiveness and efficiency was calculated based on biological damage in M1 and chlorophyll mutations in M2. Mutagenic effectiveness increased with the increase in dose/treatment. Intermediate treatments in general were found more efficient in causing less biological damage and inducing maximum amount of mutations. The order of efficiency was EMS > gamma rays.

Key words: Mutation, Effectiveness, Efficiency, EMS, Gamma Rays.

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INTRODUCTION

In the world food basket, pulses shared about 57.32 per cent metric tonnes of production with an area of about 68.3 million hectares. India is being largest for the production and cultivation of pulses in the world, accounting for nearly 35.2 per cent of the world area and 27.65 per cent of world production (Chaturvedi and Ali, 2002). The pulses are good source of not only proteins but also minerals, carbohydrates, B complex vitamins and nutrients which is essential for a healthy diet. Chick pea is considered as an important grain legume since ancient time for human diet. In India, the chick pea ranks first among in other pulses with regards to area of cultivation. Even though, the attainment of food and nutritional security is the biggest challenge for the country in this millennium also. To overcome such scenario, efforts are necessary for developing high yielding varieties with proper growth habit. Genetic enhancement for yield, nutrient composition, synchronization, resistance to pathogens and tolerance to biotic and abiotic stresses of the crop to a large extent is the foremost concern in chick pea due to its less genetic variability. The possibility offered by a mutagenic agent to create new genetic variation through induced mutation provides an extreme interest and importance in breeding programme.

Mutagenic effectiveness and efficiency are two different properties, which are important in mutation breeding programs. Knowledge of relative biological effectiveness and efficiency of various mutagens and their selection is essential to recover high frequency of desirable mutations (Kumar and Mani, 1997). Mutagenic effectiveness is a measure of the mutations induced per unit dose of a mutagen (time x dose/concentration), while mutagenic efficiency gives an idea of genetic damage in relation to the total biological damage caused in M₁ generation (Kamau *et al.*, 2011 and Singh, 2011). Although, both are two different properties but the usefulness of any mutagen in the plant breeding program depends on both. So the present investigation aims to assess the effectiveness and efficiency of mutagens and select optimum dose for mutagen used.

MATERIALS AND METHODS

In the present study, the variety of chick pea Co – 4, obtained from Tamil Nadu Agricultural University, Coimbatore were used. Two type of mutagens; Gamma rays (20 – 60kR) and EMS (10 – 50mM) at different concentrations were chosen. The treated seeds along with control were sown in the field to raise M₁ generation.

All the recommended practices were applied during field preparation, seed sowing and subsequent management for chick pea population.

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RESULTS

The relative effectiveness and efficiency of the two mutagens used were assessed from the data on biological damages observed in M₁ generation and frequency of chlorophyll mutants in M₂ generation. The mutagenic effectiveness is a measure of point mutation induced by a unit dose/conc. of mutagen. The effectiveness of mutagenic treatments differed considerably depending upon the dose/conc. of mutagens. The mutagenic effectiveness showed a trend, which shows negative correlation to the increasing dose/conc. of mutagenic treatments up to a level and beyond declined in Chick pea (Table 1).

Table 1. Effectiveness and efficiency of gamma rays and EMS on Chick pea in M₂ generation

Mutagens	Treatment	% of seedling injury (I)	% of pollen sterility (S)	% of mitotic abnormalities	% of mutated plant progenies (Mp)	Mutagenic effectiveness (%)	Mutagenic efficiency		
							Mp/I	Mp/s	Mp/M
Control	-	-	3.26	-	-	-	-	-	-
	20kR	07.25	11.77	0.98	4	1.12	0.55	0.33	1.16
	30kR	08.80	14.00	4.54	8	0.52	0.90	0.57	1.72
Gamma rays	40kR	13.95	19.46	6.16	12	1.39	1.00	0.71	1.94
	50kR	15.30	20.61	7.54	14	0.22	0.91	0.67	1.85
	60kR	18.34	21.87	8.54	16	0.14	0.87	0.73	1.87
	10mM	08.40	13.49	3.84	2	1.91	0.23	0.14	0.52
	20mM	09.89	14.71	5.61	8	2.10	0.80	0.54	1.42
EMS	30mM	13.51	19.22	7.50	16	2.72	1.18	0.83	2.13
	40mM	15.53	23.79	8.00	14	0.85	0.90	0.58	1.75
	50mM	21.46	25.72	9.47	16	0.62	0.74	0.62	1.68

It was observed that the lower dose/conc. of both mutagens were most effective, and the effectiveness was highest at 30mM (2.72) in EMS and 40kR (1.39) in gamma rays. In terms of mean values, the lower concentration of EMS was more effective with effectiveness than gamma rays. Mutagenic efficiency is the ratio of frequency of chlorophyll mutations induced in M₂ generation to various biological damages (Such as seedling injury, pollen sterility and mitotic aberrations) observed in M₁ generation. From the data, the EMS showed lowest frequency at 50mM (0.74) concentration and highest value at 10mM (1.18) of treatment pertaining to seedling injury. The efficiency of mutagens indicated the lowest value at 50mM (0.62) of EMS in regard to pollen sterility and highest efficiency was observed at 30mM (0.83). With regards to mitotic abnormalities, the highest was shown at 30mM (2.13) and lowest was at 50mM (1.68) of EMS. As far as gamma rays are concerned, the intermediated dose/conc. was found to be the most efficient in regard to seedling injury (1.00), pollen sterility (0.71) and mitotic abnormalities (1.94). From the data on total mutagenic efficiency values, it could be noted that 30mM in EMS and 40kR in gamma rays were the most efficient. On the basis of seedling injury, pollen fertility and mitotic aberrations, the efficiency of mutagens was higher in EMS than gamma rays. The efficiency calculated on the basis of mitotic aberrations was generally higher as compared to seedling injury and pollen sterility.

DISCUSSION

The usefulness of any mutagen can be determined based on its effectiveness and efficiency. Mutagenic effectiveness is an indicator of the response of a genotype to the increasing dose/conc. of the mutagens in M₂ generation. The selection of useful and efficient mutagen is very necessary to recover a high frequency and spectrum of desirable mutations (Solanki and Sharma, 1994). The mutagenic effectiveness was determined based on the frequency of chlorophyll mutated

plants and were observed in the order of EMS > gamma rays. The decrease in effectiveness with increasing concentration of both the mutagens that has also been reported by Sharma *et al.*, (2006) in Urd bean, Aravindkumar *et al.*, (2007) in Blackgram, Tariq *et al.*, (2008) in Chick pea, Patil (2009) in Cow pea and Satpute and Kothekar (1996) in Safflower. EMS is superior to gamma rays in inducing useful mutation. It has been supported by earlier works done by Singh (2007) in Mung bean, Tariq *et al.*, (2008) in Chick pea. The efficiency of mutagenic agent is complex nature, as it only depends on reactivity of agent with the material and on its applicability through which physiological damage, chromosomal aberrations and pollen sterility gets induced in addition to the mutagen.

Both the mutagen exhibited a linear decrease with increasing dose/conc. in mutagenic treatments with respect to seedling injury, pollen sterility and mitotic aberrations. This was also reported by Koli and Ramakrishna (2002) and Sharma *et al.*, (2005). Dhanavel *et al.*, (2008) reported that lower concentrations of mutagens were more efficient in increasing effectiveness and efficiency than the higher ones in black gram. Several investigators have made attempts in order to determine the most efficient mutagenic treatments for the induction of desirable traits in various crops by Pillai *et al.*, (1993) in Rice and Kale (2007) in Cow pea. In general, lower dose/conc. was found to be most effective for inducing mutations. And the decrease in effectiveness at higher dose/conc. may be attributed to the failure in a comparative increase in frequency of mutation induced at higher treatments. Similar finding was also reported by Wani (2009) in Chick pea. Mutagenic efficiency calculated based on injury, sterility and mitotic aberrations with respect to induced morphological mutation in M₂ population basis, showed variation depending upon the decisive factor selected for its evaluation. The higher efficiency of mutagens at lower dose/conc. is due to the increase in seedling injury and pollen sterility along with increases in mutagenic concentration at a rate faster than the mutations frequency (Blixit, 1964). The mutation rate based on mitotic aberrations was highest followed by injury and sterility.

Conclusion

The mutagenic effectiveness showed a trend, which shows negative correlations to the increasing dose/conc. of mutagenic treatments. In terms of mean values, the lower or intermediate concentration of EMS was found to be more effective with effectiveness than gamma rays. The efficiency of mutagenic treatment was determined on the basis of seedling injury, pollen sterility and mitotic abnormality. On the basis of

seedling injury, mitotic aberrations and pollen fertility, the efficiency of a mutagen was higher in EMS than gamma rays.

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