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Mutagenic Effectiveness and Efficacy of Gamm Rays and EMS in Coriander (*Coriandrum sativum* L.)

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ABSTRACT

Mutagenesis is an important tool to create variability in crops where the hybridization is difficult. However, the usefulness of any mutagenic agent depends on its ability to induce high frequency of desirable changes as compared to undesirable ones. Hence, often it is necessary to assess the effectiveness and efficacy of mutagens for efficient and effective use. In coriander, creating variability through hybridization was difficult due to small flower size and compound umbel. Studies on induced mutagenesis in coriander involving EMS and gamma rays are scanty. Mutagenic effectiveness and efficiency of gamma rays and ethyl methane sulphonate (EMS) were estimated in the genotype of coriander variety Swathi. The studies revealed that gamma rays were found to be more effective in inducing mutations than ethyl methane sulphonate (EMS). However, with regard to mutagenic efficiency EMS was more efficient than gamma rays. There was a progressive increase in mutation frequency of chlorophyll mutations with the increase in gamma rays and EMS doses. Synergistic effects were observed for increasing mutation frequency in M_2 generation in combination treatments of gamma rays with EMS. Both mutagenic effectiveness and efficiency were found to be higher at higher doses of both the mutagens. However, trend was not observed in case of efficiency measured based on injury. The possible reason for increase in mutagenic efficiency and effectiveness with increase in dose may be due to lower dose of mutagens used in the present investigation and less damaging effect of lower doses of chemicals on the genetic material.

Keywords: *Coriander, EMS, Gamma rays, Variability, mutagenic efficiency, mutagenic effectiveness*

INTRODUCTION

Mutation has been recognized as one of the driving forces of evolution during 20th century. It provides tools for studying the nature and functioning of genes. At the same time, it creates variation in the parent material by which new cultures can be produced[6,15,10]. Effectiveness of mutation breeding programme depends on the effectiveness and efficacy of mutagenic treatments[1,2]. Hence, the present investigation in coriander (*Coriandrum sativum* L) was undertaken with physical (gamma rays) and chemical mutagen (Ethyl Methane Sulphonate i.e. EMS) at different concentrations to assess their effectiveness and efficacy in inducing mutation.

MATERIAL AND METHODS

Genetically pure and uniform size seeds of coriander variety Swathi were treated in different concentrations of gamma rays, EMS (for four hours) and combination of EMS with 5Kr gamma rays under normal room temperature. Prior to treatment of chemical mutagens, the seeds were presoaked in distilled water for ten hours.

Different doses of gamma rays used in the present study were 5, 10 and 15Kr and that of EMS were 0.2, 0.3 and 0.4 % respectively along with concentrations of 5Kr gamma rays with 0.2, 0.3 and 0.4 % EMS. Treated seeds of one set were sown in the laboratory to study germination and other seedling parameters and the other set were sown in the field to rise M_1 generation. Seeds of the M_1 plants were harvested individually to rise M_2 generation. Observations on germination, shoot length, and root length were recorded on 10^{th} day of sowing in laboratory experiment and data were expressed in percentage of control to determine injury due to mutagenic treatment. In M_2 generation observations on chlorophyll and morphological mutations were recorded from 15^{th} day (of sowing) onwards and frequencies of chlorophyll and morphological mutations for different treatments were estimated. Mutagenic effectiveness (= M/t.c, where M = percentage of M_2 plants segregating for chlorophyll mutations; t = period of treatment with chemical mutagens in hours and c = concentration of chemicalmutagen in percentage) and efficacy (= M/I, where M = percentage of M_2 plants segregating for chlorophyll mutations and I = percentage of injury or reduction in height of seedlings) were calculated for both chemical mutagens using the formulae suggested by Konzak *et al*.,[6].

RESULTS AND DISCUSSION

Effect of mutagens on seedling traits:

Data on effect of mutagens on seed germination, root length and shoot length were presented in Table 1. Germination was reduced in all the treatments of the mutagens with increase in dose of mutagens. More reduction was observed at higher doses indicating dose dependency reduction due to mutagenic treatment. Among the mutagens, gamma rays appeared to be more effective in reducing germination both under field and lab than EMS and combination treatments. However maximum reduction was observed under field conditions than lab indicating the sensitivity of the mutagens to environmental conditions. Maximum reduction in germination percentage was observed with 15Kr gamma rays (61%) followed by 10Kr (61%) gamma rays. With regard to germination under field conditions also similar trend was observed (48.33 and 50.5 at 15 and 10Kr respectively). Similar results of reduction in germination with mutagens were reported in coriander[14], in fenugreek[19, 20], in cumin5 and in fennel[9].

The seedling parameters viz., root length and shoot length revealed more or less similar trend. Reduction on shoot and root length was invariably observed in all mutagenic treatments. The reduction was more conspicuous at higher doses and vice-versa indicating again dose dependency reduction in these parameters. However 0.3% EMS treatment recorded mild stimulatory effect on shoot length and.5 Kr + 0.3% EMS treatment recorded mild stimulatory effect on root length. Combination treatments brought about more reduction in these parameters as compared to EMS and gamma rays. Maximum reduction in root length was observed at 5Kr+ 0.2%EMS (4.36cm) followed by 15Kr (4.48cm). Similarly maximum reduction in shoot length was observed at 5Kr+0.4% EMS (3.47 cm) followed by 5Kr+0.3% EMS (4.20cm). The present result relating to dose dependency reduction and effectiveness of gamma rays in bringing about more reduction was in conformity with the earlier findings Wang and Yu[17], Solanki and Sharma[11], Solanki and Sharma[12], Kumar and Selvaraj[7] and Solanki and Phogat[13].

Effect of mutagens on mutagenic effectiveness and efficacy:

The mutation frequency ranged from 0.84 % to 1.3 % in different mutagenic treatments as against none in the control. Highest frequency (1.3 %) was observed in 5Kr+ 0.4%EMS followed by 15Kr (1.07). Among mutagens, higher frequencies were observed in combination treatments than EMS and gamma rays treatments. The effectiveness of mutagenic treatments varied depending on the dose and type of mutagen (Table2). It was higher in case of EMS treatments as compared to gamma rays and combination treatments. Girija and Dhanavel[4], Dhanvel *et al.*, [3] and Wani[18] also reported that EMS was more effective mutagen than gamma rays and combination treatments in inducing mutation.

In general, the effectiveness of mutagenic treatments decreased with increase in dose in gamma rays, where as effectiveness increased with increase in dose of chemical and combination treatments. The effectiveness was highest (60.75) in 0.4%EMS and least in 15Kr gamma rays (7.11 %).

The mutagenic efficiency (due to lethality and sterility) also exhibited similar variation depending on dose of mutagenic treatments and type of mutagens used. However, contrary to the earlier trend, efficacy due to injury (17.3) was higher in case of combination treatments. The mutagenic efficacy due to injury decreased with increase in dose of the gamma rays and such trend was not observed with other mutagens. Among the mutagenic treatments, the highest efficacy due to lethality (4.09) was observed in EMS,, the highest efficacy due to injury (17.37) was observed in gamma rays + EMS, the highest efficacy due to sterility (4.63) was observed in gamma rays. Higher mutagenic effectiveness and efficiency was observed in *Lathyrus sativus* by Waghmare and Mehra[16], and Kumar *et al.*,[8] in limabean.

Table 1. Mutagenic effect on M_1 seedling traits in coriander variety Swathi

Mutagenic concentration	Germination percentage in lab	% of Control	Germination percentage in field	% of Control	Root length	% reduction in root length	Shoot length	% reduction in shoot length
5 Kr Gamma Rays	67.67	78.68	56.00	74.30	5.35	81.01	6.10	95.06
10 Kr Gamma Rays	62.00	72.09	50.50	67.00	4.73	71.67	5.23	81.56
15 Kr Gamma Rays	61.00	70.93	48.33	64.12	4.48	67.83	4.53	70.65
0.2 % EMS	72.00	83.72	64.93	86.15	5.43	82.32	5.03	78.44
0.3 % EMS	67.67	78.68	55.98	74.28	4.77	72.22	5.57	86.75
0.4 % EMS	66.00	76.74	51.50	68.33	4.60	69.70	5.00	77.92
5 Kr Gamma Rays + 0.2 % EMS	77.67	90.31	58.01	76.96	4.36	66.01	5.30	82.60
5 Kr Gamma Rays + 0.3 % EMS	74.23	86.32	56.07	74.39	6.24	94.60	4.20	65.45
5 Kr Gamma Rays + 0.4 % EMS	73.00	84.88	51.97	68.95	5.25	79.49	3.47	54.03
Control	86.00	100.00	75.37	100.00	6.60	100.00	6.42	100.00
CD	4.35		3.15		0.18		0.28	
CV	7.56		10.39		3.99		6.95	

Table 2: Effectiveness and efficacy of mutagenic treatments in Coriander variety Swathi

Treatment Dose in Kr/conc.	Mutation frequency % on population basis (M)	Effectiveness M/TC/Kr	Mutagenic efficiency		
		M -------x100 TC / Kr	M ----x 100 L	M ----x 100 I	M ----x 100 S
GAMMA RAYS					
5Kr Gamma rays	0.48	9.52	1.74	3.12	3.27
10Kr Gamma rays	0.85	8.52	2.42	3.95	4.93
15Kr Gamma rays	1.07	7.11	2.41	1.97	5.69
Mean	0.80	8.38	2.19	3.02	4.63
EMS					
0.20% EMS	0.40	50.55	3.58	4.88	3.10
0.30% EMS	0.56	46.42	3.62	3.89	3.34
0.40% EMS	0.97	60.75	5.07	10.30	4.84
Mean	0.64	52.57	4.09	6.36	3.76
COMBINATIONS					
5Kr + 0.2%	0.56	13.93	1.82	4.59	2.89
5Kr + 0.3%	0.84	14.03	2.60	35.17	3.85
5Kr + 0.4%	1.30	16.19	3.27	12.36	5.33
Mean	0.90	14.72	2.57	17.37	4.03
Control	-	-	-	-	-

Where,

M = Mutation Frequency on M_2 plant basis.
T = Period of treatment with chemical mutagens in hours.
C = Concentration of the chemical mutagens in percentage.
Kr = Kilorad (Dose of physical mutagen in kilorad).
L = Percentage of lethality or survival reduction of seedlings.
I = Percentage of injury or reduction in seedling height.
S = Percentage of pollen sterility in M_1 plants.

REFERENCES

1. Dellaert, L.M.W. Ph.D. Thesis. Wageningen Agril. University, Wageningen, The Netherlands pp.169 (1980)
2. Dellaert, L.M.W. IAEA Tech. Doc. 289. IAEA Vienna, pp.333 (1983)
3. Dhanavel, D.P. Pavadai, L. Mullainathan, D. Mohana G, Raju. M, Girija. and Thilagavathi, C. Effectiveness and efficiency of chemical mutagens in cowpea [*Vigna unguiculata* (L.) Walp.] *African Journal of Biotechnolology*, **7**: 4116 – 4117 (2008)
4. Girija, M. and Dhanavel, D. Mutagenic Effectiveness and Efficiency of Gamma Rays Ethyl Methane Sulphonate and their combined treatments in Cowpea (*Vigna unguiculata* L. Walp). *Global Journal of Molecular Sciences*, **4(2)**: 68 -75 (2009)
5. Koli, N. Gamma ray induced variability in cumin (*Cuminum cyminum*L) Msc (Ag) thesis Rajasthan Agriculture University Bikaner (1997)
6. Konzak, C.F. Nilan, R.A. Wanger, J. and Foster, R.J. Efficient chemical mutagenesis.In Symposium on the use of induced mutatins in plant breeding FAO/IAEA Rome p 4970. *Radiation Botany (Suppl*), **5**: 4970 (1965)
7. Kumar, J.S. and Selvaraj, R. Mutagenic effectiveness and efficiency of gamma rays and Ethyl methane sulphonate in sunflower *(Helianthus annus* L.). *Madras Agricultural Journal*, **90(79)**: 574 – 576 (2003)
8. Kumar, D.S. Nepolean, T. and Gopalan, A. Effectiveness and efficiency of the mutagens gamma rays and ethyl methane sulfonate on limabean *(Phaseolus lunatus L.*). *Indian Journal of Agricultural Research*, **37(2)**: 115 – 119 (2003)
9. Mahla, H.R. and Ramakrishna, K. Effectiveness and efficiency of physical and chemical mutagens in fennel. *Annals of Arid Zone*, **41(2)**: 149 – 152 (2002)

10. Micke, A. Donini, B. and Maluszynski, M. Induced mutations for crop improvement-a review. *Mutation Breeding*, **7**:1 41 (1990)
11. Solanki, I.S. and Sharma, B. Mutagenic effectiveness and efficiency of gamma rays, ethylene imine and NnitrosoNethyl urea in acrosperma imine and nitrosoNethyl urea in macrosperma lentil (*Lens culinaris* Medik.). *Indian Journal of Genetics*, **54(1)**: 72 – 76 (1994)
12. Solanki, I.S. and Sharma, B. Induced polygenic variability in different groups of mutagenic damage in lentil (*Lens culinaris* Medik.). *Indian journal of Genetics and Plant Breeding*, **62(2)**: 135 – 139 (2002)
13. Solanki, I.S. and Phogat, D.S. Chlorophyll mutation induction and mutagenic effectiveness and efficiency in macrosperma lentil (*Lens culinaris Medik*.). *National Journal of Plant Improvement*, **7(2)**: 81 – 84 (2005)
14. Singh, Bhavani. Dashora, S.L. Sharma, R.K. and Sastry, E.V.D. Gamma rays induced variation in coriander (*Coriandrum sativum*)L.). *Indian Cocoa Areca nut and Spices Journal*, **16(2)**: 60 – 62 (1992)
15. Thomas, H. and Grierson, D. (eds.) Developmental Mutants in Higher Plants. Press Syndicate. University of Cambridge, pp.288 (1987)
16. Waghmare, V.N. and Mehra, R.B. Induced chlorophyll mutations, mutagenic effectiveness and efficiency in *Lathyrus sativus* L. *Indian Journal of Genetics*, **61(1)**: 53 – 56 (2001)
17. Wang, P.Y. and Yu, B.S. Preliminary study on gamma rays chronic radiation for growing plants in soybean. *Soybean Genetics Newsletter*, **18**: 82 – 85 (1988)
18. Wani, A.A. Mutagenic effectiveness and efficiency of gamma rays EMS and their combination treatments in chick pea (*Cicer arietinum L.*). *Asian journal of plant sciences*, **8(4)** :318 – 321 (2009)
19. Yadav, S.M. Gamma rays induced variability in M_1, M_2 and M_3 generation of Fenugreek. M.Sc(Ag) Thesis submitted to Rajasthan Agricultural University Bikaner (1992)
20. Yadav, S.K. Dashora, S.L. and Sastry, E.V.D. Assessment of gamma rays induced variability in M_2 generation of fenugreek (*Trigonella foenum gracum*). *Agricultural Science digest*, **20(3)**: 156 – 158 (2000)