Journal of Experimental Sciences Vol. 2, Issue 3, Pages 07-08 [2011]
www.jexpsciences.com

Regular Article

Mutagenic Effectiveness and Efficiency of Gamma Rays and Ethyl Methanesulphonate in Pea (*Pisum sativum* L.)

G. S. Dhulgande[1*], D.A. Dhale[2], G. L. Pachkore[3] and R. A. Satpute[4]

[1]Department of Botany, S. P. College, Tilak Road, Pune-30 (M.S. India); [2]Department of Botany, SSVPS's, L.K.Dr.P.R.Ghogrey Science College, Dhule (M.S. India); [3]Department of Botany, P. V. P. Mahavidyalaya, Patoda, Dist. Beed (M.S. India); [4]Department of Botany, Government Institute of Science, Aurangabad (M.S. India)

ABSTRACT: Mutagenic effectiveness is a measure of the frequency of mutations induced by unit dose of a mutagen while efficiency gives the proportion of mutations in relation to other associated undesirable biological effects such as lethality, pollen sterility and gross chromosomal aberrations induced by the mutagen (Konzak,*et.al.*,1965). The usefulness of any mutagen in plant breeding depends not only on its mutagenic effectiveness but also on its mutagenic efficiency. Studies on mutagenic effectiveness and mutagenic efficiency of physical mutagen (gamma rays) and chemical mutagen (EMS) on two varieties of pea, namely, DDR-53 and DMR-55 have been reported. The treatments included three doses of gamma rays (5kR, 7kR, and10kR) and three concentrations of EMS (0.05%, 0.10% and 0.15%).

Key words: Mutagenic effectiveness, Mutagenic efficiency, Mitotic aberrations, Pollen sterility, Lethality

Introduction

A large number of legume species possess great potential for contributing to not only protein-rich food for humans but also excellent quality forage for animals. Among such novel legumes the pea (*Pisum sativum* L.) is quite notable and belongs to family Leguminosae. The mutation breeding has been used worldwide for improvement of grain legumes through increased genetic variation and of novel alleles. Therefore, mutation breeding is more desirable to create variability in pea. Physical and chemical mutagens provide handy tools to enhance natural mutation rate, thereby enlarging the genetic variability and increasing the scope of obtaining desired mutants. In order to induce variability and utilize useful mutations for efficient plant breeding, the systematic and comparative study of induced mutagenic effectiveness and mutagenic efficiency in a variety of crop plants is essential.

Extensive studies on mutagenic effectiveness and efficiency of several chemical mutagens and physical mutagens proved most potent tool to induce genetic variability.

Materials and Methods

Dry and healthy seeds of two varieties of pea (*Pisum sativum* L.), namely DDR-53 and DMR-55 obtained from the Department of Genetics and Plant Breeding, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) were used in present study. The seeds were exposed to CO^{60} gamma rays each 5kR, 7kR and 10kR doses at Department of Biophysics, Government Institute of Science, Aurangabad. Separate seed lots of these varieties were presoaked in distilled water for 6 hrs. The soaked seeds were treated with 0.05%, 0.10% and 0.15% EMS for 6 hrs. (P^H 7.0). The untreated seeds of both the varieties were soaked in distilled water for 6 hrs. to serve as to control. After this, the seeds were immediately sown in field by followed randomized block design (RBD) method to raise the M1 generation. The seeds of the M1 plants were collected separately and again sown in the field in next season to raise M2 generation on plant to row basis and similarly those of the M2 generation were used to raise the M3 generation. The plant survival, pollen sterility were recorded from field grown plants to estimate mutagenic effect in M1 generation. Mean pollen sterility was determined on the basis of Acetocarmine stainability. Also the 50 root tips from primary roots were excised from germinated seeds from each treatment including control. The root tips were fixed in Cornoy's solution (1:3:6, glacial acetic acid: chloroform: absolute alcohol) for 24 hours for cytological studies. The root tips were boiled in Acetocarmine solution (1 gm in 45% Acetic acid) and smear were observed under microscope for cytological analysis. Both mutagenic effectiveness and efficiency were determined using the formulae of Konzak, *et.al*, 1965.

Results and Discussion

Mutagenic effectiveness

The data presented in tables (1 and 2) indicated that the effectiveness of various mutagens and response of varieties was varying. In variety DDR-53, 0.05% EMS concentration was most effective and showed highest effectiveness value (10.73%), also variety DMR-55, 0.05% EMS concentration was most effective and showed highest effectiveness value (11.53%). As regards the mutagens, the EMS concentration indicated the highest values of effectiveness followed by gamma rays treatment in both the varieties. It was further observed that the lower dose or concentration of the two mutagens proved to be most effective than the higher ones in all the mutagenic treatments. The effectiveness values decreased with increasing dose or concentration of the mutagens. This agrees with the results obtained by Gaul (1962), Siddiq and Swaminathan (1968), Prasad (1972) and Satpute and Kothekar (1994) in different plant systems. Physical mutagens showed inverse dose relationship, whereas the chemical mutagens showed positive and direct dose dependence. Overall effectiveness for mutagens indicated that NMU was most effective mutagen followed by Fast neutrons and EMS (Kharkwal, 1998).

Table 1 Mutagenic effectiveness and efficiency of mutagens in M2 generationof pea (*Pisum sativum* L.) variety DDR-53

Conc./Dose	Frequency of chlorophyll mutants (MF)	Effectiveness (MF/Dose) or (MF/ T×C)	Efficiency		
			MF/L	MF/S	MF/MA
0.05% EMS	3. 22	10. 73	0. 15	0. 31	0. 92
0.10% EMS	3. 84	6. 40	0. 17	0. 23	1. 11
0.15% EMS	5. 55	6. 16	0. 22	0. 30	0. 88
5 kR GR	2. 61	0. 52	0. 14	0. 18	0. 59
7 kR GR	3. 27	0. 46	0. 14	0. 18	0. 74
10 kR GR	6. 27	0. 62	0. 18	0. 33	0. 89

* Corresponding Author, Email: gsdhulgande@yahoo.co.in

Table 2 Mutagenic effectiveness and efficiency of mutagens in M2 generationof pea (*Pisum sativum* L.) variety DDR-55

Conc./Dose	Frequency of chlorophyll mutants (MF)	Effectiveness (MF/Dose) or (MF/ T×C)	Efficiency		
			MF/L	MF/S	MF/MA
0.05% EMS	3. 46	11. 53	0. 15	0. 28	1. 33
0.10% EMS	4.77	7. 95	0. 14	0. 26	1. 67
0.15% EMS	5. 63	6.25	0. 75	0. 27	1. 29
5 kR GR	4. 07	0. 81	0. 14	0. 30	1. 27
7 kR GR	4. 96	0. 70	0. 20	0. 30	1. 20
10 kR GR	6. 01	0. 60	0. 15	0. 35	1. 05

Mutagenic efficiency

The results in above cited tables (1 and 2) that the degree of mutagenic efficiency of various mutagens is varying. In variety DDR-53, the parameter like lethality demonstrated most efficient (0.22%) at 0.15% EMS concentration. As regards the mutagenic treatments, the EMS concentration is most efficient than gamma rays treatment. The pollen sterility is most efficient (0.33%) at 10kR dose of gamma ray treatment. Comparatively the EMS concentration is most efficient than gamma rays treatments regarding with pollen sterility. The chromosomal aberrations were found in 0.10% EMS concentration. Similar findings are observed in lentil (Singh, *et.al.* 2007). EMS concentration induced high chromosomal aberrations than gamma ray treatments which indicate greater efficiency of EMS for inducing mitotic abnormalities in the cells of treated population. El-Araqi, *et.al.*, 1996, reported chromosomes are damaged by induced mutation. Similar relationships has been reported in lentil (Sarkar and Sharma, 1989; Gaikwad and Kothekar, 2004), in *Lathyrus* (Waghmare and Mehra, 2001) and in urdbean (Sharma, *et.al.* 2005). Mutagenic treatment causes chromosomal aberrations in cells that affect the enzyme production. The poor enzyme production affects growth and metabolism in plants results in reduced seedling height (Singh, 1987).

As regards variety DMR-55, the efficiency for lethality is most efficient (0.20%) observed at 7kR dose of gamma ray treatment and it shows slight fluctuations as per the concentration or dose of mutagens, the highest efficiency for pollen sterility was recorded at 10kR dose of gamma ray treatment. Here gamma ray treatment showed highest mutagenic efficiency than EMS concentration. On the other hand the highest efficiency for mitotic aberrations showed by 0.10% EMS concentration. It is evident from the results presented in table 2 that, high mutagenic efficiency was found in EMS concentration followed by gamma ray treatments. Similar findings were recorded in lentil (Singh, *et.al.* 2007).

In present investigation, the efficiency decreased for lethality, pollen sterility and mitotic aberrations from EMS concentration to gamma rays in variety DDR-53, while in variety DMR-55 the efficiency for lethality and pollen sterility increased from EMS to gamma rays but efficiency for mitotic aberrations decreased from EMS to gamma rays. Prasad and Singh (1986) noted that the mutagenic efficiency was higher in gamma rays followed by EMS concentration in mustard and in lentil (Singh, *et.al.* 2007).

It appears quite apparent that the different mutagens could be of immense help in the recovery of a range of distinct mutant types and one can very well increase the mutation rate through the selective application of appropriate mutagenic treatments.

Acknowledgements

The authors are very thankful to Prof. Dr. V. S. Kothekar, Dept.of Botany, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, and Dr. M.W.Patale, Head, Dept. of Botany, S. P. College, Pune-30 for their timely valuable guidance and constant encouragement.

References

El-Araqi K. T., Gilot-Delhallej., Moultschen-Dabmen J. and Moutschen- Dabmen M. (1996): Evaluation of chromosome damage due to nitropaphtofuran derivative: R7372 on the plant *Nigella damascena* L. Cytologia, 61(1): 1-6.

Gaikwad N. B. and Kothekar V. S. (2004): Mutagen effectiveness and efficiency of EMS and SA in lentil. Indian J. Genet., 64(1): 73-74.

Gaul H. (1962): Ungewohrich hohe mutations ruten nei gerste mach Anwendung von Athul methan sulphonate und Rontgen strahlen. Naturwissenschaften. 49: 431-432.

Kharkwal M.C. (1998): Induced mutations in chickpea (*Cicer arientum* L.). Comparative mutagenic effectiveness and efficiency of physical and chemical mutagens. Indian J. Genet., 58(2): 159-167.

Konzak, C.F. Nilan R.A., Wagner J. and Foster R.J. (1965): Efficient chemical mutagenesis. Rad. Bot. (suppl.) 5:49-70.

Prasad M.V.R. (1972): A comparison of mutagenic effectiveness and efficiency of gamma rays, EMS, NMU and NG. Indian J. Genet., 32(3): 360-367.

Prasad R. and Singh B. (1986): Mutagenic effectiveness and efficiency of gamma rays and EMS in Indian mustard J. oilseeds Res. 3: 102-106.

Sarkar A. and Sharma B. (1989): Effect of mutagenesis on M_1 parameters in lentil. Lens, 16(2): 8-10.

Satpute R.A. and Kothekar V. S. (1996): Mutagenic efficiency and effectiveness in safflower. J. Nuclear. Agric. Biol., 25(4): 230-234.

Sharma S. K. Sood Ritu and Pandey D. P. (2005): Studies on mutagen sensitivity, effectiveness and efficiency in urdbean (*Vigna mungo* L. Hepper). Indian J. Genet., 65(1): 20-22.

Siddiq E. A. and Swaminathan M. S. (1968): Enhanced mutation induction and recovery caused by NG in *Oryza sativa* L. Indian J. Genet. 28: 297-300.

Singh D. (1987): Mutagenesis in lentil (Lens culinaris Medik). Ph. D. thesis, Banaras Hindu University, Varanasi.

Singh S. P., Singh R. P., Singh N. K. Prasad J. P. and Sahi J. P. (2007): Mutagenic efficiency of gamma rays, EMS and its combination on microsperma lentil. Internat. J. Agri. Sci. Vol. 3(1): 113-118.

Waghmare V. N. and Mehra R. B. (2001): Induced chlorophyll mutations; mutagenic effectiveness and efficiency in *Lathyrus sativus* L. Indian J. Genet. 61: 53-56.