

Study of Mutagenic Efficiency of EMS and SA in Winged Bean (*Psophocarpus tetragonolobus* (L.) DC.)

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Abstract: The seeds of two varieties namely II-EC-178313 and 2I-EC-38825 of winged bean (*Psophocarpus tetragonolobus* (L.) DC.) were treated with Ethyl methane sulfonate (EMS) and Sodium azide (SA). The effectiveness and efficiency of mutagen is determined by observing frequency of mutations induced by mutagenic treatment. In the present investigation from results it is observed that effectiveness is reduced when concentration of mutagen is increased. The mutagenic efficiency increased with increase in concentration of mutagen. The mutation rates were calculated taking into consideration the mean values of efficiency for each treatment. This gives an idea about the average rate of mutation induction per mutagen. Taking into consideration of lethality and sterility, variations in mutation rates were recorded.

Keywords: EMS, SA, Efficiency, Mutation rate, Sterility

1. Introduction

Winged bean botanically described as *Psophocarpus tetragonolobus* (L.) DC., is a member that belongs to family Fabaceae. It is a crop with great many positive attributes. It has been described as a wonder legume in the sense that virtually every part of the plant is edible and comprises a rich source of good quality protein. Many developing nations have already designated it as a priority crop for research purposes. It has potential to fix carbon and nitrogen in the difficult humid tropical environment and to transform the its seed proteins and oil composed of nutritionally valuable configurations of amino and fatty acids (NAS, 1981). Though it possess several positive attributes the winged bean plant could not get popularity and acceptance among the farmers because of some negative properties.

2. Material and Methods

The seed material of two varieties of winged bean (*Psophocarpus tetragonolobus* (L.) DC.) namely II-EC-178313 and 2I-EC-38825 obtained from the National Bureau of Plant Genetic Resources, Regional Station, PKV, Akola was used in the present study. The chemical mutagens such as Ethyl methane sulfonate (EMS) an alkylating agent and Sodium azide (SA) manufactured by Sigma chemical company Ltd. U.S.A. was used in the present investigation.

3. Details of Mutagenic Treatments

The pilot experiments were conducted for determining the suitable concentrations for further studies. The chemical mutagenic treatments were administered at room temperature of $25 \pm 2^\circ \text{C}$. The fresh aqueous solutions of the mutagens were prepared prior to treatment.

Prior to mutagenic treatment seeds were immersed in distilled water for 6 hours. The presoaking enhances the rate of uptake of the mutagen through increase in cell

permeability and also initiates metabolism in the seeds for treatment. Such presoaked seeds were later on immersed in the mutagenic solution for 6 hours with an intermittent shaking. Seeds soaked in distilled water for 12 hours served as control.

The different concentrations used for the chemical mutagenic treatments were 0.05%, 0.10% and 0.15% for EMS and 0.01%, 0.02% and 0.03% for SA respectively. Immediately after the completion of treatment, the seeds were washed thoroughly under running tap water. Later on they were kept for post soaking in distilled water for 2 hours.

4. Matageneic Effectiveness and Efficiency

In mutation breeding it is necessary to determine the effectiveness and efficiency of mutagen. Frequency of mutations induced by mutagenic treatment is an index of the effectiveness of mutagens. The mutagenic effectiveness is a measure of factor mutations induced by a unit dose of mutagen. By observation of the values the major trends pertaining to this parameter influenced by different concentrations of mutagen can be understood. Konzak et al. (1965) showed that mutagenic efficiency provides the best available measure to evaluate different mutagenic treatments.

Ehrenberg (1960) and Kawai (1969) stated that the mutagenic efficiency may be counted on the basis of highest mutation frequency. But highest mutation frequency may result in the undesirable changes such as lethality, sterility (Konzak et al. 1965). So it is necessary to see the negative effect of such highest mutation frequency and those mutagenic treatments which can produce high mutations along with less undesirable changes.

In the present study EMS and SA proved to be effective. At the higher concentrations of mutagen effectiveness values reduced considerably. It is also proved by Gaul (1962),

Harsulkar (1994), Prasad (1972), More (1992) and Satpute (1994) in different crops.

A higher effectiveness value for chemical mutagens over the gamma rays has been recorded by Blixt (1964), Wellensick (1965), Spence (1965) and Monti (1968). Konzak et al. (1965) proposed that the relatively higher efficiency of lower dose/concentration of the mutagen could be ascribed to the lesser percentage of injury at such doses.

5. Results and Discussion

The mutagenic effectiveness is a measure of factor mutations induced by unit dose of mutagen (Table-1). By observation of the values, the major trend pertaining to this parameter as influenced by different treatment of mutagen can be understood.

In the M_2 generation of winged bean, it was observed that the numerical values of effectiveness gradually reduced with an enhancement in concentration of both the mutagens in variety II-EC-178313 and in variety 2I-EC-38825 of winged bean. At the 0.01% concentration of SA the highest effectiveness values (72.33 and 64.83) could be seen in variety II-EC-178313 and in variety 2I-EC-38825 of winged bean. While the lowest values (7.78 and 7.52) could be noted at 0.15% concentration of EMS in variety II-EC-178313 and variety 2I-EC-38825. The lower concentrations of the two mutagens (EMS and SA) proved to be more effective in both the varieties of winged bean. The effectiveness varied from 18.96 to 7.78 in EMS and 72.33 to 37.61 in SA treatment in M_2 generation of variety II-EC-178313 of winged bean. In case of variety 2I-EC-38825, effectiveness values ranged from 16.36 to 7.52 in EMS and 32.00 to 64.83 in SA treatments.

The efficiency of mutagen indicates the extent of desirable changes excluding undesirable changes (Table-2). In case of EMS treatment, the mutagenic efficiency with gradual increase in concentration pertaining to pollen sterility in variety II-EC-178313 and in variety 2I-EC-38825. In variety II-EC-178313, the highest efficiency could be noted at 0.10% concentration of EMS as regards lethality, while in variety lowest values could be noted at the same concentration of EMS.

With SA treatments, the efficiency value was highest at the highest concentration in respect of lethality in variety II-EC-

178313, but in variety 2I-EC-38825, there was lowest efficiency (0.17) at 0.01% SA treatment and the highest value (0.21) could be observed at 0.02% SA. In regard to pollen sterility, the efficiency values were found to be random in both the varieties of winged bean.

The mutation rates were calculated taking into consideration the mean values of efficiency for each treatment (Table-3). This has given an idea about the average rate of mutation induction per mutagenic treatment. By considering the mutation rates based on efficiency, the order of mutagen changes as the mutagens carry different values in respect of lethality and sterility. Taking in to consideration the mutation rates for lethality, the values were 0.22(EMS) and 0.19(SA). While the mutation rate for pollen sterility was considered the values were 0.40(EMS) and 0.31(SA) in variety II-EC-178313 and the values for variety 2I-EC-38825 were 0.34(EMS) and 0.31(SA).

6. Conclusion

In the present investigation the mutagen SA proved to be more effective than EMS. The effectiveness values reduced with increasing concentration of mutagen employed. Thus 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 frequency/mutagenic efficiency/mutation rate through the selective application of appropriate mutagenic treatments.

Table 1: The effectiveness of mutagens in two varieties of *Psophocarpus tetragonolobus* (L.) DC

Variety	Mutagens	Concentration 6 Hours	% Chlorophyll mutants	Effectiveness MF/T x C
II-EC-178313	EMS	0.05 %	5.69	18.96
		0.10 %	6.75	11.25
		0.15 %	7.01	7.78
2I-EC-38825	EMS	0.05 %	4.91	16.36
		0.10 %	4.67	7.78
		0.15 %	6.77	7.52
II-EC-178313	SA	0.01 %	4.34	72.33
		0.02 %	4.54	37.83
		0.03 %	6.77	37.61
2I-EC-38825	SA	0.01 %	3.89	64.83
		0.02 %	5.19	43.26
		0.03 %	5.76	32.00

Table 2: The relative efficiency of mutagenic treatments *Psophocarpus tetragonolobus* (L.) DC

Mutagen	Variety	Concentration	% Chlorophyll Mutants (MF)	Lethality (L)	MF/L	Pollen sterility(S)	MF/S
EMS	II-EC-178313	0.05 %	5.69	24.37	0.23	10.79	0.52
		0.10 %	6.75	28.00	0.24	16.34	0.41
		0.15 %	7.01	33.34	0.21	24.22	0.28
EMS	2I-EC-38825	0.05 %	4.91	20.00	0.24	11.32	0.43
		0.10 %	4.67	28.67	0.16	13.11	0.35
		0.15 %	6.77	22.67	0.29	26.22	0.25
SA	II-EC-178313	0.01 %	4.34	22.67	0.19	11.28	0.38
		0.02 %	4.54	26.67	0.17	18.40	0.24
		0.03 %	6.77	32.00	0.21	21.14	0.32
SA	2I-EC-38825	0.01 %	3.89	22.64	0.17	11.47	0.33
		0.02 %	5.19	24.67	0.21	15.28	0.33
		0.03 %	5.76	30.00	0.19	20.31	0.28

Table 3: The mutation rates of mutagens based on efficiency in *Psophocarpus tetragonolobus*(L.) DC

Variety	Mutagens	Mutation rates based on	
		Lethality	Sterility
II-EC-178313	EMS	0.22	0.40
	SA	0.19	0.31
2I-EC-38825	EMS	0.23	0.34
	SA	0.19	0.31

References

- [1] Blixt S. (1964): Studies on induced mutations in peas VIII Ethylene imine and gamma rays treatment of the variety witham wonder. Agric.Hort.Genet., 22:171-183.
- [2] Ehrenberg L. (1960): Induced mutation in plants; Mechanism and principles. Genet. Agric. 12:364-389.
- [3] Gaul H. (1962): Ungewohrlich hohe mutations ruten bei Gerte mach Anwendung Von Athul Methan Sulfonat und Rontgen Strahlen. Naturwissenschaften, 49:431-432.
- [4] Harsulkar A.M. (1994): Studies on the mutagenic effects of pesticides in Barely, Ph. D. Thesis, Dr.Babasaheb Ambedkar Marathwada Univresity, Aurangabad, India.
- [5] Kawai T. (1969): Relative effectiveness of physical and chemical mutagens “ Induced mutations in plants”, Proc. Series, IAEA, Vienna: 137-152.
- [6] Konzak C. F., Nilan R. A., Wanger J. and Foster R. J.(1965): Efficient chemical mutagenesis. In:The use of induced mutation in plant breeding”, Rad. Bot.(Supl.), 5:49-70.
- [7] More A. D.(1992): Cytogenetical studies in *Medicago sativa* L. Ph. D. Thesis , Marathwada University, Aurangabad, MS, INDIA.
- [8] Monti L. M. (1968): Mutation in peas induced by diethyl sulfate and x-rays, Mut. Res. 5:187-191.
- [9] National Academy of Science (1981): The winged bean; A high protein crop of the tropics. National Academy of Science, Washington, DC.
- [10] Prasad M.V.R. (1972): A comparison of the mutagenic effectiveness and efficiency of gamma rays, EMS and NG. Ind. J. Genet. 32:360-367.
- [11] Satpute R. A.(1994): Mutational studies in safflower (*Carthamus tinctorius* L.) Ph. D. Thesis, Dr. Babasaheb Ambedkar Marathwada University Aurangabad MS ,India.
- [12] Spence R. K. (1965): The influence of sodium azide on the biological effects of ionizing radiation in moist barely seeds. M.Sc. Thesis Washington State Univ. Pullman, Wash.
- [13] Wellensiek S. J. (1965): Comparison of effects of EMS, Neutrons, gamma rays and x-rays in peas. In; “ The use of induced mutation in plant breeding”, FAO/IAEA, Rad. Bot.,(suppl.) 5:227-235.