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Mutagenic effectiveness and efficiency of Ethyl methane sulphonate and Sodium azide in chickpea (*Cicer arietinum* L.).

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Abstract

The mutagenic effectiveness is a measure of the frequency of mutation induced by a unit dose of mutagen. The mutagenic efficiency gives an idea of mutation frequency in the relation to biological damages such as lethality, injury, sterility, chromosomal aberrations etc. caused as a result of mutagenic treatments (Konzak *et.al*, 1965). In case of EMS treatments there was decrease in effectiveness values in BDN 9-3 and in PG-5; it was more or less similar at lower and higher concentrations. In both the cultivars of chickpea, lethality and pollen sterility increased as the concentrations of mutagen increased.

Keywords: Effectiveness, Efficiency, EMS, SA, chickpea.

Introduction

Chickpea (*Cicer arietinum* L.) is one of important crops of India, it is commonly known by different names in different parts like *chana* in Uttar Pradesh, Rajasthan, Bihar, Madhya Pradesh, Gujrat and Haryana; *chhole* in Punjab; *chholla* in West Bengal; boot in Orissa; *butmah* in Assam; *canagalu* in Andhara Pradesh; *harbara* in Maharashtra; *kadalai* in Tamilnadu; *kadala* in Kerala and *kadale* in Karnataka. Chickpea is an important nutritious food legume which has high content of proteins, carbohydrates, calories, fats, vitamins and minerals. Among pulses chickpea has great biological value (i.e. chemical score) about 52-78 % (ICAR, 1982). Chickpea contains about 361 calories/100gm; 20.6% crude protein, 2.2% fat; 61.2 % carbohydrates; 190 mg/100gm ca; 9.8 mg/100gm Fe; 280mg/100gm P; 0.30 mg/100gm vitamin B1; 0.51mg/100gm vitamin B2 and 2.6mg/100gm niacin (Aykroyd and Doughty, 1964 and Gupta 1982).

From an agricultural stand point the pulses are valuable in the maintenance of soil fertility, primarily through their ability to fix atmospheric nitrogen. With the help of symbiotic bacteria to improve the quality and fertility of soil. Among the various growing in India, chickpea stands first, followed by pigenpea, urdbean, mungbean, horsebean, lathyrus and mothbean (Kaur, 1996).

They also frequently play an important role in crop association and rotations, in the stabilization of soil, in generating farmers' income and in agricultural diversification. Pulses require relatively low water for their cultivation which is crucial factor for increasing agricultural production in India's dry lands which constitute more than 75% of the total cropped area of the country.

The mutation breeders have visualized that the desirable mutant in different legumes and oil crops would be able to contribute effectively towards yield and protein content besides providing induced variation for diseases, insects and pest resistance.

Improvement of crops in regard to quality and economic traits can be achieved by hybridization and breeding programmes. But it has been thought that the improvement of crops is normally not achieved by hybridization within shortest possible time. This goal is however achievable within shortest period of time of restoring to induced mutations.

Materials and Methods

In the present study of effect of chemical mutagens in chickpea, two cultivars were selected namely BDN 9-3 and PG-5. The chickpea cultivars seeds were obtained from Agricultural Research Station Badnapur, Dist: Jalna (MH) and Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist: A. Nagar (MH) India. Mutations were induced in chickpea by using different concentrations of two chemical mutagens like 0.05%, 0.10% and 0.15% of Ethyl methane sulphonate (EMS) and 0.01%, 0.02% and 0.03% of Sodium Azide (SA).

Mutagenic effectiveness and efficiency of different mutagens were calculated according to formulae by Konzak *et, al.*(1965). Mutagenic effectiveness is a measure of the frequency of mutation induced by a unit dose of mutagen (kR or concentration × time); mutagenic efficiency depicts the proportion of mutation in relation to biological damage induced.

The formulae proposed by Konzak *et, al.* (1965) were followed for the calculations of mutagenic effectiveness and efficiency by incorporating the mutation frequency values recorded for each mutagenic treatment.

$$\text{Mutagenic effectiveness} = \frac{\text{Mutation frequency (MF)}}{\text{Time (T)} \times \text{concentration (C)}}$$

$$\text{Mutagenic efficiency} = \frac{\text{Mutation frequency (MF)}}{\text{Biological damage}}$$

$$= \text{MF/L, and, MF/S,}$$

Where,
MF - % of chlorophyll mutations in M_2-generation.
L - % of lethality in M_1-generation.
S - % of pollen sterility in M_1-generation.
C - Concentration of mutagen
T - Duration of treatment with mutagen

Results

Effectiveness of mutagens:

The mutagenic effectiveness is a measure of point mutations include by a unit dose of mutagen. The data pertaining of these parameters varied for each concentration of the two mutagens in both cultivars of chickpea. In case of EMS treatments there was decrease in effectiveness values in BDN 9-3 and in PG-5, it was more or less similar at lower and higher concentrations **(Table 1, 2)**.

In EMS treatments in BDN 9-3 it was 20.00, 18.30 and 15.50 at 0.05%, 0.10% and 0.15% concentration respectively, while in PG-5, it was 16.66, 12.60 and 17.77 at 0.055, 0.10% and 0.15% concentration respectively. Were as in SA treatments, in BDN 9-3, the values of mutagenic effectiveness recorded were 66.60, 75.00 and 66.66 at 0.01%, 0.02% and 0.03% concentration, respectively, while in PG-5, they were respectively, 66.60, 91.66 and 83.33 at 0.01%, 0.02% and 0.03% concentration of SA. The effectiveness of mutagens was highest at the 0.02% of SA in both the cultivars of chickpea revealing values of 75 in BDN 9-3 and 91.66 in PG-5.

Table 1: The Effectiveness of mutagens in chickpea. Variety: BDN 9-3.

Treatment	Concentration 6 hrs. %	Chlorophyll mutants(MF) %	Effectiveness MF/Time× conc.
EMS	0.05	06	20.00
	0.10	11	18.30
	0.15	14	15.50
SA	0.01	04	66.60
	0.02	09	75.00
	0.03	12	66.66

Table 2: The Effectiveness of mutagens in chickpea. Variety: PG-5.

Treatment	Concentration 6 hrs. %	Chlorophyll mutants(MF) %	Effectiveness MF/Time× conc.
EMS	0.05	05	16.66
	0.10	12	12.60
	0.15	16	17.77
SA	0.01	04	66.60
	0.02	11	91.66
	0.03	15	83.33

Mutagenic efficiency:

During the mutagenic treatments, nobody knows about the mutations, which may get produced in the plant system. There may be desirable or undesirable changes. The efficiency of mutagens indicates to extend of desirable changes excluding undesirable changes.

Efficiency of mutagen is measured by the proportion of mutations produced by a mutagen in relation to its undesirable effects like lethality (L) and pollen sterility (S). The total mutagenic efficiency was calculated by adding the above efficiency values (lethality and pollen sterility) together to get total mutagenic efficiency for particular concentration **(Table 3,4)**.

In both the cultivars of chickpea, lethality and pollen sterility increased as the concentrations of mutagen increased. The mutagenic efficiency values for lethality with EMS treatments were 0.60, 0.61, 0.58 and 0.41, 0.75 and 0.66, at 0.05%, 0.10% and 0.15% concentration in BDN 9-3 and PG-5, respectively. The numerical values for SA were 0.30, 0.42, 0.44 and 0.36, 0.52 and 0.55 at 0.01%, 0.02% and 0.03% concentration in BDN 9-3 and PG-5 respectively.

The mutagenic efficiency values for pollen sterility in EMS treatments were 0.49, 0.47, 0.40 and 0.44, 0.48 and 0.49 at 0.05%, 0.10% and 0.15% concentrations in BDN 9-3 and PG-5 cultivars of chickpea respectively. While the efficiency values for SA for the same parameters were 0.49, 0.59, 0.55 and 0.56, 0.83 and 0.74 at 0.01%, 0.02% and 0.03% concentration in BDN 9-3 and PG-5 cultivars, respectively.

Table 3: The relative efficiency of mutagenic treatments in chickpea. Variety: BDN 9-3.

Treatment	Concentration %	% Chlorophyll mutants (MF)	Efficiency				
			Lethality	*MF/*L	*Pollen sterility*(S)	*MF/*S	*Total efficiency*
EMS	0.05	6	10	0.60	12.05	0.49	1.09
	0.10	11	18	0.60	23.26	0.47	1.08
	0.15	14	24	0.58	34.69	0.40	0.98
SA	0.01	4	12	0.33	8.12	0.49	0.82
	0.02	9	21	0.42	15.10	0.59	1.01
	0.03	12	27	0.44	21.46	0.55	0.99

Table 4: The relative efficiency of mutagenic treatments in chickpea. Variety: PG-5.

Treatment	Concentration %	% Chlorophyll mutants (MF)	Efficiency				
			Lethality	*MF/*L	*Pollen sterility*(S)	*MF/*S	*Total efficiency*
EMS	0.05	5	12	0.41	11.20	0.44	0.85
	0.10	12	16	0.75	24.50	0.48	1.23
	0.15	16	24	0.66	32.10	0.49	1.15
SA	0.01	4	11	0.36	7.05	0.56	0.92
	0.02	11	21	0.52	13.10	0.83	1.35
	0.03	15	27	0.55	20.11	0.74	1.29

The total mutagenic efficiency values at EMS treatments were 1.09, 1.08, 0.98 and 0.85, 1.23 and 1.15 at 0.05%, 0.10% and 0.15% concentration in BDN 9-3 and PG-5 cultivars of chickpea respectively. While for SA, the values were 0.82, 1.01, 0.99 and 0.92, 1.35 and 1.29 at 0.01%, 0.02% and 0.03% concentration of the mutagen in BDN 9-3 and PG-5 cultivars respectively.

From the data on total mutagenic efficiency values, it could be observed that the 0.05% EMS treatments and the 0.02% SA treatments were most efficient in BDN 9-3. Were as PG-5, the 0.15% EMS and 0.02% SA treatments were most efficient.

Discussion

Various attempts have been made to determine the most effective and efficient mutagens and treatments for the induction of desirable characters in different plants. The mutagenic effectiveness is a measure of the frequency of mutation induced by a unit dose of mutagen. The mutagenic efficiency gives an idea of mutation frequency in the relation to biological damages such as lethality, injury, sterility, chromosomal aberrations etc. caused as a result of mutagenic treatments (Konzak *et.al*, 1965). Hence, mutagen is useful only if it is effective as well as efficient, since it results in the production of desirable changes with minimum undesirable effects.

Ehenberg (1960) and Kawai (1969) stated that the highest mutation frequency achieved should be taken into consideration while comparing mutagenic efficiency. However, quite open it would be noticed that mutagen dose that yields the highest mutation rate also induces a high degree of undesirable effects such as lethality, sterility (Konzak *et.al*, 1965). So it is necessary to note the negative effect of such highest mutation frequency along with less undesirable changes, deserve to be practiced.

In the present study, the SA mutagen has proved more effective than EMS. Similar types of results were obtained by Reddy and Annadurai (1991), Gaikwad (2002) in various lentil cultivars where SA was most effective than EMS and gamma rays. Some researchers found that alkylating agents are more effective and efficient in inducing mutation than gamma rays. Such workers include Blixt (1964), Wellensiek (1965), Konzak et.al, (1965), Monti (1968), Prasad (1972), Pawar *et.al*, (1978), Sharma and Sharma (1979), Bhamburkar (1981) and Sudharani (1900) in different plant systems.

Higher mutagenic effectiveness and efficiency at lower doses have been reported by Siddiq and Swaminathan (1968), Prasad (1972), Farook (1978), Bhamburkar (1981), Chary (1983), Sudharani (1990), Reddy and Annadurai (1991), and Solanki and Sharma (1994). According to Konzak *et.al*, (1965), lower concentrations are more efficient as the injury, lethality or sterility increases with the mutagen concentration at a faster rate than mutations.

In the present study SA was more effective than the EMS. Maximum effectiveness in both the cultivars of chickpea was observed at 0.02% concentration of SA treatment. When mutation rates based on efficiency were compared, EMS was most efficient as far as lethality is concerned and SA proved to be the most efficient for pollen sterility in both the cultivars of chickpea.

It is thus evident that both the mutagens could be of immense help in the recovery of new mutant types and one can very well increase the mutation frequency many fold through the application of various mutagenic treatments.

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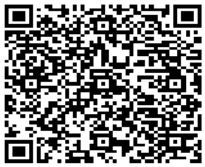	**Website:** www.ijarbs.com
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