J Indian bot Soc Vol 77 (1998) 1-4

MUTAGENIC EFFICIENCY AND EFFECTIVENESS OF SEPARATE AND COMBINED TREATMENTS WITH GAMMA RAYS, EMS AND DES IN KHESARI (*LATHYRUS SATIVUS* L.)

SUSHIL KUMAR AND D.K. DUBEY
Department of Botany, Janata Mahavidyalaya, Ajitmal, Etawah (U.P.) 206 121
(Accepted April, 1997)

Mutagenic effectiveness and efficiency of Gamma rays, EMS, DES annd their combinations were studied in *Lathyrus satiyus* L. Increasing injury was recorded with the increasing radiatioon dose in individual as well as combined treatments.Among combined treatments of gamma rays wit EMS or DES only those involving two higher irrediation doses showed an additive effect of two mutagens on injury. A substantial amount of sterility was induced by almost all the mutagenic treatments. The efficiency on the basis of seedling injury was generally higher as compared with that based on sterility. The efficiency of individual EMS and DES treatment was 2 to 3 times higher in comparison to most other mutagenic treatments. EMS proved to be more effective than DES. Combined treatments of two mutagens did not show any synergestic responses with regard to mutagenic efficiency.

Key Words : Mutagenic efficiency, effectiveness, gamma rays, EMS, DES, Khesari.

Mutagenic effectiveness is a measure of the frequency of mutations induced by a unit dose of mutagen. Mutagenic efficiency refers to the proportion of mutations in relation to other associated undesirable biological effects, such as gross chromosomal aberrations, lethality and sterility, induced by the mutagen in question (Konzak *et al.*, 1965). Several earlier studies based on combined application of physical and chemical mutagens have given encouraging results in different crops (Nerkar, 1977; Sharma and Sharma, 1979; Dixit and Dubey, 1986; Reddy and Smith, 1984; Tripathi and Dubey, 1990 and Ratnam and Madhava Rao, 1993). The present paper deals with the effectiveness and efficiency of treatments with gamma rays. Ethyl methane sulphonate (EMS) and Diethyl sulphate (DES) individually as well as in combinations, in *Lathyrus sativus* L. var. P-505 (Khesari).

MATERIALS AND METHODS

Dry seeds of khesari var. P-505 were exposed to 15, 25 and 35 Kr of gamma rays at Division of Genetics, IARI, New Delhi. Some irradiated and some fresh seeds were also treated with 0.125% EMS or 0.50% DES for 6 hours. In this way there were 11 mutagenic treatments and the control, with 100 seeds in each treatment. Twenty five seeds from each treatment were sown in sand in large petridishes to study the effect of different treatments on seed germination and seedling height. On the 19th day of sowing, percentage germination and seedling height were recorded and compard to the control.

The remaining seeds of each treatment and the control seeds were sown in field in randomised row design to raise the M_1 generation. Seeds of individual M_1 plants were harvested separately and sown as M_2 families. Data on survival (%) and seed set (%) were recorded in M_1 generation and on the frequency of chloromutations in M_2 generation. Efficiency was worked out after Konzak *et al.* (1965) and segregation ratio was calculated according to the formula suggested by D'Amatoo *et al.* (1962).

RESULTS AND DISCUSSIOON

Table 1 summerises the effects of mutagen treatments on seed germination, seedling height, survival, seed set, mutation frequency and segregation ratio for chloromutants and also mutagenic efficiency based on injury (MSP/I) and sterility (MSP/S). Seed germination was reduced by all mutagens except the lowest dose of gamma rays, applied individually and in combination with EMS. Gamma ray treatments individually or in combination with EMS or DES caused progressive decrease in germination with increasing dose of radiation. Combined treatments did not show any additive effect on seed germination. Progressive decrease in seedling height was also recorded with

Received February, 1996

Table 1: Muttagenic effectiveness and efficiency of different mutagenic treatments in *Linthyrus sativus*

Treatments	Germination (%)	Seedling height (%)	Survival (%)	Seed set (%)	Frequency of chlorophyll mutations			Efficiency				
					MSP	MSD	SR(%)	Injury (I)	Sterility (S)	MSP/I	MSP/S	MSD/S
Control	100.00	100.00	100.00	100.00	-	-	-	-	-	-	-	-
Gamma rays												
15Kr	100.00	91.08	87.31	49.64	14.54	0.76	5.23	8.92	50.36	1.63	0.29	0.02
25Kr	64.00	81.39	61.91	39.38	28.20	1.26	4.47	18.61	60.62	1 51	0.46	0.02
35Kr	64.00	50.00	60.33	14.89	23.68	1.40	5.91	50.00	85.11	0.47	0.28	0.02
EMS 0.125%	96.00	95.35	76.20	71.84	25.00	1.68	6.72	4.65	28.16	5.38	0.89	0.06
DES 0.50%	84.00	94.96	74.62	73.70	14.89	0.98	6.58	5.04	26.30	2.95	0.57	0.04
Gamma rays + EMS 0.125%												
1Kr + EMS	100.00	95.35	69.85	55.19	20.45	1.02	4.99	4.65	44.81	4.40	0.47	0.02
25Kr + EMS	84.00	69.77	65.09	37.23	24.39	1.14	4.67	30.23	62.77	0.81	0.39	0.02
35Kr + EMS	80.00	35.27	63.49	19.05	25.00	1.67	6.68	64.73	80.95	0.39	0.31	0.02
Gamma rays + DES 0.50%												
15Kr + DES	80.00	95.35	58.89	56.10	10.81	0.44	4.07	4.65	43.90	2.32	0.25	0.01
25Kr + DES	76.00	77.91	55.57	29.46	31.43	1.32	4.20	22.09	70.54	1.42	0.44	0.00
35Kr + DES	76.00	40.70	54.17	12.14	29.41	1.62	5.51	59.30	87.86	0.49	0.33	0.02

MSP = Mutation events/100 M_2 progenies
MSD = Mutation events/100 M_2 seedlings
SR = Segregation ratio (%
I = % seedling height reduction (% of control)
S = % reduction in seed set (% of control)

increasing dose of radiation, individually as well as in combination with EMS or DEs. Combined application of the 35kr dose of gamma rays with EMS or DES induced more severe effects on seedling height than all other treatments. Plant survival and percentage seed set also showed dose dependent reduction following all mutagenic treatments. Combination of higher doses of gamma rays with DES or EMS produced more severe effects on these traits also.

Reduced germination percentage, seedling height, plant survival and seed set are common effects of mutagens in various crops (Blixit *et al* 1969; Sinha and Godward, 1972; Prasad and Das, 1980, Dixit and Dubey, 1981 and Kumar *et al.*, 1983). Promoting effect of low doses of mutagens on germination has also been recorded earlier in several crops (Sax, 1963; Venkateshwarlu *et al.*, 1978; Vandana and Dubey, 1988 and Kumar and Dubey, 1994).

Percentage of families segregating for chloromutants was much higher in the combined application of 25kr gamma ray dose with DES while the number of chloromutants per 100 M_2 seedlings shows dose dependent increase in gamma ray treatments individually as well as in combination with DES or EMS. Application of EMS induced highest number of chlorophyll mutations.

Segregation ratio is the ratio between the percentage of mutated population and the percentage of families segregating for mutants, expressed in terms of percentage. It is apparent from the table that chemical mutagens namely EMS or DES individually induced higher segregation ratios than varying doses of gamma rays. In the combind treatments of both EMS and DES, the segregation ratio did not attain the level induced by individual applilations of the chemical concerned. A dose dependent increase for segregation ratio was recorded in the gamma ray treatments applied individually and in combination with EMS or DES. Individual application of EMS induced highest segregation ratio. Earlier studies of D'Amato *et al* (1962) in wheat, Kawai and Sato (1965) in rice, Nerkar (1976) in Khesari and Reddy and Smith (1984) in *Sorghum* revealed increasing segregation ratios with increasing dosage of physical and chemical mutagens.

A measure of injury caused by mutagenic treatments was obtained in terms of percentage reduction in seedling height while reduction in seed set per-

cent served as a measure of induced sterility. Increasing injury was recorded by increasing radation dose, individually as well as in combined treatments. From among the combined treatments of gamma rays with EMS and DES, only those treatments involving 25kr and 35kr doses of radiation showed an additive effect of the two mutagens on injury. Substantial amount of sterlity was induced by almost all mutagenic treatments.

Estimate of mutagenic efficiecy varied depending upon the criteria used for its estimation. Calculated on the basis of seedling injury (MSP/I), the efficiency was generally higher compared to that based on sterility (MSP/S or MSD/S). Mutagenic efficiecy of individual EMS and DES treatmenst, according to all three criteria, was several times higher in comparision to most other mutagenic treatments, EMS proved to be more effective than DES. Varyng gamma ray doses did not induce any dose dependent response with regard to mutagenic efficiency in separate or combined treatments. No synergestic response with regard to muttagenic efficiency was recorded in the combined treattments of the two mutagens. Sharma and Sharma (1979). Dixit and Dubey (1986) and Ratnam and Madhava Rao (1993) have reported in lentil and sunflower respectively that mutagenic efficiency increased with increase in radiation dose but Gupta and yashvir (1975) reported that in foxtail millet he effectiveness decreased with the increasing doses of gamma rays, DES and EMS. However, Nerkar (1977) observed that the mutagenic effectiveness was higher at lower doses of EMS and gamma rays in different varieties of *Lathyrus sativus* L.

REFERENCES

Blixit S, L Ehrenberg & O Gelin 1960 Quantitative studies on induced mutations in Peas III. Mutagenic effect of ethylene imine. *Agric Hort Genet* **18** 109-123.

D'Amato F, G A Scarascia L M Monti & A Bozzini 1962 Types and frequencies of chloropyll mutations in durum wheat induced by radiations and chemicals. *Radiat Bot* **2** 217-239.

Dixit P & D K Dubey 1981 Studies on the effects of separate and simulataneous application of gamma rays and NMU on lentil (*Lens culinaris* Medic) I Germination growth fertility and yield, *Botanical Progress* **4** 10-15.

Dixit P & D K Dubey 1986 Mutagenic efficiency of Gamma rays NMU and their combinations in lentil (Lens culinaris Med) var T 36 *Indian J Genet* **46**(3) 501-505.

Gupta P K & Yashvir 1975 Induced mutation in foxtail millet (*Setaria italica* Beauv) 1 Chlorophyll mutations induced by Gamma rays EMS and DES. *Theor Appl Genet* **545** 242-249.

Kawai T & H Sato 1965 Studies on artificial induction of mutations in rice by chemicals. I Chlorophyll mutations by ethylene imine and ethylene oxide treatments. *Bull NATl INSt Agric Sci* (Japan) **13** 133-162.

Konzak C F, R A Nilan J Wagner & R J Foster 1965 Efficient chemical mutagenesis, in the use of induced mutations in plant breeding. *Radiat Bot* (Suppl) **5** 49-70.

Kumar S, Vandana & D K Dubey 1993 Studies on the effect of Gamma rays and diethyl sulphate (DES) on germination growth fertility and yield in faba bean (*Vicia faba* L) *FABS Newsletter* **32** 15-18.

Kumar S & D K Dubey 1994 Effect of DES and EMS on Germination growth fertility and yield in yellow sarson (*Brassica campestris* Linn.) var DIRA -313 *Indian bot Reptr* **13** (1+2) 19-24.

Nerkar Y S 1976 Mutation studies in *Lathyrus sativus* *Indian J Genet* **36**(2) 223-229.

Nerkar Y S 1977 Mutagenic effectiveness and efficiency of Gamma rays ethyl methane sulphonate and nitroso methyl urea in *Lathyrus sativus* L, *Indian J Genet* **37**(1) 137-141.

Prasad A B & A K Das 1980 Relative sensitivity of some varieties of *Lathyrus sativus* L to Gamma trradiation. *J Cytol Genet* **15** 156-165.

Ratnam S V & K V Madhava Rao 1993 Mutagenic efficiency of Gamma ray irradiation in sunflower. *J Indian bot Soc* **72** 315-316.

Raddy C S & J D Smith 1984 Mutagenic effectiveness and efficiency of HZ and EMS in *Sorghum bicolor, Indian J Genet* **44**(1) 49-54.

Sax K 1963 The stimulation of plant growth in ionizing radiation. *Radiat Bot* **3** 179-186.

Sharma S K & B Sharma 1979 Mutagenic effectiveness and efficiency of Gamma rayss and N-Nitroso-N-Methyl Urea in lentil. *Indian J Genet* **39**(3) 516-520.

Sinha S S N & MBE Godward 1972 Radiation studies in *Lens culinaris, Indian J Genet* **32**(3) 331-339.

Tripathi A & D K Dubey 1990 Mutagenic efficiency of separate and combined treatments with Gamma rays and EMS in two varieties of lentil (*Lens culinaris* Med). *Indian Bot Reptr* **9**(2) 66-70.

Vandana & D K Dubey 1988 Effect oof ethyl methane sulphonite (EMS) and diethyl sulphate (DES) on germination growth fertility and yield of *Vicia faba* L *FABS Newsletter* **20** 25-29.

Venkateshwarlu S R M Singh R B Singh & B D Singh 1978 Radiosensitivity and frequency of chlorophyll mutations in pigeonpea. *Indian J Genet* **38**(1) 90-94.