

Short Communication

Efficiency and effectiveness of the gamma rays, EMS and their combinations in urdbean

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To induce variability for efficient plant breeding, a comparative and systematic study of the mutagenic response of the cultivars is essential. Although a number of studies on induced mutations in cereals have been made in the past, such studies are limited in pulse crops, particularly in urdbean (2). Among a number of chemical and physical agents having mutagenic action, ethyl methane sulphonate and gamma rays are the most commonly used mutagens (5). Mutagenic effectiveness is a measure of frequency of the mutations induced by unit mutagen dose, whereas mutagenic efficiency is a measure of proportion of mutations in relation to undesirable changes. The present investigation was undertaken to study efficiency and effectiveness of EMS, gamma rays and their combinations in urdbean cultivars, Pant Urd 19 (PU 19) and Pant Urd 30 (PU 30).

Four hundred healthy, pure, uniform and dry (9.5% moisture) seeds were used for each treatment of the EMS, gamma rays and combinations of both in two cultivars, namely PU 19 and PU 30 of urdbean. The seeds were treated with four doses (100, 200, 300 and 400 Gy) of gamma rays (Source ⁶⁰Co) at I.A.R.I., New Delhi and pre-soaked seeds were treated with four concentrations (0.2, 0.4, 0.6 and 0.8 %) of freshly prepared aqueous solution of EMS in phosphate buffer (pH

7.5) for 8 h. For combination treatments, another four hundred seeds for each treatment treated with four doses of gamma rays were again treated with 0.2% EMS. The treated seeds with EMS were thoroughly washed in running water for 4 h to remove the residual effect of the chemical and then dried on blotting paper. Three hundred fifty seeds of each treatment were sown in the experimental plot of Agricultural Research Farm, Banaras Hindu University, Varanasi during Summer, 2001. In M₁ generation, pollen sterility and plant lethality at maturity were recorded and expressed as percentage of control. Each M₁ plant was harvested separately to raise M₂ following plant to progeny row method. Frequency and spectrum of chlorophyll mutations per 100 M₂ plants were recorded at seedling stage following classification of Venkateswarulu *et al.* (6) and the frequency and spectrum of macro-mutations (viable) per 100 M₂ plants were observed on the basis of the morphological changes at various developmental stages. The mutagenic efficiency and effectiveness of the mutagens were calculated according to Konzak *et al.* (3).

It is evident from the data presented in Table 1 (PU 19) and Table 2 (PU 30) that the pollen sterility and lethality increased with the increase in dose of gamma rays, EMS and combination treatments. The maximum pollen sterility was

Table 1. Efficiency and effectiveness of the mutagens in urdbean cv. Pant Urd 19

| Treatment | Pollen sterility (%) | Plant lethality (%) | Mutations (%) (MP) | Mutagenic efficiency | | Mutagenic effectiveness [MP/ (unit dose) X t |
|---------------------|----------------------|---------------------|--------------------|----------------------|-----------|--|
| | | | | Pollen sterility | Lethality | |
| Gamma rays | | | | | | |
| 100 Gy | 5.91 | 8.41 | 1.09 | 0.185 | 0.130 | 0.109 |
| 200 Gy | 7.81 | 15.61 | 1.48 | 0.190 | 0.095 | 0.074 |
| 300 Gy | 14.77 | 23.42 | 1.45 | 0.098 | 0.062 | 0.048 |
| 400 Gy | 25.95 | 39.04 | 1.00 | 0.039 | 0.026 | 0.025 |
| EMS | | | | | | |
| 0.2% | 5.27 | 8.71 | 0.79 | 0.150 | 0.091 | 0.494 |
| 0.4% | 12.13 | 17.41 | 1.26 | 0.104 | 0.072 | 0.394 |
| 0.6% | 28.48 | 38.14 | 1.39 | 0.049 | 0.036 | 0.290 |
| 0.8% | 37.24 | 56.15 | 1.04 | 0.028 | 0.019 | 0.163 |
| Combinations | | | | | | |
| 100 Gy +0.2 % | 9.49 | 11.11 | 1.61 | 0.170 | 0.145 | 0.101 |
| 200 Gy+0.2% | 21.10 | 22.82 | 1.94 | 0.092 | 0.085 | 0.061 |
| 300 Gy +0.2% | 27.00 | 27.63 | 2.05 | 0.076 | 0.074 | 0.043 |
| 400 Gy+0.2% | 35.23 | 40.54 | 1.33 | 0.038 | 0.033 | 0.021 |

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Table 2. Efficiency and effectiveness of the mutagens in urdbean cv. Pant Urd 30

| Treatment | Pollen sterility (%) | Plant lethality (%) | Mutations (%) (MP) | Mutagenic efficiency | | Mutagenic effectiveness [MP/(unit dose) X t] |
|---------------|----------------------|---------------------|--------------------|----------------------|-----------|--|
| | | | | Pollen sterility | Lethality | |
| Gamma rays | | | | | | |
| 100 Gy | 5.38 | 9.54 | 1.08 | 0.201 | 0.113 | 0.108 |
| 200 Gy | 11.29 | 16.93 | 1.28 | 0.113 | 0.076 | 0.064 |
| 300 Gy | 21.31 | 26.16 | 1.57 | 0.074 | 0.060 | 0.052 |
| 400 Gy | 27.43 | 35.39 | 1.32 | 0.048 | 0.037 | 0.033 |
| EMS | | | | | | |
| 0.2 % | 6.22 | 13.23 | 0.97 | 0.156 | 0.073 | 0.606 |
| 0.4 % | 13.92 | 18.16 | 1.02 | 0.073 | 0.056 | 0.319 |
| 0.6 % | 25.00 | 26.16 | 1.21 | 0.048 | 0.046 | 0.252 |
| 0.8 % | 34.92 | 46.16 | 0.81 | 0.023 | 0.018 | 0.127 |
| Combinations | | | | | | |
| 100 Gy +0.2 % | 7.07 | 11.39 | 1.22 | 0.173 | 0.107 | 0.076 |
| 200 Gy+0.2 % | 18.99 | 23.08 | 2.07 | 0.109 | 0.090 | 0.065 |
| 300 Gy +0.2 % | 25.63 | 38.16 | 1.85 | 0.072 | 0.048 | 0.039 |
| 400 Gy+0.2 % | 30.49 | 42.16 | 1.16 | 0.038 | 0.028 | 0.018 |

recorded at the highest dose (0.8%) of EMS, *i.e.*, 56.15% in PU 19 and 46.16% in PU 30 followed by the highest dose of combination treatment (400 Gy +0.2%) and gamma rays (400 Gy). A similar trend was observed in case of plant lethality in both the cultivars, which might be attributed to the same parentage of both the cultivars. The highest number of mutations (chlorophyll + viable) per 100 M₂ plants was recorded in combination treatments of 300 Gy + 0.2% (2.05) in PU 19 and 200 Gy + 0.2% (2.07) in PU 30 followed by 200 Gy + 0.2% in PU 19 (1.94) and 300 Gy + 0.2% in PU 30 (1.85). The gamma rays treatments produced maximum mutations in comparison to the EMS treatments in both the cultivars. Similar findings were reported by Singh and Singh (4) in urdbean.

The effectiveness and efficiency of gamma rays, EMS and their combinations decreased with the decrease in mutagenic doses from lower to higher in both the cultivars in the present study (4, 7). All the treatments of EMS were found to be more effective followed by 100 Gy of gamma rays (0.109% in PU 19 and 0.108% in PU 30) and 100 Gy+0.2% treatment of combination (0.101% in PU 19 and 0.076% in PU 30) in both the cultivars. The mutagenic efficiency was found maximum (0.190%) at 200 Gy followed by 0.185% at 100 Gy dose of gamma rays and 0.170 % at 100 Gy +0.2% of combination treatment for pollen sterility whereas, the maximum efficiency (0.145%) was observed with 100 Gy + 0.2% dose of combination treatment followed by 100 Gy (1.30%) dose of gamma rays for plant lethality in PU 19. The 100 Gy dose of gamma rays was found most efficient (0.201%) followed by 100 Gy +0.2% dose of combination treatment (0.173%) for pollen sterility whereas, the maximum efficiency (0.113%) was observed at 10 kR dose of gamma rays followed by 100 Gy +0.2% dose of EMS

(0.107%) in PU 30. However, Gautam *et al.* (1) reported that gamma rays were more effective than EMS and EMS was more efficient than gamma rays in blackgram. It can be concluded that the cv. PU 19 was found more responsive to induction of mutations in comparison to cv. PU 30.

LITERATURE CITED

- Gautam, A.S., Sood, K.C. and Richharia, A.K. 1992. Mutagenic effectiveness and efficiency of gamma rays, ethyl methane sulphonate and their synergistic effects in black gram (*Vigna mungo* L.). *Cytologia* 57: 85-89.
- Ignacimuthu, S. and Babu, C.R. 1988. Radiosensitivity of urd and mung beans. *Indian Journal of Genetics & Plant Breeding* 48(3): 331-341.
- Konzak, C.F., Nilan, R.A., Wagner, J. and Foster, R.J. 1965. Efficient chemical mutagenesis. *Radiation Botany (Suppl.)* 5: 223-229.
- Singh, V.P. and Singh, M. 2001. Efficiency and effectiveness of single and combination treatments of gamma rays, EMS and SA in urdbean. In poster abstract of Diamond Jubilee Symposium, ISGPB, New Delhi, Nov. 6-9, 2001, pp. 222.
- Singh, V.P., Singh, M. and Lal, J.P. 1999. Mutagenic effects of Gamma rays and EMS on frequency and spectrum of chlorophyll and macromutation in urdbean (*Vigna mungo* L. Hepper). *Indian Journal of Genetics & Plant Breeding* 59(2): 203-210.
- Venkateswarulu, M., Susheclamma, B.N., Kumar P. and Subhash K. 1988. Studies on induced frequency in *Carthamus roseus* L. by gamma rays and EMS individually and combination. *Indian Journal of Genetics & Plant Breeding* 48(3): 313-316.
- Waghmare, V.N. and Mehra, R.B. 2001. Induced chlorophyll mutations, mutagenic effectiveness and efficiency in *Lathyrus sativus* L. *Indian Journal of Genetics & Plant Breeding* 61(1): 53-56.