Induced Mutagenic Effectiveness And Efficiency Studies on Finger Millet (Eleusine Coracana (L.) Gaertn.) Var- Co 13 in M_2 Generation

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Abstract- *Finger millet (Eleusine coracana (L.) Gaertn.) provides food for millions of people in Africa and Asia. The present investigation was carried out to study mutagenic effectiveness and efficiency of EMS and DES treatments in finger millet (Eleusine coracana (L.) Gaertn.) Var- Co 13. The relative effectiveness and efficiency of the both mutagen used were assessed from the data on biological damage in M_1 generation and frequency of chlorophyll and viable mutants in M_2 generation. The spectrum of chlorophyll mutants such as xantha, albino, chlorina and viridis, viable mutants such as tall, dwarf, early flower, early maturity, late maturity, bushy, high yield and seed mutants were observed in both the mutagenic treatments. Among the chlorophyll mutants xantha was found more in number. The mutagenic effectiveness and efficiency were found to be higher at 30 mM of EMS and 40 mM of DES. The mutation rate of EMS was higher in terms of effectiveness than that of DES. More number of chlorophyll and viable mutants was observed in EMS treatment when compared with DES and control.*

Keywords- EMS, DES, Chlorophyll, effectiveness, efficiency, frequency, injury, lethality, mutagen, viable.

I. INTRODUCTION

Finger millet (*Eleusine coracana* L. Gaertn) (2n=36) is one of the most important small grain cereals grown in eastern and southern Africa for food security and subsistent economy its high nutritive and cultural value (Dida et al., 2008). Finger millet is an important food in traditional low input cereal-based farming system (Wolie and Dessalegn, 2011), and the crop is also highly cultivated in South India, Myanmar, Sri Lanka, Bhutan and China (Upadhyaya et al., 2004). The nutritional quality of finger millet is highly superior to that of most cultivated cereals in the world, being rich in proteins, fiber and minerals; most importantly calcium and iron, which greatly help in alleviating the problems associated with malnutrition and anemia in countries where it is widely consumed as a staple food (Babu et al., 2006). This crop is also widely used as herbal medicine in many rural areas and this makes it the most important staple food for the rural populations in developing arid and semi-arid countries. Finger millet is a hardy crop that can withstand harsh environments, making it ideal for the areas that have unsuitable environment for production of other cereal crops (Upadhyaya et al., 2007). The crop can withstand longer periods with minimum rainfall.

Genetic improvement of crop depends on the amount of genetic variability present in the population. Mutation is gene level causes alterations in the structure and position of gene on chromosome called point mutation. This results in the alteration of phenotype of an organism. Changes in basic chromosome number either any addition of loss of any set or parts of them cause appearance of disappearance of new characters. Once the mutation in gene level or chromosomal level is firmly established in populations, they are subjected to natural or artificial selection.

Mutation breeding is the tool in the hand of breeder to create variability in crop population and to make selection in the population with the view to bring about further improvement in crop. In general mutation breeding has been playing a key role in self-pollinated crop with limit variability. Mutation breeding has been reported by many workers, in castor (Ankineedu, Sharma, & Kulkarni, 1968), in wheat Swaminathan, 1969), in sesame (Sharma, 1993), in cowpea Dhanavel et al., 2008), in black gram (Thilagavathi & Mullainathan, 2009) and soybean (Padmavathi, Devi, & Kiranmai, 1992,developed and improve plant varieties by mutation breeding. Gamma irradiation as mutagen can induce useful as well as harmful mutation in plants (Gupta, 1996; Micke & Domini, 1993). The present investigation was undertaken to study the mutagenic effectiveness and efficiency in M_1 generation and to study effects of EMS and DES in quantitative characters of finger millet in M_2 generation and results are discussed.

II. MATERIALS AND METHODS

The seeds of Finger millet (*Eleusine coracana* (L.) Gaertn.) Var- Co 13. Varieties collected from Tamilnadu Agricultural Research Institute Villupuram. Was used for the present study. The healthy seeds treated with various concentrations of chemical mutagens.

Ethyl methane Sulphonate (EMS)

EMS ($CH_3SO_2OC_2H_5$), an alkylating agent having molecular weight 124.16 was used in the present study. For the treatment of EMS, the seeds were pre-soaked in distilled water for 6 hours in order to make them relatively more sensitive to mutagenic action. Pre soaked seeds were treated with different concentrations of EMS (10, 20, 30, 40 and 50mM) for 4hours with repeated stirring. After the chemical treatment, the treated seeds were washed throughly in running tap water to remove the residues of the chemicals. Healthy, well- matured and untreated seeds were used as control.

Diethyl sulphate (DES)

Seeds of Finger millet were subjected to different treatment levels (20, 30, 40, 50 and 60mM) of Diethyl sulphate for induced mutagenesis. Before treatment, seeds were pre-soaked in distilled water for 12hrs at room temperature. Later on these seeds were dried on filter paper. All seeds were uniformly exposed to Diethyl sulphate solution by stirring with a glass rod. After treatment seeds were rinsed thoroughly with distilled water, air-dried and stored for later studies. All the agricultural practices, namely, irrigation, weeding, and plant protection methods were carried out during the growth period of the crop. The seed germination, lethality, seedling injury, and plant survival at maturity were recorded in M_1 generation.

For raising M_1 generation, the seeds were treated with different concentrations of EMS and DES were sown along with controls at the Botanical garden Department of Botany, Annamalai University, Annamalai nagar in a Randomized Block Design (RBD). The spacing was maintained at 15 cm (Plant to plant in a row) and 30cm (between the rows) in the field. All the surviving individual plants were harvested in each treatment in M_1generation. M_1 plants having sufficient seeds in different treatments were grown to raise M_2 generation with three replications. Screening was done for chlorophyll and viable mutation. Chlorophyll mutations were classified in accordance with the system of Gustaffson (1940) and Blixtnd Gottschalk (1975). Frequency of viable mutations was calculated in M_1 plants and M_2 seedling basis. Data on biological abnormalities such as injury and lethality in M_1generation and chlorophyll mutation frequency in M_1generation and M_2 generation were used to determine the mutagenic efficiency and effectiveness according to the formula suggested by Konzak et al. (1965).

1) Mutagenic effectiveness and mutagenic efficiency

$$\text{Mutagenic effectiveness (EMS)} = \frac{\text{Mutation rate}}{\text{concentraton of EMS in mM}} \times 100$$

$$\text{Mutagenic effectiveness (DES)} = \frac{\text{Mutation rate}}{\text{concentration of DES in mM}} \times 100 \text{ and}$$

$$\text{Mutation efficiency} = \frac{\text{Mutation rate}}{\text{Percentage of lethality or biological injury in M}_1}$$

Where

M	-	Mutation frequency for 100 M_2 plants
t	-	Period of treatment with chemical mutagen in hours
C	-	Concentration of chemical mutagens in mM
L	-	Reduction in height of seedling on 15th day
I	-	Lethality percentage or survival reduction of seedling

III. RESULT AND DISCUSSION

Chlorophyll and Viable Mutation Frequency

In present investigation chlorophyll and viable mutations were observed in M_2 generation. Various chlorophyll mutants such as albino, xantha, chlorina and viridis and viable mutants such as tall, dwarf, bushy, early maturity, late maturity, seed mutant and high yield mutant were observed in all the mutagenic treatments. In intermediate concentrations was found to be more effective and producing high mutation frequency of chlorophyll and viable mutations in both mutagens (Tables 1). Such type of chlorophyll and viable mutants was observed earlier workers in different plants Solanki and Sharma (2001) in lentil, The frequency of chlorophyll and viable mutants observed in M_2 generation is mainly used as a dependable measure of genetic effects of mutagens Gautam *et al*., 1998.

The maximum frequency of chlorophyll and viable mutations was observed at 30mM (15.78%) of EMS and 40mM (13.28%) of DES treatments (Table 1).

Mutagenic efficiency

The mutagenic efficiency increased concentration of both EMS and DES treatments. The mutagenic efficiency varies on different concentration of mutagen. The highest mutagenic efficiency was observed in 30mM of EMS and 40mM of DES. Singh (2007) reported mutagenic effectiveness, efficiency of gamma rays and ethyl methane sulphonate in Mungbean and treatments of the mutagens suggesting the direct relationship with the dose dependent increase.

IV. CONCLUSION

The seedling injury, lethality and mutation frequency increased with an increase in concentration of mutagenic treatments of both EMS and DES. Mutagenic effectiveness and efficiency varies on different concentration of mutagen. In the present study, it was concluded that (EMS) Ethyl methane Sulphonate are more effective including maximum mutation frequency as observed in Finger millet.

REFERENCES

[1] Ankineedu, G., Sharma, K. D., & Kulkarni, L. G. (1968). Effects of fast neutrons and gamma rays on castor. Indian Journal of Genetics and Plant Breeding, 28,37e39.

[2] Babu, B.K.,Senthil, N., Gomez, S.M., Biji,K.R., Rajendraprasad, N.S., Kumar, S.S., and Babu, R.C. (2006). Assessment of genetic diversity among finger millet (*Eleusine coracana* L. Gaertn) accession using molecular markers. Genetic Research and Crop Evolution 54:339-404.

[3] Blixt S, Gottschalk W (1975). Mutation in the leguminosae. Agric. Hort. Genet. 33:33-85.

[4] Dhanavel, D., Pavadai, P., Mullainathan, L., Mohana, D., Raju, G., Girija, M., et al. (2008). Effectiveness and efficiency of chemical mutagens in Cowpea (Vigna unguiculata (L.) Walp.). African Journal of Biotechnology, 7, 4116e4117.

[5] Dida, M.M., Wanyera, N., Ramakrishnan, S., Harrison-Dunn, M.L., Bennetzen,J.L., Devos, K.M. 2008. Population structure and diversity in finger millet (*Eleusine coracana*) germplasm. Tropical Plant Biology 1: 131-141.

[6] Gautam AS, Sood KC, Mittal RK (1998). Mutagenic effectiveness and efficiency of gamma rays and ethylmethane sulphonate in rajmash (*Phaseolus vulgaris* L). Legume Res;21:217-20.

[7] Gustafsson A (1940). The mutation system of the chlorophyll apparatus. Lunds Univ. Arrks. N.F. Adv. 36:1-40.

[8] Konzak CF, Nilan RA, Wagner J, Foster RJ (1965). Efficient chemical mutagenesis in the use of induced mutations in plant breeding. Rad. Bot.5:49-70.

[9] Padmavathi, T., Devi, P., & Kiranmai, V. (1992). Induced variability for different biological parameters in soybean. Journal of Cytology and Genetics, 27, 175e177.

[10] Sharma, S. M. (1993). Utilization of national collection of sesame in India. ICAR-IBPGR Reg. Workshop on sesame evaluation and improve, 28e30th, Sep., Nagpur, India.

[11] Singh AK (2007). Mutagenic effectiveness and efficiency of gamma rays and ethyl methane sulphonate in mungbean. Madras Agric. J. 94:7-13.

[12] Solanki IS, Sharma B (2001). Frequency and spectrum of chlorophyll mutations in macrosperma lentil (*Lens culinaris* Medik). Indian J Genet ;61:283-6.

[13] Swaminathan, M. S. (1969). Role of mutation breeding in a changing agriculture. In induced mutations in plants (pp. 719e734). Vienna: IAEA.

[14] Thilagavathi, C., & Mullainathan, L. (2009). Isolation of macro mutants and mutagenic effectiveness, efficiency in black gram (Vigna mungo (L.) Hepper). Global Journal of Molecular Science: 4(2): 76-79.

[15] Upadhyaya, H.D., Gowda, C.L.L., and Reddy, V.G. 2007. Morphological diversity in finger millet germplasm introduced from Southern and Eastern Africa. Journal of SAT Agricultural Research 3: 1-3.

[16] Upadhyaya, H.D., Gowda, C.L.L., Pundir, R.P.S., Reddy,V.G.,and Singh, S. 2004. Development of core subset of finger millet germplasm using geographical origin and data on 14 quantitative traits. Genetic Resource and Crop Evolution 53: 679-685.

[17] Wolie, A., and Dessalegn, T. 2011. Correlation and path coefficient analysis of some yield related traits in finger millet (*Eleusine coracana* L. Gaertn) germplasms in Northwest Ethiopia. African Journal of Agricultural Research 6: 5099-5105.