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# Effect of Gamma Rays and EMS on Chlorophyll Mutation Frequency and Spectrum in Safflower (*Carthamus tinctorius* L.)

**Pawar Pratiksha, Bolbhat Sadashiv* and Kanade Ashok [3]**
Research Center in Botany, Annasaheb Awate Arts, Commerce and Hutatma Babu Genu Science College, Manchar, Tal. - Ambegaon, Dist.- Pune (410503) M.S. India."
**Corresponding Author:** Bolbhat Sadashiv
Email: bolbhats@gmail.com

**ABSTRACT**
*Cultivar of Safflower (Carthamus tinctorius L.) cv. Phule Bhivra, a systematic and comparative study was conducted on the frequency and spectrum of chlorophyll mutations induced by Ethyl methane sulphonate (EMS) (0.2%, 0.3%, 0.4% EMS), Gamma rays (200,300,400Gy)and their combination(200Gy+0.2%EMS, 200Gy+0.3%EMS, 200Gy+0.4%EMS,300Gy+0.2% EMS, 300Gy+0.3%EMS,300Gy+0.4%EMS, 400Gy+0.2%EMS,400Gy+0.3%EMS, 400Gy+0.4%EMS). In the $M_2$ generation, a diverse range of chlorophyll mutants was produced, such as xantha, chlorina, and albina. With increased dosages of gamma rays, the frequency of chlorophyll mutations increases. Also in EMS treatment concentration increases the frequency of chlorophyll mutation increases. In combination treatment mutation frequency increases with increases in doses of gamma rays and concentration of EMS, except in a few treatments 300Gy+0.3%EMS, 400Gy+0.2%EMS, and 400Gy+0.3%EMS.*

***Keywords****- Safflower, Gamma rays, EMS, Chlorophyll Mutation, Frequency, Spectrum*

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## INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is a member of the family Asteraceae that is widely grown throughout South Asia and the Mediterranean, including India (8). The ability of the plant to take in moisture and nutrients from many soil types is made possible by its deep-rooting structure (19). As a crop for oilseeds, safflower is mostly grown on dry land. Safflower has a delayed first development phase following seed germination. At the base of the stem, leaves are generated during the time of slow development also known as the rosette stage (15). Young seedlings are consumed as green leafy vegetables in India because the leaves are high in carotene, riboflavin, and vitamin C (14). The formation of chlorophyll appears to be regulated by several genes spread across several chromosomes, maybe close to the centromere and proximal section of the chromosome (17). Chlorophyll mutant segregation is an indication of the mutagenesis impact and a useful tool for predicting the range of genetic diversity that may result from muted sectors (13).

## MATERIAL AND METHOS

### Physical and Chemical mutagenesis-

To induce diversity for physical mutagenesis, well-filled, healthy seeds of safflower were exposed to three different gamma radiation dosages at the Department of Chemistry, Savitribai Phule Pune University, Pune:200 Gy, 300 Gy, and 400 Gy. Also, seeds were exposed to three different EMS concentrations - 0.2%, 0.3%, and 0.4% EMS to induce chemical mutagenesis. For combination treatment, Gamma ray-treated seeds are treated with various concentrations of EMS. Such as a 200Gy+0.2%EMS, 200Gy+0.3%EMS, 200Gy+ 0.4% EMS, 300Gy+0.2%EMS,300Gy+0.3%EMS, 300Gy+0.4%EMS, 400Gy+0.2%EMS,400 Gy+ 0.3% EMS,400Gy+0.4%EMS.

**Field evolution of physical and chemical mutagens-**

The irradiated/treated seeds were grown along with the control at the research field of the Department of Botany at "Annasaheb Awate Arts, Commerce, and Hutatma Babu Genu Science College in Manchar, Tal. Ambegaon, District Pune" (Maharashtra) India. Each $M_1$ plant seed was picked separately treatment-wise and concentration-wise and cultivated as a plant-to-progeny row to raise $M_2$ generation.

**Method and analysis-**

To grow the crop, customary cultural practices were adhered to. Using Gustafson's 1940 terminology, investigated the spectrum of chlorophyll mutations in the Safflower (*Carthamus tinctorius* L.). According to Gaul (1960), the frequency of chlorophyll mutants can be expected as follows: a variety of mutants/ total no. of $M_2$ plants.

**RESULTS AND DISCUSSION**

**Table No.1. Effect of mutagens on the frequency and spectrum of chlorophyll mutations in $M_2$ generation Safflower.**

| Treatment | No. of $M_2$ Plants | Total Chl. Mutant | Frequency of Chl. Mutation (%) | Spectrum of Chlorophyll Mutation (%) | | |
|---|---|---|---|---|---|---|
| | | | | Albina | Chlorina | Xantha |
| Control | 150 | - | - | - | - | - |
| 200 Gy | 134 | 3 | 2.23 | (1)33.33 | - | (2)66.66 |
| 300 Gy | 126 | 2 | 1.58 | - | (1)50.00 | (1)50.00 |
| 400 Gy | 56 | 2 | 3.57 | (1)50.00 | - | (1)50.00 |
| **Average** | **-** | **2.33** | **2.46** | **49.96** | **16.66** | **55.55** |
| 0.2% EMS | 138 | 2 | 1.44 | - | (1)50.00 | (1)50.00 |
| 0.3% EMS | 108 | 2 | 1.85 | (1) 50.00 | - | (1) 50.00 |
| 0.4% EMS | 76 | 3 | 3.94 | (2)66.66 | - | (1)33.33 |
| Average | - | **1.66** | **2.41** | **38.88** | **16.66** | **44.61** |
| 200+0.2 | 113 | 2 | 1.76 | (1)50.00 | - | (1)50.00 |
| 200+0.3 | 101 | 2 | 1.98 | (1)50.00 | (1)50.00 | - |
| 200+0.4 | 124 | 3 | 2.41 | (1)33.33 | - | (2)66.66 |
| 300+0.2 | 105 | 3 | 2.85 | - | (2)66.66 | (1)33.33 |
| 300+0.3 | 101 | 2 | 1.98 | (1)50.00 | (1)50.00 | - |
| 300+0.4 | 73 | 3 | 4.10 | (1)33.33 | - | (2)66.66 |
| 400+0.2 | 89 | 2 | 2.24 | - | (1)50.00 | (1)50.00 |
| 400+0.3 | 62 | 2 | 3.22 | (1)50.00 | (1)50.00 | - |
| 400+0.4 | 47 | 2 | 4.25 | (1)50.00 | - | (1)50.00 |
| **Average** | **-** | **2.33** | **2.76** | **35.18** | **24.07** | **40.73** |

The main purpose of the frequency of chlorophyll mutants in the $M_2$ generation is as a dependable measure of the genetic effects induced by the mutagens (7). The result presented in (Table No.1) is an increase in chlorophyll mutation frequency with an increase in the doses of gamma rays. 400 Gy dosage showed the highest frequency of chlorophyll mutations (3.57 %) on an $M_2$ generation. A similar type of results are observed in soybean (4), groundnut (16), and sesame (1),(9). EMS treatment increases chlorophyll mutation frequency with an increased concentration of EMS and the highest chlorophyll mutation frequency showed in 0.4% EMS (3.94%). Similar types of results were observed in Safflower (12), linseeds (18), and Groundnuts (6). In combination treatment the frequency of Chlorophyll mutation with increases the doses of gamma rays and concentration of EMS, except few treatments which are 300Gy+0.3%EMS, 400Gy+0.2%EMS, and 400Gy+0.3%EMS. Parallel types of results were observed in soybeans (5). This crop generally had a low frequency of chlorophyll mutants, which may be due to the oilseed crops' resistance to the production of chlorophyll mutations (10),(11).

Based on Gustafson's terminology (3), investigated the chlorophyll mutations *viz*. Albina, Chlorina, Xantha (Fig.no.1). In Gamma rays was found that Xantha frequency was the most common chlorophyll mutant, followed by albina > chlorina also same trend followed in EMS treatment. In combination treatment also shows that Xantha frequency was the most common chlorophyll mutant, followed by chlorina > albina. These three types of chlorophyll mutants were found in soybean (5). The chlorophyll mutation types are explained below briefly.

**Albina:** The seedlings of the Albina mutants are dull white in color and lack carotenoids, chlorophyll, and other pigments. The mutants are short in stature, and they only live for 20 days after germination before

 

goingextinct.
**Chlorina:** The first light green leaves of chlorina mutant seedlings eventually become green. Their levels of chlorophyll, particularly chlorophyll b, are lower. These mutations can occur in the future and are variable. Xantha: Mutants of this species are bigger than albina and feature a yellow first pair of leaves. They have an 8–10 days survival rate. The differences in the position of genes concerning the centromere may be the cause of variances in the mutation spectrum and rate in various genotypes (17).

**a) Albina** **b) Chlorina**

**c) Xantha**

**Fig.no.1. Chlorophyll Mutant in $M_2$ generation**


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## REFERENCES


1. Burghate, S. K., Mishra, M. N., Chikhale, N. J., Mahalle, A. M. and Dhole, V. J. (2013). Impact of mutagens on its efficiency and effectiveness in groundnut (*Arachis hypogaea* L.). Scholarly Journal of Agricultural Science, 3(7), 284-288.
2. Gaul, H., (1960). Critical analysis of the methods for determining the mutation frequency after seed treatment with mutagens. *Genetica Agaria*, 12: 297-318.
3. Gustafsson, A., (1940). The mutation system of the chlorophyll apparatus. *Kungliga Fysiografiska Sallskapets i Lund Handlingar*, 51(11).
4. Kavithamani, D., Kalamani, A., Vanniarajan, C. and Uma, D. (2008). Mutagenic effectiveness and efficiency of gamma rays and EMS in Soybean (*Glycine max* (L.) Merrill). Madras Agricultural Journal, 95(Jul-dec), 1.

5. Khan, M. H., and Tyagi, S. D. (2010). Studies on effectiveness and efficiency of gamma rays, EMS, and their combination in soybean (*Glycine max* (L.) Merrill*)*. *Journal of Plant Breeding and Crop Science*, *2*(3), 55-58.
6. Manjunath, N. G., Saravanan, S., Sushmitha, R., Pillai, M. A., Sheela, J. and Shoba, D. (2020). Mutagenic efficiency and effectiveness of gamma rays and EMS in groundnut (*Arachis hypo*gaea L.). Electronic Journal of Plant Breeding, 11(3), 875-880.
7. Nilan, R. A. and Konzak, C. F. (1961). Mutation and Plant breeding. In NAS Symposium (Vol. 437, p. 460).
8. Oad F.C, Samo M.A, Qayyum S.M, Oad N.L. (2002). Inter and intra row spacing effect on the growth, seed yield and oil content of safflower *Carthamus tinctorius* L. F. Asian Journal of Plant Sciences 1(1): 18-19.
9. Pradhan, M. and Paul, A. (2019). Spectrum and frequency of chlorophyll mutation in Sesame (*Sesamum indicum*). The Pharma Innovation, *8*, 453-455.
10. Rajan S.S. (1969). On radiations and radioactive substance in mutation breeding. In: *Relative biological effectiveness of monoenergetic fast neutrons on oilseeds.* Department of Atomic Energy, pp. 79-98.
11. Rangaswmay M (1973). Induced mutagenesis in gingelly (*Sesamum indicum* L.) with gamma rays and ethyl methane sulphonate. M.Sc. Thesis, TNAU, Coimbatore, India.
12. Satpute, R. A. and Kothekar, V. S. (1996). Mutagenic efficiency and effectiveness in safflower. Journal of Nuclear Agriculture and Biology, *25*, 230-234.
13. Sengupta, S., and Datta, A. K. (2005). Induced narrow leaf mutant of sesame (*Sesamum indicum* L.). Indian Journal of Genetics and Plant Breeding, *65*(01), 59-60.
14. Singh, R. J. (Ed.). (2006). *Genetic Resources, Chromosome Engineering, and Crop Improvement: Vegetable Crops,* Volume 3 (Vol. 3). CRC press.
15. Singh, V. and Nimbkar, N. (2006). Safflower (*Carthamus tinctorius* L.). *Chapter*, *6*, 167-194.
16. Sonone, N., Deshmukh, S., Patil, S., Rathod, S., and More, G. (2008). Comparison of mutagenic efficiency and effectiveness of EMS and gamma rays in groundnut (*Arachis hypogaea* L.). Crop Res. 36(1-3): 336- 340.
17. Swaminathan M.S. (1964). A comparison of mutation induction in diploids and polyploids, In The use of induced mutations in plant breeding, Rad. Mut. Organ: FAO/IAEA, Vienna, 619-641.
18. Thakur, G., Paul, S. and Kumar, A. (2020). Mutagenic effectiveness and efficiency of ethyl methane sulphonate (EMS) mutagen in linseed (*Linum usitatissimum* L.). Indian Society of Oilseeds Research, *37*, 260-266.
19. Weiss, E. A. (1983): "Oil seed crops. Pub." 402-462.