



## Effectiveness and Relative Efficiency of Mutagens in *Coriandrum Sativum* Linn.

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### Manuscript details:

Received: 30.10.2023  
Accepted: 24.12.2023  
Published: 31.12.2023

### Cite this article as:

Salve KM (2023) Effectiveness and Relative Efficiency of Mutagens in *Coriandrum Sativum* Linn., *Int. J. of Life Sciences*, 11 (4): 375-378

Available online on <http://www.ijlsci.in>

ISSN: 2320-964X (Online)

ISSN: 2320-7817 (Print)



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### ABSTRACT

Effectiveness is a measure of gene mutation in relation to dose and efficiency is a phrase used to evaluate biological effects in plants such as mortality, damage, and sterility. In the present investigation, EMS treatment was found to be most effective mutagen in *Coriandrum sativum* L. as compared to Gamma rays. The order of effectiveness and efficiency of the mutagens were EMS > GR. The decrease in effectiveness with increasing concentrations of mutagens produced the biological damage like lethality and pollen sterility.

**Keywords:** Effectiveness, efficiency, mortality. Sterility

### INTRODUCTION

*Coriandrum sativum* Linn. is a member of the Apiaceae family. It is frequently referred to as coriander. The term "coriander" comes from the plant's overall pungent odour, which is particularly pronounced in the unripe fruit (from the Greek Koris, a bedbug). The green spice coriander, also known as 'Dhania', is a staple across all of India. It is pronounced Kothembiri in Maharashtra. The seeds and leaves of coriander are frequently used to flavour meals. In Indian agriculture, it is very valuable both economically and nutritionally. In addition to all of its uses, it is a well-known drug in conventional medicine, such as Ayurveda. Due of its applications and economic worth, this plant has been the subject of mutational research. An innovative method for introducing biochemical changes in plants is mutation breeding Bhosale (2014).

### MATERIAL AND METHODS

Tamil Nadu Agriculture University, Coimbatore, and Tamil Nadu provided the seed stock for the coriander variety CS-287. Treatment methods included the use of EMS, a chemical mutagen, and gamma rays, a physical mutagen.

#### **Gamma rays treatment:**

The nuclear chemistry division, department of chemistry, Savitribai Phule Pune University, Pune, Ganeshkhind, Pune-411007, exposed the

experimental seed material to radiation. The dry, healthy seed was packed and exposed to 10 kR, 20 kR, 30 kR, and 40 kR of gamma radiation from source Co60.

#### EMS treatment:

Ethyl Methane Sulphonate (EMS), a chemical mutagen with a molecular weight of 124.16 and a density of 1.20, was obtained from Spectrochem Pvt. Ltd. in Mumbai. EMS was applied to dry and healthy seeds at concentrations of 0.050 %, 0.075 %, 0.10 %, and 0.125 %. In order to raise the M1 generation, seeds of each treatment, as well as control (untreated seeds), were sown in the research field using a Complete Randomized Block Design (CRBD) with three replications.

#### Estimation of Mutagenic effectiveness and efficiency:

The mutagenesis efficiency and effectiveness of various mutagens were calculated using the formula recommended by Konzak et al. (1965). Mutagenesis efficiency is a measure of the frequency of mutations induced by a unit dose of mutagen (kR or time times concentration), so although mutagenesis efficiency is a small fraction of mutations associated with biological damage, such as lethality, seedling damage, pollen sterility, and Chromosomal aberrations.

$$\text{Mutagenic effectiveness} = \frac{\text{Mutation frequency (MF)}}{\text{Dose or (Time X Concentration)}} \times 100$$

$$\text{Mutagenic efficiency} = \frac{\text{Mutation frequency (MF)}}{\text{Biological damage}} \times 100$$

#### Mutation rate

The mutation rate was calculated by the following formula:

$$MR = \frac{\text{Some of values of effectiveness or efficiency of a particular mutagen}}{\text{Number of treatments of that particular mutagen}}$$

## RESULT AND DISCUSSION

#### Mutagenic effectiveness: (Table 1)

At 0.05% the concentration was 2.55, whereas at 0.10% it was 3.906. The effectiveness of the M2 generation of Coriander (after being treated with gamma radiation) gradually decreased with an increase in the dose of the mutagen. The two mutagenic treatments are most effective when they are administered in sequence, with EMS being the most effective first.

#### Efficiency in relation to lethality (Table 2)

In the EMS treatment, the efficiency increased as the concentration of the poison increased. The maximum efficiency value was observed at a concentration of 0.10%, while the minimum value was observed at a concentration of 0.050%. When treated with gamma rays, the efficiency ranges from 0.0425% to 0.0715%.

#### Efficiency in relation to Pollen sterility (Table 2)

Observations made regarding pollen sterility efficacy have demonstrated a concentration/dose dependent enhancement of most M2 generation coriander mutagenic treatments. The efficiency of emergency medical services (EMS) improves as the number of treatments administered increases. This range spans from 0.0655% to 0.1704%. The efficiency at which gamma rays kill pollen varies from 13.22% to 36.17%.

Table No. 1: Effectiveness of mutagens in M<sub>2</sub> generation in *Coriandrum sativum* L.

| Mutagens   | Concentrations/ Dose | % Chlorophyll mutations (MF) | Effectiveness MF/dose or MF/T×C |
|------------|----------------------|------------------------------|---------------------------------|
| Control    | -                    | -                            | -                               |
|            | 0.050%               | 0.5                          | 2.55                            |
|            | 0.075%               | 0.7936                       | 2.64                            |
|            | 0.10%                | 1.5625                       | 3.906                           |
| EMS        | 0.125%               | 1.3071                       | 2.614                           |
|            | 10 kR.               | 1.234                        | 0.1234                          |
|            | 20 kR.               | 2.0833                       | 0.1041                          |
|            | 30 kR.               | 2.631                        | 0.108                           |
| Gamma Rays | 40 kR.               | 3.076                        | 0.0769                          |

Table 2: Relative Efficiency of treatment of mutagens in M<sub>2</sub> generation of *Coriandrum sativum* L.

| Mutagens   | Concentrations/<br>Dose | %Chlorophyll<br>mutation (MF) | %Lethality (L.) | Efficiency<br>MF/L. | Pollen<br>sterility (S.) | Efficiency<br>MF/S |
|------------|-------------------------|-------------------------------|-----------------|---------------------|--------------------------|--------------------|
| Control    | -                       | -                             | -               | -                   | -                        | -                  |
| EMS        | 0.050%                  | 0.5                           | 25              | 0.020               | 1.886                    | 0.0655             |
|            | 0.075%                  | 0.7936                        | 30              | 0.026               | 4.652                    | 0.1286             |
|            | 0.10%                   | 1.5625                        | 33              | 0.047               | 5.876                    | 0.1726             |
|            | 0.125%                  | 1.3071                        | 37              | 0.035               | 7.634                    | 0.1704             |
| Gamma Rays | 10 kR.                  | 1.234                         | 29              | 0.0425              | 2.636                    | 0.1322             |
|            | 20 kR.                  | 2.0833                        | 32              | 0.0651              | 5.512                    | 0.2857             |
|            | 30 kR.                  | 2.631                         | 37              | 0.0711              | 7.764                    | 0.3526             |
|            | 40 kR.                  | 3.076                         | 43              | 0.0715              | 10.756                   | 0.3617             |

Table No. 3: The mutation rate of the mutagens based on effectiveness and efficiency in M<sub>2</sub> generation of *Coriandrum sativum* L.

| Mutagens   | Mutagen rate based on<br>Effectiveness | Mutation rate-based Efficiency<br>Lethality | Mutation rate-based Efficiency<br>Pollen sterility |
|------------|--|---|--|
| EMS        | 2.9275                                 | 0.032                                       | 0.1342   |
| Gamma Rays | 0.1031                                 | 0.06255                                     | 0.2830   |

**Mutation rate (Table No.3)**

Mutation rates vary based on efficiency. The order of mutagens changes as the mutagens have varied values in relation to lethality and pollen sterility. Considering the mortality rates for these treatments, the value was 0.032 for EMS and 0.0625 for Gamma rays treatments. With respect to lethality, gamma radiation produced more deaths than did the use of antibiotics in M<sub>2</sub> generation of Coriander plants. The mutation rate for pollen sterility was 0.1342 for EMS and 0.2830 for gamma radiation treatments. With respect to pollen sterility, gamma rays were more effective than emergency medical services.

**DISCUSSION:****Mutagenic effectiveness and efficiency:**

EMS treatment was determined to be the most effective mutagen in *Coriandrum sativum* L. in the current experiment when compared to Gamma rays. The mutagens were EMS > GR in order of effectiveness and efficiency. As mutagen concentrations rose, their potency decreased, causing biological harm like death and pollen sterility. Numerous researches found the same outcome in various plants, including (Ojiewo *et al.*, 2005) in *Solanum nigrum* L., (Kostov *et al.*, 2007) in tomatoes, (Matsukura *et al.*, 2007) in *Solanum lycopersicum* L., (Watanabe *et al.*, 2007) in *Solanum lycopersicum* L., (Kowalczyk *et al.*, 2008) in *Solanum muricatum* Ait., (Das *et al.*, 2010) in Withania, Sri Devi

and Mullainathan (2012) in *Capsicum annuum* L. and (Sikder *et al.*, 2013) in *Solanum lycopersicum* L., Kothekar (1978), in *Solanum nigrum* L., Deshpande (1980) in *Momordica charantia*, Hakande (1992) in Winged bean.

Similarly, increase in mutagenic effectiveness and efficiency with increase in dose and concentration of the Gamma rays, EMS, Sodium azide and their combinations was studied by Mahla and Ramkrishna (2002) in fennel. They claimed that higher doses of three mutagens were linked to greater efficiency. The outcome suggested that among the mutagens, mutagenic effectiveness is more variable than mutagenic efficiency.

In case of *Coriandrum sativum* L. the order of efficiency of mutagens with reference to different biological parameters studied in M<sub>1</sub> generation. Pertaining to the lethality the efficiency degrees in the order EMS followed by Gamma rays EMS > GR. The efficiency based on pollen sterility revealed the order as EMS > GR. Many research workers such as Kothekar (1978), in *Solanum nigrum* L., Deshpande (1980) in *Momordica charantia*, Hakande (1992) in Winged bean, have reported alkalyting agents to be more effective than the Gamma rays. In contrast to these Gamma rays were recorded to be more efficient than the alkalyting agent inducing seed sterility in rice Siddiq and Swaminathan (1968) and in wheat, Prasad (1972).

In the present investigation, when the mutation rate based on the efficiency are compared the EMS could be seen as the more efficient as a parameter of lethality while pollen sterility by EMS could be observed as the more efficient.

**Conflict of Interest:** None of the authors have any conflicts of interest to disclose.

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