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Study on Effectiveness and efficiency of different Doses of Gamma-rays in Sesame

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ABSTRACT: Sesame is a valuable oilseed crop with several uses. The most important prerequisites for increasing seed yield are the presence of genetic variation within a particular crop population. A well-known method for increasing genetic variety is mutagenesis. Mutagenic effectiveness and efficiency of gamma rays were investigated in the two sesame (*Sesamum indicum)* genotypes (Rama and Tillotoma). The irradiated seeds were subjected to tests to determine their lethal dosage (LD_{50}), which was defined as the level at which 50% of the seeds germinated. The mutagenic effectiveness and efficiency was calculated in M_2 generation based on biological damage like lethality or survival %estimated in M_1 generation. With an increase in mutagen dosage, mutagenic efficacy and efficiency increased. It was cleared from the result that 400Gy was most efficient in inducing mutation in both the genotypes of sesame.

Keywords: Mutagen, Effectiveness, Efficiency, Gamma rays, *Sesamum indicum*.

INTRODUCTION

The sesame plant, *Sesamum indicum* L (2n=26), also known as gingelly or til, belongs to the Pedilaceae family and is one of the oldest and most widely used oilseeds in human history. It is renowned for its high-quality seed oil. Because to its high oil content (38–54%), protein content (18–25%), calcium, phosphorus, oxalic acid, and the superior quality of the seed oil and meal, sesame is known as the "Queen of oilseeds" (Prasad, 2002).

Sesame production in India leads the globe with an annual output of 0.82 million tonnes, or around 20% of the total production of oilseeds (Ministry of Agriculture and Farmer's Welfare, 2014–15).

Although sesame is an ancient oilseed crop, it is still at an early stage of its breeding. The generation of commercially high yielding mutants is facilitated by induced mutation, which is also a reasonably quick procedure for crop improvement. Application of suitable physical mutagen dosages has resulted in sufficient mutations that may help the sesame breeding project. According to Shah *et al*. (2008) mutagens can alter the genetic makeup of an organism, disrupt genetic linkages, and produce a variety of fresh, promising characteristics that can be used to improve crop plants. The best method for generating variability is still ionising radiation (Brunner, 1995; Bhatia *et al*., 2001; Irfaq and Nawab 2003; Joseph *et al*., 2004; Sangsiri *et al*., 2005). By causing cytological, genetic, biochemical, physiological, and morphogenetic changes in cells and tissue, gamma rays are known to have an impact on growth and development.

Any mutagen's value in plant breeding depends on both its effectiveness and efficiency as mutagens, with efficient mutagenesis being the result of the greatest amount of favourable modifications and the fewest amount of unwanted changes. Effectiveness and efficiency are two different characteristics of mutagens that have been thoroughly studied in other publications (Kawai, 1975; Shah *et al*., 2008; Girija and Dhanavel 2009).

The aim of the present study was to examine the effectiveness and efficiency of various gamma-ray dosages in sesame in the M_2 generation using two well-known genotypes of the plant, Rama and Tilottoma.

MATERIALS AND METHODS

For each treatment in the gamma chamber at 250, 300, 350, 400 Gy doses of gamma rays in (60Co) gamma source (irradiation source capacity to release 3000 Ci delivery 7200 r/min), dry, uniform, bold, healthy seeds of variety Rama and Tillotoma packed in moist germination paper each weighing 150g were chosen. The gamma irradiation was done at BARC in Mumbai, India's Trombay neighbourhood. In order to raise the M_1 generation, the irradiation seed and the control were planted in the post-kharif season of 2018. During the 2019 pre-kharif season, a single plant seed from the M_1 generation was gathered for breeding the M_2 generation. In order to raise the M_1 generation in a split plot design with three replications, the seeds were sown right away in the field alongside their corresponding controls. The spacing used for all treatments, including the controls, was 45 cm between rows and 20 cm between plants. During the crop's growing cycle, irrigation, weeding, and plant production techniques were all implemented as suggested.

The percentage of plants that survived till maturity was used to calculate plant survival (L). The reduction in plant survival was used to compute the biological harm (lethality/injury). At maturity, all of the M_1 viable plants that had survived were harvested individually, and seeds were then seeded the next season in plant progeny rows to produce the M_2 generation.

The percentage of mutant M_2 progenies in each treatment was used to compute the mutation frequency. The percent frequency of a mutation brought on by a given dose of a mutagen is known as mutagenic efficacy. As a result, it is the ratio of the mutagen dose applied to the % mutation frequency. The frequency of mutations recovered for each unit of damage brought on by the mutagen treatment is known as mutagenic efficiency. Lethality is often calculated based on injuries.

The Mutagenic effectiveness and efficiency were calculated on the basis of formulae suggested by Konzak *et al.* (1965).

RESULTS AND DISCUSSION

To recover a high frequency of desirable mutations in any mutation breeding operation, selecting effective and efficient mutagen (s) is crucial. The rate of mutation induction in response to the mutagenic dose is referred to as mutagenic effectiveness. The information in Table 1 showed that different doses had varying degrees of effectiveness, and different genotypes responded in different ways. The efficiency of the mutagenesis process increased with dosage in both genotypes. Most of the time, it was discovered in earlier investigations that mutagenic effectiveness rose with decreasing doses. The findings of the current investigation showed that effectiveness is also influenced by the genetic make-up of the material undergoing mutagenic treatment.

The usefulness of a specific mutagen depends on both its effectiveness and efficiency in generating mutation. According to Nilan (1967), mutagenic effectiveness refers to the ratio of the mutagen in issue to any related harmful biological effects including gross chromosomal abnormality, mortality, and infertility.

Girija and Dhanavel (2009); Jyothsna *et al*. (2022); Kumar and Srivastava (2013); Mangaiyarkarasi *et al*. (2004); Satpute and Fultambkar (2012); Shah *et al*. (2008); Raina *et al*. (2022); Waghmare and Mehra (2001) used gamma rays in their experiment to study mutagenic effectiveness and efficiency of different doses of gamma rays.

According to the data, both genotypes were most effective at 400 Gy. At 400 Gy of therapy, the highest efficiencies were seen for Tillotoma (0.03) and Rama (0.02 and 0.03 respectively).

On the basis of the degree of damage in M_1 generation, which defines the mutability of genes regardless of the mutagen utilised, the low values for mutagenic efficiency can be understood. Furthermore, the effectiveness of a mutagen is complex in that it depends not only on the material with which it interacts and the biological system to which it can be applied, but also on the extent to which the agent also causes physiological harm, chromosomal aberration, and sterility in addition to mutations. All mutagens and their doses will therefore produce roughly equivalent amounts of mutations when subjected to harm of the same intensity.

Table 1: Effectiveness and efficiency of different doses of gamma-rays in the two genotypes of sesame (Rama and Tillotoma).

Genotype	Treatment	No. of M_2 plant studied	No. of mutant plants in M_2	Mutation rate in M_2 (%)	Lethality or plant survival reduction (%)	Mutagenic effectiveness	Mutagenic efficiency
Rama	250 Gy	11444	17	0.15	67.31	0.0006	0.0022
	300 Gy	9720	29	0.30	50.16	0.001	0.0059
	350 Gy	8578	38	0.44	41.30	0.0012	0.010
	400 Gy	6932	61	0.88	42.91	0.0022	0.020
Tillotoma	250 Gy	6721	19	0.28	57.64	0.0011	0.0048
	300 Gy	4567	22	0.48	50.11	0.0016	0.0095
	350 Gy	3456	29	0.84	47.79	0.0024	0.0175
	400 Gy	2589	30	1.16	35.50	0.0029	0.0326

CONCLUSIONS

The current study evaluated the manner in which the sesame varieties Rama and Tillotoma responded to mutagenesis effectiveness and efficiency. Among the different doses of gamma rays, 400 Gy was most effective in mutagenicity in both the genotypes. The effectiveness and efficiency of the mutagens were found to be increasing with an increase in the mutagen dose. The high dose of treatment recorded the maximum biological damage. Therefore, optimum dose is recommended. The selection of the optimum mutagenic doses for future works can be made by the determination of mutational frequency, effectiveness, and efficiency. Optimum doses of mutagen have been utilised in creation of variation and crop improvement programmes.

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Conflict of Interest. None.

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