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Gamma Rays Sensitivity of Two Sesame cultivars in M_1 Generation

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ABSTRACT

The present study investigated the gamma ray sensitivity of two sesame (*Sesamum indicum* L.) varieties viz., AKT-64 and N-8 irradiated with five different doses from 400Gy to 700Gy. Germination percentage, root and shoot length, Survival percentage decreased gradually and observed a dose dependent relationship with an increase in dosage of gamma rays. N-8 showed a pronounced maximum reduction in germination percentage (28.44%) than AKT-64 (35.78%) at 700Gy, whereas survival percentage of AKT-64 (32.79%) and N-8 (26.45%) was drastically reduced at 700Gy dose. At a higher dose of 700Gy, root (2.42cm) and shoot (2.06cm) length of seedlings of N-8 were greatly inhibited. LD_{50} values that showed 50% reduction in biological parameters differed between AKT-64 and N-8. Based on all the biological parameters studied, the mutagen sensitivity of N-8 is higher than AKT-64. The overall considerations on M_1 generation effects showed that N-8 were highly sensitive to gamma rays.

Key words: *Gamma rays sensitivity, Sesamum indicum L,* LD_{50}

Introduction

Sesame (*Sesamum indicum* L.) is one of the oldest and economically important oilseed crops known to man and is widely cultivated in tropical and subtropical parts of the world (Ashri, 1998). There are a lot of disagreements about where sesame came from, where it was domesticated in Africa, and where it was grown in the subcontinent of India, the two alternative sites proposed for its origin. Most of the wild sesame was endemic to Africa. Sesame is variously known as til, gingelly, simsim, gergelim and is one of the nine major oilseed crops in India. It is described as the "Queen of Oil Seeds" due to its excellent oil quality and it is mostly grown for its seeds and the oil extracted from seed (Bedigian and Harlan, 1986).

Sesame is a member of the order Tubiflorae, family Pedaliaceae with a chromosome number 2n=26, It is an erect, annual, branched or unbranched herb. Leaves may be ovate or lanceolate and pointed with entire or serrate margins. Leaf colour varies from light greener to dark green Flowers are zygomorphic with five lobes tubular and campanulate corolla. Corolla is pigmented with a wide range of colors ranging from white to pink, violet, red and maroon. The sesame fruit is a capsule, normally pubescent, rectangular in section and typically grooved with a short triangular beak.

Sesame is an important source of high quality oil

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and protein, the chemical composition of sesame shows that the seed is an important source of oil (44–58%), protein (18–25%), carbohydrate (13.5%) and ash (5%) (Elleuch *et al*., 2007), the oil in seeds makes up around half of their weight and is highly stable because it contains natural antioxidants such sesamolin, sesamol, and sesamin (Brar and Ahuja, 1979). Sesame oil is perhaps the most resistant vegetable oils to oxidative rancidity, especially after hydrogenation. The oil contains a very high percentage of unsaturated fatty acids, about 85%. Major fatty acids present in oil have been oleic acid (37% to 50%), followed by linoleic acid (37% to 47%), palmitic acid (7% to 9%) and stearic acid (4% to 5%); however, the fatty acid composition of sesame oil varies considerably among different cultivars worldwide (Yermanos *et al.,* 1972).

Physical mutagens that ionize and can cause mutations in both plants and animals are gamma rays. Compared to X-rays, they have a shorter wavelength and so higher energy per photon. These rays penetrate up to many cm which is generally produced in a wide range of energies like X-rays. Use of gamma rays, ionizing radiation highly penetrate biological tissues and react with water molecules to produce free radicals which in turn disrupts the H-bond between complementary base pair in double helix DNA. Mutagen sensitivity is estimated through percentage of seed germination, seedling injury, survival percentage and chromosomal aberrations (Kivi, 1965). Radiation tolerance or mutagen sensitivity also differs between species and even among genotypes within a species (Sparrow, 1966). It is inevitable to determine the appropriate doses for each genotype to induce artificial mutagenesis with least biological damage, Therefore, in this study; we examined the mutagen susceptibility of gamma rays in two well-known sesame species AKT-64 & N-8 in M_1 generation.

Materials and Methods

The experiment was carried out during Kharif season 2019 at the Instructional Farm of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra.

Plant Materials

For the present study two genotypes of sesame *viz.*, AKT-64 and N-8 were used

Gamma Irradiation

Two genotypes of sesame viz., AKT-64 and N-8 were exposed to gamma irradiation at different doses (400Gy, 500Gy, 600Gy and 700Gy) using Cobalt-60 (^{60}Co) gamma source installed at BARC (Bhabha Atomic Research Center) Trombay, Mumbai. The irradiated seeds were sown in the field along with control (non - treated) seeds.

Field Study

The seeds of each treatment were sown in the field followed by Randomize block design with five replications along with control. Each plot consists of 3 rows with 3 meter length keeping row to row and plant to plant distances at 30 cm and 10 cm respectively. All the agronomic practices and plant protection measures were taken throughout the entire experiment as per the crop production guidelines. In the M_1 generation various biological parameters and several other quantitative traits were measured to assess the effect of gamma rays.

Studies on Biological Injury

Mutagen sensitivity was estimated with the help of biological injury and measured in terms of germination percentage on 10 DAS, survival percentage followed by root and shoot length

Germination percentage

The emergence of cotyledonary leaves above the ground surface was taken as an indication of germination. The observations were recorded after 10 days of sowing. The germination percentage was worked out for all treatments including control as per the formula given below.

$$\text{Germination (\%)} = \frac{\text{Total no. of seeds germinated}}{\text{Total no. of seeds sown}} \times 100$$

Root and Shoot Length

Shoot length measured from cotyledonary node to the shoot tip and root length from cotyledonary node to primary root tip expressed in cm.

Plant survival

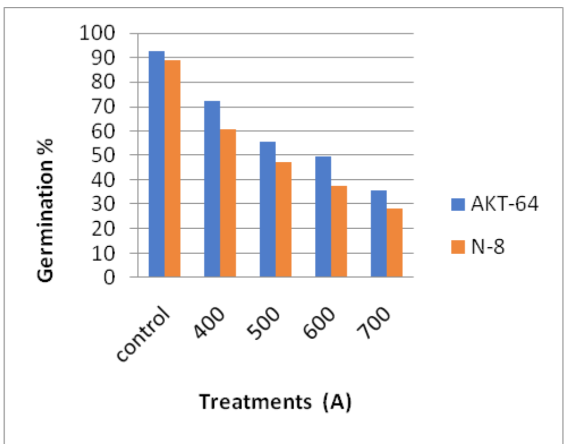
The survival percentage was worked out from the number of seeds germinated and number of plants at maturity by the following formula.

$$\text{Survival (\%)} = \frac{\text{Number of plants at maturity}}{\text{Number of seedlings germinated}} \times 100$$

Results and Discussion

The concept of "radiosensitivity" indicates a dose rate at which the biological materials exposed to the radiation experience detectable effects (Van Harten, 1998). Therefore, the biological effects and relative mutagen sensitivity in the context of similarities and dissimilarities of the sesame genotypes AKT-64 and N-8 in regard to radiation sensitivity were investigated.

The germination percentage of mutated seeds ranged from 72.22% (400Gy) to 35.78% (700Gy) for AKT-64 and from 60.44% (400Gy) to 28.44% (700Gy) for N-8. Significant reduction in germination per cent was exhibited by both AKT-64 and N-8. However, the highest percentage of reduction in seed germination was observed at 700Gy (28.44%) of N-8 and 35.78% for AKT-64 respectively (Table 1 and Fig.1). The LD_{50} was found to occur at a dose of 600Gy for the AKT-64 genotype and 500Gy for the N-8 genotype. Response of the genotypes for the dose which causes 50% reduction in seed germination percentage was different because of their genetic background. The works of Emrani *et al.* (2011); Anbarasan *et al.* (2013); Anbarasan *et al.* (2015), in various sesame genotypes observed a dose dependent reduction in germination percentage. Seed germination is inhibited by gamma rays because they interfere with the altered seeds' metabolic process, producing physiological alterations and chromosomal damage (Sjodin, 1962 and Sinha and Godward, 1972). Above results in accordance with various earlier researchers as follows; Kumari *et al*. (2016) reported LD_{50} at 450-600Gy dose for LKT-4 variety of sesame; Layrisse *et al.* (1992) recorded LD_{50} at 630Gy dose in Venezuelan sesame cultivars whereas Rajaramadoss *et al.* (2014) reported a similar result of reduced germination with increased doses of gamma rays.



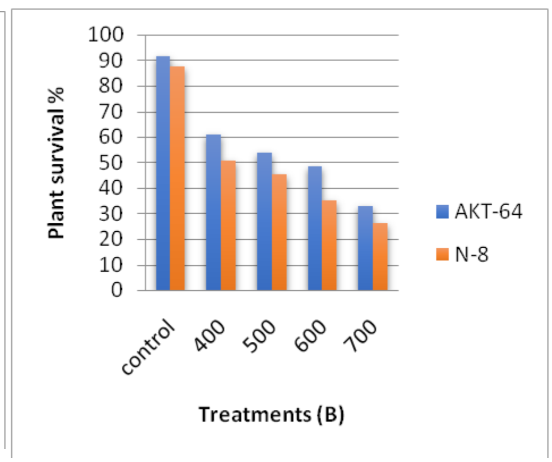


Fig. 1. Effect of gamma rays on seed germination (A) and Survival percentage (B)

Table 1. Effect of gamma radiation on sesame genotypes in M_1 generation.

Genotypes	Doses of Gamma rays	Germination (%)	Germination Per cent over control	Root length (cm)	Shoot length (cm)	Seedling height (cm)	Seedling Injury (%)	Plant survival (%)	Reduction in survival over control
AKT-64	Control	92.44	-	5.34	6.64	11.98	-	91.49	-
	400	72.22	33.37	4.52	5.22	9.74	17.71	60.96	47.52
	500	55.56	41.32	5.12	5.72	10.84	10.25	53.69	65.49
	600	49.56	46.90	3.98	3.6	7.58	36.34	48.58	71.29
	700	35.78	64.16	2.48	1.8	4.28	59.02	32.79	85.90
N-8	Control	88.67	-	5.24	5.88	11.12	-	87.80	-
	400	60.44	42.44	3.20	4.22	7.42	33.23	50.54	60.54
	500	47.11	48.19	3.50	5.12	8.62	20.86	45.49	72.28
	600	37.33	59.84	3.18	3.8	6.98	37.42	35.26	83.14
	700	28.44	69.87	2.42	2.06	4.48	59.34	26.45	90.23

The root lengths of gamma-irradiated plants and control plants varied significantly in both genotypes of sesame. According to Table 1, The length of the root decreased gradually from 4.52 cm (400Gy) to 2.48 cm (700Gy) for AKT-64 and from 3.20 cm (400Gy) to 2.42 cm (700Gy) for N-8. Similarly, shoot length decreased from 5.22 cm to 1.8 cm and 4.22 cm to 2.42 cm for AKT-64 and N-8 respectively (Table 1). The 700Gy dose induced the smallest root lengths (2.48 cm in AKT-64 and 2.42 cm in N-8) in both genotypes. Higher shoot length was found in lower gamma rays doses. Maximum shoot length was observed in the genotype, 500Gy dose in both the genotypes. The maximum root and shoot length were obtained in both of the controls as compared to treated seeds. Similar results of shorter roots in sesame plants treated with gamma rays were reported by Kumari *et al.* (2016).

In both genotypes, the maximum seedling injury over control was noted at a dose of 700Gy (59.02% in AKT-64 and 59.34% in N-8), while the minimum seedling injury was noted at a dose of 500Gy (10.25% in AKT-64 and 20.86% in N- 8). Significant differences between genotypes were found in both root and shoot length due to their difference in radio sensitivity. N-8 observed significant root and shoot length reduction than AKT-64. Similar results were reported by Pradhan *et al.,* (2019); Rajaramadoss *et al.* (2014) and Anbarasan *et al.* (2015) for a dose dependent relationship for root length, shoot length and seedling height of M_1 generation.

Survival percentage decreased significantly at 700Gy (26.45%) for N-8 and for 32.79% AKT-64. At 400Gy of both genotypes showed an uptrend in reduction of plant survival than the remaining doses (60.96% and 50.54% of AKT-64 and N-8 respectively). Highest percentage of reduction in plant survival was recorded at 700Gy of N-8 (90.23%) and AKT-64 (85.90 %) (Table 1 and Fig.1). The effect of gamma rays highly pronounced in plant survival rate for both the genotypes under study. The lowest reduction in survival percentage was observed at 400Gy for AKT-64 and N-8 (47.52 % and 60.54% respectively). Similar result were recorded by the earlier researchers, Anbarasan *et al.* (2013); Kumari *et al.* (2016); Uttarde *et al.* (2020); Raut *et al.* (2021) in sesame in which they observed a steady decrease in survival rate with an increasing dose of mutagen. In terms of survival rate N-8 was found to be more radiosensitive than AKT-64. Similar studies on the effect of mutagens on M_1 parameters have revealed similar results in a variety of crops, including soybean, sesame, and pigeon pea. Because of the genetic abnormalities brought on by higher mutagen doses, treated seeds and M_1 plants have lower survival rates.

From the study, variety AKT-64 showed high germination percentage, plant survival (%) root and shoot length in all the treatments than N-8. Gamma rays has proven to be a possible and more efficient mutagen to induce essential economic mutations in AKT-64. The results also suggest that the lower doses or concentrations of mutagen are more effective and efficient than the higher doses to exploit desirable mutants, However, it is possible to successfully increase the genetic variability in sesame by using the lower doses of mutagens used in the current study.

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Conflict of Interest- None

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