MUTAGENIC EFFECTS OF GAMMA RAYS ON VEGETATIVE GROWTH OF THREE SESAME (*Sesamum indicum* L.) VARIETIES

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ABSTRACT

The effects of gamma irradiation on three Nigerian sesame varieties: NCRIBEN 04E, NCRIBEN 01M and NCRIBEN 03L was observed to determine the genetic variability of the varieties due to the irradiation treatment. Three grams (3g) of each variety was divided into five groups and exposed to gamma irradiation from the Cobalt-60 source at 50, 100, 150 and 200 Gy; with the fifth group being an un-irradiated control (tagged as 0 Gy). The irradiated seeds along with their respective controls were grown to maturity using a Factorial Experiment with Complete Randomised Block Design Method. There were significant differences ($P \leq 0.05$) between the plants of each variety at the different doses of gamma irradiation for the emergence count, germination percentage, plant height, length of petiole, number of leaves per plant and leaf surface area observed. The results recorded no significant difference ($P \leq 0.05$) in the emergence count and germination percentage of the NCRIBEN 04E variety in both the control and the 50 Gy dose (7.67 and 84.67% respectively). The highest germination percentage (90%) was observed in the NCRIBEN 03L variety at the 200 Gy dose. NCRIBEN 04E recorded the highest plant height at 6 weeks after planting (20.86 cm) at 150 Gy dose. This value was significantly different from the control (16.31 cm). The highest number of capsules in NCRIBEN 03L variety (26.17) was recorded at the 200 Gy dose and its lowest value (11.83) was recorded in the 100 Gy dose. The NCRIBEN 01M variety recorded the highest surface area at the 100 Gy dose (28.25 cm^2). It was observed that there were significant positive correlations ($P \leq 0.05$) between the plant height with increasing irradiation doses of NCRIBEN 04E at the 4^{th} (0.745) and 6^{th} week after planting (0.705). A significant positive correlation (0.847) was also recorded between the leaf surface area and irradiation doses of the NCRIBEN 03L variety. This observed variability for the vegetative parameters with varying doses of gamma irradiation is an indication of the possibilities of gamma rays in causing variations that could be explored for further improvement of the sesame varieties.

Keywords: Gamma irradiation, Sesame, Varieties, Vegetative, Dose

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INTRODUCTION

Sesame, also known as beniseed is one of the oldest cultivated plants (Sudhir *et al.*, 2001). It is an important oil-yielding crop (Chung *et al.*, 2003) and is grown in the tropical and subtropical regions of the world within the rainy and dry season (Gandhi, 2009). Sesame has many species, most being wild and native to sub-Saharan Africa. *Sesamum indicum*, the cultivated type, originated from India (Pham, 2011) and is tolerant to drought-like conditions, growing where other crops fail (Jayakumar *et al.*, 2015). In Nigeria, *S. indicum* and *S. radiatum* are the indigenous species and are naturally self-pollinated (Falusi and Salako, 2001). Sesame seed is highly rich in quality proteins and essential amino acids (Bedigian, 2000), especially methionine which is considered as a rejuvenative and anti-aging for human body (NAERLS, 2010). Sesame seed is also a rich source of linoleic acid, vitamins E, A, B1, B2 & niacin and minerals including calcium, manganese, magnesium, iron, zinc and phosphorus (Tunde-Akintunde *et al.*, 2012). The high level of polyunsaturated fatty acids (PUFAs) in sesame oil is claimed to reduce blood cholesterol, high blood pressure and play an important role in preventing atherosclerosis, heart diseases and cancers (Hibasami *et al.*, 2000; Miyahara *et al.*, 2001). It is these attributes that motivate interests in the production of the crop.

Mutation breeding by gamma rays is one of the most powerful methods for introducing a wide genetic variability in crops, as well as developing new varieties (Animasaun *et al.*, 2014). They are effective in improving growth and quality of plants, through their high mutation frequency; and can interact with atoms and molecules, thus producing free radicals in cells that affect the morphology, anatomy, biochemistry and physiology of the plants (Chahal and Gosal, 2002; El-Khateeb *et al.*, 2016). Sesame is a very important economic crop plant and the demand for the crop and its products is very high. However, the low seed yield has been discouraging to farmers and breeders, especially in Nigeria, and this has led to the general low production of the crop in the country, subsequently leading to a deficit in the breeding and improvement of the crop. Insufficient genetic variability has also been identified as one of the major problems in breeding programmes which also affects the yield of the crop due to the limited parental stock for breeding.

The successful utilization of gamma rays to generate genetic variability in plant breeding has been reported in sesame. It has been observed that induced mutations can lead to changes in the morphological parameters as well as increase yield and other quantitative traits in sesame (Ghanei *et al.*, 2013; Ravichandran and Jayakumar, 2014; Falusi *et al.*, 2015). This can thus result in the development of new varieties.

MATERIALS AND METHODS

Three varieties of sesame, NCRIBEN 04E, NCRIBEN 01M and NCRIBEN 03L varieties were collected from the National Cereal Research Institute (NCRI) Badeggi, Niger State. The seeds were divided into five groups and irradiated at the Centre for Energy Research and Training, Ahmadu Bello University Zaria, Kaduna State, at doses of 0, 50, 100, 150 and 200 Gy using a Cobalt-60 source. The seeds were tested

for viability before and after irradiation using the Germination Test method.

Evaluation of the effects of the gamma irradiation doses on the sesame varieties was carried out at the Experimental Garden Department of Biological Sciences, Federal University of Technology, Minna. A Factorial Experiment with Complete Randomized Block Design (CRBD) method was adopted for the research. It consisted of thirty (30) pots per block with four replications. Sandy loam soil collected from an uncultivated land within the Experimental Garden was used to fill the planting pots to the brim. Ten seeds were planted per pot (i.e. five per hole in each pot). Three weeks after planting, each pot was thinned to two plants per pot.

The emergence count, germination percentage, plant height, length of petiole, number of leaves per plant and leaf surface area were observed and recorded following standard procedures. Data recorded was subjected to Analysis of Variance, Duncan Multiple Range Test and the Pearson's Linear Correlation. All parameters were considered significant at $P \leq 0.05$.

RESULTS

The effects of gamma irradiation on the vegetative parameters observed were presented in Table 1. There was a significant difference in the emergence count of the three varieties of sesame studied due to irradiation treatment. The highest emergence count in the ten (10) seeds planted per pot was observed in the 50 Gy dose of NCRIBEN 01M (7.83). This was significantly different from the emergence count observed in other doses. The least emergence count was recorded in the 50 Gy dose of NCRIBEN 03L (3.67) and was significantly similar to other doses of the variety with the exception of the control and the 150 Gy dose treatment. The lowest germination percentage was recorded in NCRIBEN 04E variety (76.33%) at the 200 Gy dose treatment and this value was significantly different from other doses. There was no significant difference in the germination percentage from the 0 Gy dose treatment, 50 Gy and 150 Gy dose of the same variety, although the 0 Gy and 50 Gy dose treatment were significantly the same (84.67% respectively).

There was no significant difference in the plant height of NCRIBEN 04E at the 50 Gy (4.38 cm), 100 Gy (3.73 cm) and 150 Gy (3.66 cm) dose treatment, and these values were significantly different from the other two doses. A similar trend was also observed in the 4th week after planting with the lowest and highest plant height also being recorded in the 0 Gy (8.43 cm) and 200 Gy (10.01 cm) dose of the variety respectively. In contrast, the NCRIBEN 01M variety recorded the highest plant height at 2 weeks after planting in the 200 Gy dose treatment (4.24 cm). This value was significantly similar with the plant height of the 0 Gy dose (4.05 cm) but significantly different from the plant height of other dose treatments. The NCRIBEN 03L variety which was exposed to 0 Gy showed the least plant height in all the varieties at 2 weeks after planting (3.35 cm).

The petiole length was recorded at 6 weeks after planting, on the 5th leaf from the base of each plant. The result showed significant variations from the control, in the petiole length of the three varieties of sesame, with the exception of the NCRIBEN 01M variety (Table 1). The

NCRIBEN 01M variety recorded no significant differences from the control in the petiole length of the variety. In the NCRIBEN 04E variety, the longest petiole length was observed in the 50 Gy dose (2.20 cm) of the variety and the least value was found in the 100 Gy (1.71 cm) dose treatment. The result for the number of leaves per plant also showed significant variations among the varieties. The least number of leaves for NCRIBEN 04E was observed in the 100 Gy dose (14.75) and this value was significantly different from other doses (Table 1). The 0 Gy (15.88), 50 Gy (15.50) and 150 Gy (16.00) doses recorded significantly similar number of leaves.

There were significant differences in the result for leaf surface area in all the varieties (Table 1), however NCRIBEN 01M showed a significantly higher leaf surface area (28.25 cm^2) at the 100 Gy dose and was significantly different from the leaf surface area of other doses (Table 1). The least surface area was found in the 50 Gy dose (13.30 cm^2), and this was significantly similar to the surface area recorded in the 150 Gy dose treatment (14.95 cm^2).

There was a significant positive correlation between the irradiation doses and the plant height of the NCRIBEN 04E variety at 4th (0.745) and 6th week (0.705) after planting (Table 2). The results also recorded a significant positive correlation between the irradiation doses and the germination percentage (0.934), length of petiole (0.698) and number of leaves per plant (0.836) for the NCRIBEN 01M variety (Table 2). There were significant correlations in all the vegetative parameters measured for the NCRIBEN 03L variety with the exception of the emergence count (-0.182) and [illegible] height at six weeks after planting (-0.455) which recorded a negative correlation (Table 2).

Discussion

The significant decrease in the emergence count of all the varieties observed in this research might be attributed to the gamma irradiation treatment. This may be as a result of the inhibitory effects of the mutagen on the seeds leading to a short cotyledonary emergence. This result is similar to the work of Boureima *et al.* (2009) who observed that higher doses of gamma irradiation can lead to a decreasing emergence count from the control in sesame cultivars. The progressive decrease in the germination percentage of the NCRIBEN 04E variety at higher doses of the mutagen as observed in this research may be attributed to disturbances at cellular level caused either at physiological (or) physical level. This result is in line with the work of Anbarasan *et al.* (2013) who also reported a progressive decrease in the germination percentage of sesame varieties with an increasing gamma irradiation treatment. However, the increasing germination percentage observed in both NCRIBEN 01M variety and the NCRIBEN 03L variety is in contrast to Anbarasan *et al.* (2013); but similar to the work of Shekari *et al.* (2015) who also reported an increase in the germination percentage of sesame lines with an increase in ultrasonic treatments. These variations between the varieties are indications of different genetic makeup.

The zigzagging mean plant height in the three varieties observed could also be as a result of the gamma irradiation treatment. The pronounced increase in

plant height with an increase in irradiation treatment as observed in this research may be as a result of increased production of growth hormones and cell elongation due to irradiation treatments. This result is in contrast with Boureima *et al.* (2009) and Begum and Dasgupta (2011) who both recorded a decrease in plant height of sesame due to an increasing dose of mutagen. However, the strong negative correlations also recorded in this research is in line with both authors and may be attributed to damage inducement following mutagenic treatment causing auxin destruction in the variety, thus leading to a plant with shorter plant height.

The positive correlation for number of leaves per plant observed in this research is an indication of an increase in the parameter with increasing doses of gamma irradiation doses, as reported by Nura *et al.* (2013) who reported an increase in the leaf number of sesame variety due to induced mutagenesis. The non-significant correlation also recorded for number of leaves is an indication of no significant increase in the parameter with increasing doses of gamma irradiation as reported by Falusi *et al.* (2015). This may be due to the radiation resistant nature of sesame. An increase in the leaf surface area of the sesame varieties due to gamma irradiation treatment is an indication of an increased surface area for gaseous exchange, and might have positive correlation with yield parameters. This is in agreement with the work of Nura *et al.* (2013) who also observed an increase in the leaf surface area of sesame varieties due to induced mutation. This may be as a result of an increase in cell number due to the irradiation treatment.

CONCLUSION

It can be concluded that gamma irradiation doses between 50 to 200 Gy was able to cause variability among the sesame varieties used in this study. The results from the vegetative parameters of the three varieties revealed NCRIBEN 03L to be the most sensitive to the irradiation doses, although, different doses tend to favour certain vegetative traits in the sesame varieties. Thus, gamma irradiation can serve as a useful tool for creating useful variability in sesame.