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VEGETATIVE IMPROVEMENT OF THREE NIGERIAN SESAME VARIETIES AFTER FNI TREATMENT

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Abstract: The effects of Fast Neutron Irradiation (FNI) from an Americium Beryllium source with a flux of 1.5 × 10^4 n cm^{-2} s^{-1} on select vegetative parameters of three Nigerian sesame (*Sesamum indicum* L.) varieties were investigated. Seeds of Kenana-4 , Ex-Sudan and E-8 were irradiated with 4, 8, 12 and 16 µSv doses of FNI before they were grown to maturity, alongside their respective controls (0 µSv dose of FNI). The vegetative parameters investigated included percentage survival, petiole length, number of leaves per plant, leaf surface area and plant height. There were significant differences ($p<0.05$) between the different doses of FNI for all three varieties. Correlations between irradiation doses and morphological parameters were generally highest in E-8, followed by Kenana-4, while Ex-Sudan showed the weakest correlations, suggesting that E-8 was the most sensitive to FNI. Thus, FNI can induce genetic variability in sesame and may be important for sesame breeders who seek to expand the genetic base of their breeding material.

Key words: sensitivity, FNI, morphological parameters, sesame, genetic improvement

Introduction

Sesame (*Sesamum indicum* L.; Pedaliaceae), an annual oilseed plant, has a rich history of cultivation in Asia [BISHT & al. 1998]. The most cultivated *Sesamum* species is *S. indicum* [ASHRI, 1998], an important edible oil crop in many regions of the world that may have originated from Africa, which is where the greatest diversity of the genus *Sesamum* and its family, Pedaliaceae, is present [FALUSI & al. 2001]. Mutation technology has been used to produce many cultivars with improved economic value and to advance the study of plant genetics and development [RANALLI, 2012]. Genetic variability for desired characters can be successfully induced through mutations, with high practical value in plant improvement programs [FAHAD & SALIM, 2009]. Mutation breeding employing fast neutron irradiation (FNI) has been used to develop new varieties of pepper [FALUSI & al. 2012].

Ionizing radiation has been routinely used to generate genetic variability in sesame for breeding and genetic studies and is a way to supplement existing germplasm with additional variation and to improve existing cultivars [BOUREIMA & al. 2009]. Since FNI-induced mutations in sesame could be useful as a new source of altered germplasm, our objective was to assess the impact of FNI on vegetative parameters of three sesame varieties grown in Nigeria. A previous study using the same experimental design and cultivars indicated that FNI could improve reproductive characteristics and oil-related properties [MUHAMMAD & al. 2013].

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Materials and methods

Following the protocol of [MUHAMMAD & al. 2013], seeds of three varieties of sesame (Ex-Sudan, Kenana-4 and E-8) were obtained from the National Cereal Research Institute (NCRI) Baddegi, Niger State, Nigeria. Seeds of each variety were divided into 5 groups. Group I was not exposed to FNI and served as the control. The remaining four groups were irradiated with FNI for 30, 60, 90 and 120 min (resulting in 4, 8, 12 and 16 µSv, respectively) at the Centre for Energy and Research Training (CERT), Ahmadu Bello University, Zaria, Kaduna State, Nigeria. Pot experiments were conducted during the 2012 rainy season (May-August) at the Biological Garden, Federal University of Technology, Minna, Niger State, Nigeria. A randomized block design with 30 pots/block was used. The experiment was replicated four times, with a total of 120 pots. Ten seeds were planted per pot (i.e. 5/hole/pot). Three weeks after planting, each pot was thinned to two plants/pot and 8 pots/treatment combination were used. The physical and chemical properties of the soil were analysed at the Nigerian Institute for Science Laboratory Technology (NISLT), Ibadan, Nigeria (see Tab. 1, [MUHAMMAD & al. 2013]). No fertilizer was applied. When the crop began to flower, an insecticide (pyrethroid cypermethrin, 10-15 L/ha with controlled droplet application using spinning disc sprayers) was applied to prevent insect-borne diseases.

Plant height (cm) was measured at 2, 4 and 6 weeks after planting (WAP) and plant survival (%) was assessed 21 days after planting (DAP). Two morphological parameters were assessed at 6 WAP (petiole length (cm) and leaf surface area (LSA; cm^2)), two leaf samples randomly from every plant and 10 plants/treatment.

All data (except survival %) were subjected to analysis of variance (ANOVA). Significant differences between means were assessed by the least significant difference (LSD) test ($P \leq 0.05$). Pearson's correlation was used to assess the relationship between treatments and parameters.

Results and discussion

Significant differences ($P \leq 0.05$) were observed for all the vegetative parameters of sesame plants after exposure of seeds to different doses of FNI except for number of leaves/plant and LSA, which were statistically equal in Kenana-4 and E-8 (Tab. 1). Similar effects of FNI on morphological and yield traits were reported by FALUSI & al. (2012) in *Capsicum annuum* (peppers) and on reproductive (floral) and oil-related parameters by MUHAMMAD & al. (2013) in the same sesame cultivars. There were both positive and negative correlations between vegetative parameters and FNI level (Tab. 2). The strong positive correlation (0.953) observed for LSA (Tab. 2) in E-8 is an indication that an increase in FNI dose also increased this parameter. However, the negative correlations (Tab. 2) between morphological parameters and FNI doses are in agreement with MUHAMMAD & al. (2003) who studied the sensitivity of five *Oryza sativa* (Basmati rice) varieties to different doses of gamma-rays and observed that seedling emergence, panicle fertility and grain yield declined with increasing dose in all varieties. The positive correlations observed are, on the other hand, in agreement with FALUSI & al. (2012a, 2012b) on pepper in which yield parameters such as number of fruits/plant, number of seeds/fruit, length of fruit, width of fruit and fruit weight increased significantly as

irradiation exposure period increased. FALUSI & al. (2012a) observed that an increase in FNI irradiation dose in *Capsicum annuum* var. *accuminatum*, *C. annuum* var. *abbreviatum* and *C. annuum* var. *grossum* increased plant height, number of leaves/plant, fruits/plant, seeds/fruit, weight, length and width of fruits. The survival percentages of the three sesame varieties at different doses of FNI are shown in Tab. 3. In this study, an increase in FNI dose increased select vegetative traits. The differences observed among the varieties might be due to varietal responses to irradiation as reported by PATHIRANA & SUBASINGBE (1993), also in sesame in response to gamma radiation, and by MUHAMMAD & al. (2013) for the same sesame cultivars as this study. In contrast, the IAEA (1994) reported that sesame seeds are resistant to gamma irradiation. Moreover, seeds may be resistant to irradiation, as reported by PATHIRANA & SUBASINGBE (1993) and the IAEA (1994). In this study, vegetative parameters were most sensitive to 12 µSv. FNI has the potential to create genetic variability in sesame, and this is important for breeders seeking to expand the genetic base of their breeding material.

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Tab. 1. LSD of or select morphological parameters of three sesame varieties at different doses of FNI

	Plant height (cm)			At 6 weeks		
Treatment combinations	2 weeks	4 weeks	6 weeks	Length of petiole (cm)	Number of leaves/plant	Leaf surface area (cm^2)
Kenana-4						
0 µSv	6.67 ± 1.67 a	23.43 ± 5.29 bc	59.65 ± 14.61 a	3.72 ± 1.80 b	10.00 ± 1.16 a	36.64 ± 14.76 a
4 µSv	5.53 ± 1.29 b	20.83 ± 5.78 c	58.19 ± 16.03 a	3.80 ± 1.28 b	9.00 ± 1.25 a	33.04 ± 9.32 a
8 µSv	6.43 ± 1.71 a	21.24 ± 3.64 b	35.52 ± 19.76 b	3.53 ± 0.76 b	11.00 ± 1.90 a	35.52 ± 19.76 a
12 µSv	6.42 ± 1.28 a	25.79 ± 3.38 c	32.21 ± 10.32 b	5.08 ± 1.33 a	11.00 ± 2.18 a	32.21 ± 10.32 b
16 µSv	6.40 ± 1.84 a	20.75 ± 2.41 c	35.87 ± 13.71 b	2.11 ± 0.53 c	10.00 ± 0.95 a	35.87 ± 13.71 a
Ex-sudan						
0 µSv	7.15 ± 1.75 a	27.21 ± 4.69 a	69.90 ± 12.4 a	4.05 ± 1.48 c	11.00 ± 1.77 b	38.49 ± 17.25 b
4 µSv	7.33 ± 1.75 a	21.65 ± 2.87 d	67.54 ± 14.25 ab	4.53 ± 1.13 ab	11.00 ± 0.97 b	38.06 ± 6.86 b
8 µSv	6.97 ± 0.87 ab	26.31 ± 4.24 b	27.64 ± 8.77 c	3.88 ± 1.39 c	9.00 ± 0.82 b	27.64 ± 8.77 b
12 µSv	6.76 ± 1.52 ab	26.30 ± 3.73 bc	62.17 ± 21.51 b	5.80 ± 2.74 a	16.00 ± 7.65 a	62.17 ± 21.51 a
16 µSv	6.55 ± 1.12 c	24.49 ± 3.48 c	31.95 ± 7.68 c	4.18 ± 1.02 b	10.00 ± 0.57 b	31.95 ± 7.68 b
E-8						
0 µSv	6.51 ± 1.12 b	20.91 ± 1.93 c	49.19 ± 13.35 b	2.01 ± 0.55 c	10.00 ± 1.29 a	36.64 ± 6.787 a
4 µSv	6.89 ± 1.25 a	22.72 ± 3.10 bc	53.75 ± 12.34 a	3.05 ± 0.90 b	9.00 ± 0.99 a	33.04 ± 7.11 a
8 µSv	6.13 ± 1.36 b	21.27 ± 3.44 c	30.80 ± 6.49 c	2.34 ± 0.78 bc	11.00 ± 1.73 a	35.52 ± 6.49 a
12 µSv	5.76 ± 1.50 b	24.61 ± 3.83 a	36.20 ± 10.47 c	3.75 ± 1.34 ab	10.00 ± 1.16 a	32.21 ± 10.47 a
16 µSv	6.38 ± 0.84 b	24.04 ± 3.14 b	37.83 ± 15.34 c	4.26 ± 2.11 a	10.00 ± 1.42 a	35.87 ± 15.34 a

*Values are mean ± SD. Values followed by the same letter(s) within the same column, assessed separately for each cultivar, do not statistically differ at the 5% level according to LSD, analysed for the treatment combinations.

Tab. 2. Correlations between various morphological parameters of three sesame varieties for all doses of FNI

	Plant height (cm)			At 6 weeks			
Variety	2 weeks	4 weeks	6 weeks	PL (cm)	NOL/P	LSA (cm^2)	Survival (%)
Kenana-4	0.126	-0.029	-0.865	-0.994	-0.834	-0.874	-0.048
Ex-Sudan	-0.907	-0.056	-0.631	-0.125	-0.129	-0.245	-0.233
E-8	-0.52	0.788	-0.667	0.998	0.757	0.953	-0.850

*PL = petiole length, NOL/P = number of leaves/plant, LSA = leaf surface area

Tab. 3. Survival percentage three sesame varieties at different doses of FNI (n = 11 per dose)

	E-8	Ex-Sudan	Kenana-4
0 µSv	50.00 ± 22.52 a	50.91 ± 26.96 a	38.18 ± 17.27 a
4 µSv	46.36 ± 30.68 a	37.27 ± 21.00 ab	32.73 ± 19.23 a
8 µSv	40.00 ± 26.43 a	36.36 ± 19.23 a	41.82 ± 22.52 a
12 µSv	45.45 ± 20.53 a	21.82 ± 14.14 b	27.27 ± 18.52 a
16 µSv	34.55 ± 28.25 a	46.36 ± 23.75 a	41.82 ± 34.62 a

*Values are mean ± SD. Values followed by the same letter(s) within the same column do not statistically differ at the 5% level according to LSD, analysed for the treatment combinations.