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Research Paper

Effects of fast neutron irradiation on yield parameters of two Nigerian Sesame cultivars

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ABSTRACT

The effects of Fast Neutron Irradiation (FNI) using an Americium-beryllium source with a flux of 1.5×10^4 $ncm^{-2}s^{-1}$ on the yield parameters of two cultivars of sesame (Ex- Sudan and E-8) were studied. Seeds of each of the cultivars were irradiated for 30, 60, 90 and 120 min (that is, 4, 8, 12 and 16 µSv doses of FNI) before they were sown with their respective controls in order to assess the effects of the different irradiation treatments on their yield parameters. While each of the two cultivars showed significant differences among the doses in terms of oil content at $p<0.01$, E-8 did not show any significant difference ($p \geq 0.05$) except for weight per capsule. Ex- Sudan on the other hand, showed significant differences ($p<0.05$) in yield parameters among the doses tested. Correlations between irradiation doses and the yield parameters also varied and they were generally higher in Ex-Sudan than in E-8 suggesting that Ex-Sudan was more sensitive to Fast Neutron Irradiation (FNI). FNI therefore, could serve as a valuable tool for the improvement of yield of the crop.

Key words: Americium-beryllium, sesame, yields parameters.

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INTRODUCTION

Sesame (*Sesamum indicum*) is a very ancient crop and one of the earliest domesticated oil crops in the world. It acquired the importance as a source of cheap vegetable oil and proteins, good source of natural oxidants (Sesamin and sesamolin) which are unique for sesame and present in the oil (Ashri, 2007).

The genus consists of about thirty six (36) species out of which the commonly recognized is *S. indicum* L. (Falusi, 2006). *S. indicum* and *Sesamum radiatum* are indigenous to Nigeria and naturally self-pollinated (Falusi and Salako, 2003). The crop is described as the "Queen of oil seeds" because of its high oil content (38 to 54%), protein (18 to 25%), calcium (Ca), phosphorous (P), oxalic acid and excellent qualities of the seed oil and meal (Prasad, 2002).

The world production of sesame has been fluctuating due to local economic, crop production disturbance and weather conditions (Morris, 2009). Although, the seeds are used as an ingredient in many different food supplies, a major part it is processed into oil and meal.

Sesame oil is an excellent vegetable oil because of its high contents of antioxidants such as sesamin, sesamol and sesamolin (Suja et al., 2004). The antioxidants make the oil very stable with a long shelf life (Suja et al., 2004). The high levels of Unsaturated Fatty Acids (UFA) and Polyunsaturated Fatty Acids (PUFAs) increase the quality of the oil for human consumption (Nupur et al., 2010).

Despite the potential for increasing production and productivity of the crop, there are a number of challenges and constraints inhibiting improvement, including the lack of improved cultivars and a poor seed supply system. Efforts have been made to genetically enhance the sesame through induced mutations (Ashri, 1982; Ranalli, 2012). Gamma rays at doses ranging from 150 to 800 Gy could successfully induce useful mutations while Fast Neutron Irradiation (FNI) doses of 30 and 80 Gy were effective for the induction of useful mutations in sesame (Ashri and van Zanten, 1994).

Falusi et al. (2012a) used 12 µS of FNI to increase fruit yield, width and length in pepper. The present work aimed to investigate the effects of Fast Neutron Irradiation (FNI)

Table 1. Some Physical and chemical properties of the soil used.

P^{H}	OC	OM	TN	Exchangeable cations (Cmol/kg)				EA (Cmol/kg)			
				Na	K	Ca	Mg	CEC (Cmol/kg)	Sand (%)	Silt (%)	Clay (%)
6.72	1.63	2.84	0.1	0.133	0.153	5.936	4.117	10.52	82.52	10.28	7.2

OC= Organic carbon; OM= organic matter; TN= total nitrogen; EA= exchange acidity; CEC= cation exchange capacity.

Table 2. Yield parameters of the two varieties at different doses of FNI.

Treatment combination	Number of flower/plant	Number of capsule/plant	Length of capsule (cm)	Weight of capsule (g)	Number of seeds per capsule
Ex-Sudan					
0 µSv	3 0 ± 13^{a}	34 ± 17^{a}	2.35 ± 0.17^{bc}	0.28 ± 0.05^{bc}	52 ± 09^{b}
4 µSv	31 ± 11^{a}	36 ± 20^{a}	2.49 ± 0.27^{b}	0.23 ± 0.05^{c}	47 ± 02^{b}
8 µSv	27 ± 10^{a}	35 ± 17^{a}	2.53 ± 0.20^{a}	0.30 ± 0.08^{bc}	50 ± 08^{b}
12 µSv	34 ± 27^{a}	46 ± 22^{a}	2.42 ± 0.26^{b}	0.31 ± 0.09^{b}	53 ± 08^{ab}
16 µSv	24 ± 10^{a}	30 ± 11^{a}	2.55 ± 0.16^{a}	0.32 ± 0.06^{a}	59 ± 05^{a}
E-8					
0µ Sv	20 ± 04^{a}	26 ± 13^{a}	2.35 ± 0.19^{a}	0.44 ± 0.10^{b}	49 ± 06^{a}
4 µSv	21 ± 11^{a}	25 ± 16^{a}	2.19 ± 0.26^{a}	0.56 ± 0.09^{a}	53 ± 06^{a}
8 µSv	18 ± 05^{a}	22 ± 09^{a}	2.19 ± 0.34^{a}	0.33 ± 0.09^{c}	50 ± 08^{a}
12 µSv	21 ± 10^{a}	22 ± 11^{a}	2.32 ± 0.32^{a}	0.33 ± 0.12^{c}	49 ± 09^{a}
16 µSv	21 ± 10^{a}	21 ± 05^{a}	2.29 ± 0.45^{a}	0.15 ± 0.04^{d}	48 ± 13^{a}

*Values are mean ± SD. Values followed by the same letters within the same row do not statistically differ at the 5% level.

on yield parameters of two Nigerian cultivars of sesame.

MATERIALS AND METHODS

Seeds of two cultivars of sesame (Ex-Sudan and E-8) were obtained from the National Cereals Research Institute (NCRI) Baddegi, Niger State, Nigeria. Seeds of each variety were divided into 5 groups. The first group was not exposed to FNI and served as the control, while the remaining four groups were irradiated with fast neutrons for 30, 60, 90 and 120 min (resulting in 4, 8, 12 and 16 µSv doses, respectively) at the Centre for Energy and Research Training (CERT), Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

Field experiments were conducted during the 2012 rainy season between May and August in the Biological Garden, Federal University of Technology, Minna, Niger State, Nigeria. The arrangement used was a Randomized Block Design (RBD) with 30 pots per block. The experiment was replicated four times, with a total of 120 pots. Ten seeds were planted per pot (that is, 5 per hole in each pot). Three weeks after planting, each pot was thinned to two plants per pot. A total of 8 pots for each treatment combination were used.

The physical and chemical properties of the oil used were determined using the procedures adopted by International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria and the result is shown in Table 1. The flowering percentage at 45 days after planting (for each treatment) was taking as number of plants bearing flower over the total number of the treated plant with a given dose. The Length of capsule, number of seeds per capsule, number of capsules per plant and weight per capsule were taken at maturity and the oil content of the seeds from each treatment.

Data collected were subjected to analysis of variance (ANOVA) to show whether there were significant differences among the yield parameters. Duncan multiple range test was used to separate the means. The Pearson's correlation was also used to show relationships between the irradiation level and the parameters.

RESULTS AND DISCUSSION

While Ex- Sudan showed significant differences ($p<0.05$) in all the parameters except for number of flower per plant, number of capsule per plant and percentage flowering, E-8 however, showed no significant differences ($p \geq 0.05$) except for weight per capsule which was significantly different ($p<0.05$ (Table 2 and Figure 1).

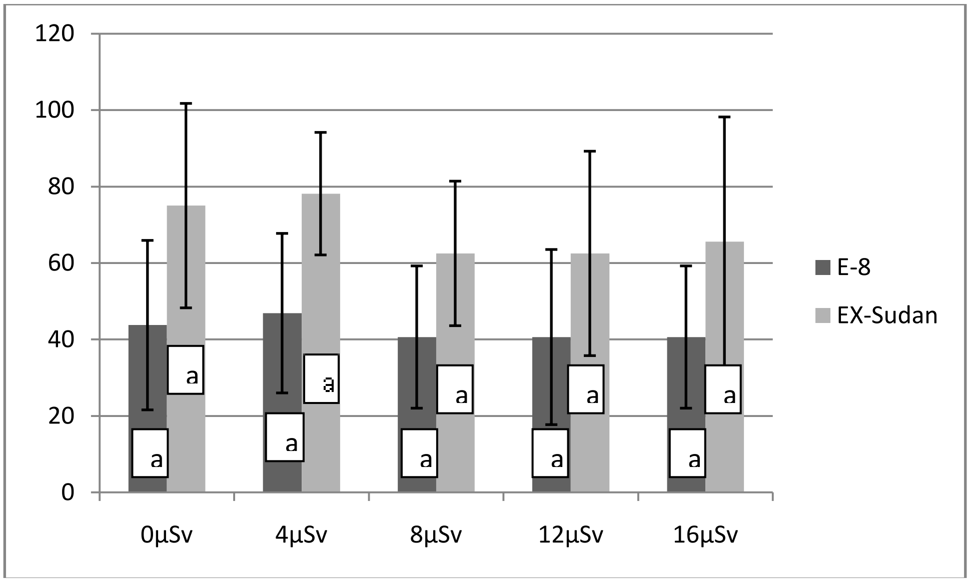

Figure 1. Percentage oil of two sesame varieties at different doses of FNI; * bars represent mean ± SD; bars of the same colour with the same letter are not significantly different at 0.01 level of significance.

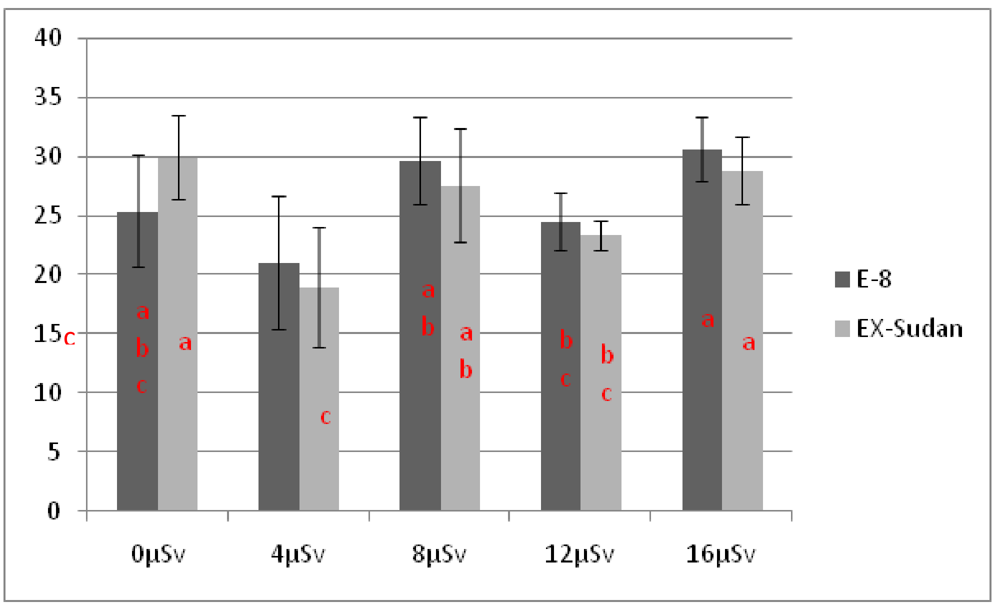

Figure 2. Percentage oil of two sesame varieties at different doses of FNI; *the bars represent mean ±SD. Bars of the same colour with the same letter are not significantly different at 0.01level of significance.

Similarly, the two cultivars showed significant differences in percentage oil at $P \leq 0.01$ (Figure 2). These variations are in conformity with the reports of Falusi et al. (2012a, 2012b) on *Capsicum annum*, Hegazi and Hamideldin (2010) on *Abelmoschus esculentus* (okra), Adamu and Aliyu (2007) and Asmahan and Nada (2006) on *Lycopersicum esculentum* (tomato).

On the other hand, the correlations between the various parameters and the irradiation doses indicate a general shift from the controls (Table 3). The positive correlations obtained are in line with Falusi et al. (2012a). They reported positive correlations between the irradiation exposure period with certain morphological and yield traits. The negative correlations observed with respect to

Table 3. Correlations of the various yield parameters with the irradiation doses.

Variety	Yield parameters						
	NOF/P	**NOC/P**	**LOC (cm)**	**WPC (g)**	**NOS/C**	**Oil%**	**FLW%**
Ex-Sudan	-0.344	0.047	0.632	0.714	0.716	0.073	-0.707
E-8	-0.430	-0.291	-0.213	0.265	0.086	0.562	-0.707

*NOF/P= Number of flower/plant, NOC/P= number of capsule/plant, LOC=length of capsule, WPC= weight/capsule, NOS/C= number of seed/capsule, FLW%= flowering percentage.

some of the parameters on the other hand, imply that as the irradiation level increases, these parameters decrease. This is close to the findings of Muhammad et al. (2003) who reported that seedling emergence, panicle fertility and grain yield of Basmati rice declined with increasing dose level in all the varieties of Basmati rice studied.

The variation in the strength of correlation coefficients in this study might be due to the fact that the radiosensitivity varies among sesame cultivars and that the seeds are highly resistant to irradiation as reported by Pathirana and Subasingbe (1993) and IAEA (1994). The doses generally do not show many differences in their effects; however, the correlations showed that Ex-Sudan was more sensitive to FNI with respect to yield parameters. Thus, FNI has the potential to create genetic variability in yield parameters of sesame.

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