EVALUATION OF GAMMA IRRADIATED MUTANTS OF SESAME (*Sesamum indicum* L.) FOR YIELD AND YIELD PARAMETERS

Ahmed, K.[1], Muhammad, M. L.[1,2], Daudu, O. A. Y.[1], Abubakar, I.[2], Audu, M. A. I.[1] and Idris, Y.[1]

[1] Department of Plant Biology, Federal University of Technology, Minna, Niger State
[2] Rice Research Program, National Cereals research institute Badeggi, Niger State

ABSTRACT: Mutation breeding is applied in many crop improvement programs as it can rapidly create the variability of inherited traits in crops. This study was designed to evaluate the yield potential of some mutant (M_4) lines of sesame. Eleven M_4 mutant lines alongside three checks were raised to maturity in a randomized complete block design (RCBD) in Minna and trial fields of National Cereals research institute, Badeggi. The results revealed M_5 mutant lines showed significant changes in some of the parameters measured. Site1 (Minna) showed improved yield traits than Site2 (Badeggi). ML11A11 exhibited the lowest days to 50% flower (47.00; 41.33). ML1A9 site1 showed the highest 1000 seed weight (3.02g), ML3A7 in site1 (2.41 g). The capsule per leaf axil in C1A12 Site2 obtained the highest (2.67). ML4A6 Site1 showed highest number of capsule (123.67). The highest yield per hectare was recorded mutant ML8A2 Site1 (779.63 kg/hectare); ML6A4 Site1 (681.86 kg/hectare); (672.59 kg/hectare). The results especially for yield, revealed the possibility of new varieties of sesame from the mutant lines, thus presenting gamma irradiation as a very effective mutagen for improvement of the crop.

Keywords: breeding, mutation, parental stock,

***Corresponding author**: kabiruahmed2@gmail.com

INTRODUCTION

Sesame (*Sesamum indicum* L.) belongs to the family Pedaliaceae and is known under various names such as til, gingelly, sim-sim, gergelim (Mohamed *et al.*, 2022). Muhammad *et al.* (2018), opined that sesame is locally called in Nigeria by different names; 'Ridi' in Hausa, 'Esso' in Nupe, 'Eeku' in Yoruba and 'Ekuku' in Igbo. Sesame is one of the oldest aromatic, medicinal, and oilseed crops in the world and is native to tropical and subtropical regions (Kavak and Boydak, 2006; Tufail *et al.,* 2020). Due to its increasing export value, its production area has expanded to arid and semi-arid regions in Africa, Asia and South America (Anilakumar *et al.,* 2010; Weldemichael *et al.,* 2021).

Food and Agriculture Organization (FAOSTAT) (2022), reported that sesame is grown on a global area of about 12.82 million hectares (ha), and Sudan, India, and Myanmar lead in terms of the harvested area, with 5,173,521, 1,520000 and 1,500,000 ha, respectively. According to FAOSTAT (2022), more than 6.5 million tons (t) of sesame seeds were produced globally in 2020. In Nigeria, Sesame seeds are mainly grown in the northern part of Nigeria. It is grown in States such as Benue, Kano, Jigawa, Katsina, Kogi, Nassarawa, Gombe, Kebbi, Plateau, Bauchi, Taraba, Kaduna, Kwara, Borno and Yobe States (Yakubu and Yusuf, 2020). The world volume of exports and imports is about 560,000 metric tons yearly with an annual growth rate of 2.6- 4% of this gross value is taken up by Nigeria and it is the second largest producer of Sesame seed in Africa and also ranked 7th in the world (Yakubu and Yusuf, 2020). The global demand and trade of sesame seeds have increased rapidly over the past two decades (Dossa *et al.,* 2017). Although the global sesame cultivation area is expanding, especially in Africa, productivity and yield are still very low, resulting in a huge gap between seed supply and demand (Sarkar *et al.,* 2016). In order to address these challenges, there is need to develop new improved varieties through technologies like induced mutation. Gamma ray is one of the most effective physical mutagens and most mutant varieties developed using a physical mutagen registered at the Mutant Variety Database (Joint FAO/IAEA) resulted from exposure to gamma rays (Hase *et al.*, 2020).

There is no doubt the ever-increasing human population is directly tied to food security. It has created pressure to increase crop production including sesame in many countries, leading to expansion of land area dedicated to farming. This is unsustainable but the only sustainable approach is cultivation of improved varieties with significant yield advantage over existing one. Therefore, aim of this study was to evaluate some mutant lines of sesame for yield and yield parameters in order to identify the lines with higher yield potentials.

MATERIALS AND METHODS

The study was conducted in two stations. Station 1 was located at Minna; Station 2 was located at National Cereal Research Institute, Badeggi. A total of 14 entries (11 mutants and 3 checks) were raised in a plot size of 3 x 3 M_2 in three replicates. In each plot, the planting space was 20 x 20 cm. An average of 3 seeds per hole was observed. The experiment was conducted between the months of August, 2021 and December, 2021 planting season. Data recorded were based on the methods stated in the standard descriptors of sesame by IPGRI and NBPGR (2004). They include; Days to 50% flowering, number of capsules per leaf axil, number of capsules per plant, yield per plot and one thousand (1000) seed weight.

Data analyses

The data were subjected to Randomized Complete Block Design combined analysis of variance (ANOVA) at P=0.05 using Statistical Tool for Agricultural Research (STAR) by International Rice Research Institute (IRRI) 2013 - 2020 All rights reserved.

RESULTS AND DISCUSSION

The results showed significant ($p < 0.05$) difference among the genotypes for each trait, hence, indicating evident variability among the mutant lines for the characters studied. There was significant variation in the days to 50% flower of the mutants in both sites. ML1A9 (50.33 ± 1.67), ML2A8 (49.00±1.00) and ML3A7 (50.67±0.66) in site1 recorded the highest number of days to 50% flowers than all mutants in both sites (Table 1). There was no significant difference in the 1000 seed weight of the mutants both sites. However, ML1A9 (3.02g; 2.98g) recorded the highest 1000 seed weight. The mutant lines showed consistent number of capsules per axil in both sites. ML1A9 and ML4A6 in site1 obtained (1.67), while ML2A8 (2.67), C1A12 (2.67), ML4A6 (3.00) in site2 recorded the highest number of capsules per axil. ML4A6 (123.67), ML10A10 (112.33) in site1 and C1A12 site2 (86.00) recorded the highest number of capsules per plant. ML8A2 (779.63 kg ha-^{1}), ML6A4 (681.11kg ha-^{1}), ML11A11 (672.58 kg ha-^{1}) in site1 while ML1A9 (664.81 kg ha-^{1}), ML8A2 (650.74 kg ha-^{1}) and ML10A10 (641.11) in site2 recorded the highest yield.

The significant variations recorded in plant yields could be due to exposure to higher doses of gamma rays. This study revealed the days to 50% flower range of (41.00 - 50.33). A similar result was obtained from the study of Suha and Paul (2017) who reported the ranges for days to 50% flowering from 43.03 to 56.77 days in sesame. The delay in flowering might be attributed disturbances in biochemical pathway which aid in synthesis of flower inducing substances as reported by Veni *et al.* (2016). The range of 1000 seed weight (2.42-3.02) observed in this study is not too far from those (2.87 -3.15 g) reported by Pavani *et al.* (2020). Similarly, Zebib *et al.* (2015) mentioned mass of 1000 seeds (2.7 to 3.1 g) for different sesame cultivars. The number of capsules per plant range (25.67-123.67) is lower than Aristya *et al.* (2018), who reported (274.57) in sesame irradiated at 400 Gy. However, Saha *et al.* (2017) reported (31.45) at 300 Gy nine sesame mutants. *Shamsiah et al.* (2022), reported high number of fruits (8/plant) in *Capsicum annuum* irradiated with 80 Gy and 40 Gy. The evident rise observed in the number of capsules per plant of some mutants could be associated to the stimulatory effects of gamma rays on capsule or pod formation and differences in the genetic makeup of these genotypes (Sabiel *et al.*, 2015).
The yield per hectare recorded range (389.63-779.63 kg ha-^{1}) is slightly higher than Saha and Paul (2017), who reported (324.2 kg ha-^{1}) in M1 generation of sesame at 450 Gy. Koitilio *et al.* (2018), reported range (409 - 1838 kg ha-^{1}) in sesame

Conclusion

Sufficient genetic variation exists among the mutant lines for seed yield and other yield traits. Gamma irradiation induced mutation with a high genetic level on sesame yield components. The variations expressed in the mutant lines provide a huge scope for the selection of promising genotypes. The mutant lines show a high potential for varietal release.

REFERENCES

Anilakumar, K. R., Pal, A., Khanum, F. and Bawa, A. S. (2010). Nutritional, medicinal and industrial uses of sesame (*Sesamum indicum* L.) seeds – An overview. *Agric Conspec Science*, 75: 159-168.

Aristya, V. F., Taryono. and Wulandari, R. A. (2018). Yield Components of some sesame mutant populations induced by gamma irradiation. *Buletin Tanaman Tembakau, Serat & Minyak Industri,* 10(2): 64–71.

Dossa, K., Diouf, D. and Wang, L. (2017). The emerging oilseed crop *Sesamum indicum* enters the "Omics" era. *Frontier Plant Sciences,* 8: 11-54.

FAOSTAT (Food and Agriculture Organization of the United Nations database). 2022.

IPGRI and NBPGR (2004). Descriptors for Sesame (Sesamum spp.). International Plant Genetic Resources Institute, Rome, Italy; and National Bureau of Plant Genetic Resources, New Delhi, India. ISBN 92-9043- 632-8.

Kavak, H. and Boydak, E. (2006). Screening of the resistance levels of 26 sesame breeding lines to Fusarium wilt disease. *Plant Pathology Journal,* 5: 157–160.

Koitilio, B., Kinyua, M.., Kiplagat, O., Pkania, K., Chepkoech E., and Kimno S. (2018). Morphological Characterization of Selected Sesame (*Sesamum Indicum* L.) Genotypes in Western Kenya. *African Journal of Education, Science and Technology,* 4 (4):10-16.

Mohamed, K., El-Harfi, M., Hanine, H., El-Fechtali, M. and Nabloussi, A. (2022). Moroccan sesame: Current situation, challenges, and recommended actions for its development. Oilseeds & fats Crops and Lipids. *OCL,* 29: 27.

Muhammad, M. L., Falusi, A. O., Adebola, M. O., Oyedum, O. D., Gado, A. A. and Dangana, M. C. (2018). Spectrum and Frequency of Mutations Induced by Gamma Radiations in Three Varieties of Nigerian Sesame (*Sesamum indicum* L.). *Notulae Scientia Biologicae,* 10(1): 87-91.

Pavani, K., Ahamed, M, Ramana, J. V. and Sirisha, A. B. M. (2020). Studies on genetic variability parameters in sesame (*Sesamum indicum* L.). *International Journal of Chemical Studies,* 8(4): 101-104.

Saha, and Paul, A. (2017). Gamma irradiation effect on yield and yield attributing traits of sesame (*Sesamum indicum* L.) In M_1 generation. *Journal of Pharmacognosy and Phytochemistry,* 6(5): 1311-1315.

Saha, S. Begum, T and Dasgupta. T. (2017). Effects of gamma rays on some yield parameters of four Indian sesame (*Sesamum indicum* L.) cultivars in M_2 generation. *Journal of Crop and Weed,* 13(2): 15-19.

Sarkar, P. K., Khatun, A. and Singha, A. (2016). Effect of duration of waterlogging on crop stand and yield of sesame. *International Journal Innovation and Applied Studies,* 14(1): 1.

Shamsiah, A., Norumaimah, O., Nur Amalina, F. S., Susiyanti, AbdulRahim, H. and Shuhaimi, S. (2022). Effects of gamma irradiation on agromorphological characteristics of chilli (*Capsicum annuum* L.) var. Kulai. *Food Research* 6 (1): 45 – 52.

Tufail, T., Riaz, M., Arshad, M. U., Gilani, S. A., Ain, H. B. U., Khursheed, T., Islam, Z., Imran, M., Bashir, S., Shahid, M..Z. and Kazmi, S. M. U. (2020). Functional and nutraceutical scenario of flaxseed and sesame: A. *International Journal of Biosciences,* 17: 173-190.

Veni, K., Vanniarajan, C.and Souframanien, J. (2016). Effect of Gamma Rays on Quantitative Traits of Urdbean in M_1 Generation. *Advances in Life Sciences,* 5(6): 2066-2070.

Weldemichael, M. Y., Baryatsion, Y. T. and Sbhatu, D. B. (2021). Effect of sodium azide on quantitative and qualitative stem traits in the M2 generation of Ethiopian sesame (*Sesamum indicum* L.) genotypes. The *Scientific World Journal,* 1-13.

Yakubu, Z. and Yusuf, S. H. (2020). Problems facing sesame production: a case study of Hadejia local government, Jigawa state, Nigeria. *International Journal of Agriculture, Environment and Bioresearch,* 5(6): 288-298.

Table 1. Yield parameters of M_4 generation of irradiated sesame lines

Mutants	Pedigree	Days to 50%F		1000-seed weight	
		Site1	Site 2	Site1	Site 2
ML1A9	04E450G1-3	50.33 ± 1.67ab	41.33 ± 0.58a	3.02 ± 0.02a	2.98 ± 0.01a
ML2A8	04E450G2-3	49.00 ± 1.00ab	43.00 ± 0.33a	2.86 ± 0.02abc	2.81 ± 0.02abcd
ML3A7	04E450G3-3	50.67 ± 0.66ab	43.00 ± 0.00a	2.41 ± 0.03e	2.42 ± 0.04e
C1A12	0	47.00 ± 0.00b	42.3 3± 0.33a	2.59 ± 0.05bcde	2.57 ± 0.01bcde
ML4A6	01M350G2-22	47.00 ± 0.00b	41.00 ± 0.00a	2.66 ± 0.12bcde	2.67 ± 0.16abcde
ML5A5	01M350G1-21	48.00 ± 1.00b	42.67 ± 1.67a	2.56 ± 0.01cde	2.54 ± 0.05bcde
ML6A4	01M550G2-2	49.00 ± 1.45ab	41.00 ± 0.00a	2.61 ± 0.10bcde	2.64 ± 0.06abcde
ML7A3	01M350G1-2	47.00 ± 0.00b	41.67 ± 0.67a	2.52 ± 0.04de	2.49 ± 0.09cde
C2A13	0	53.67 ± 3.67a	41.67 ± 0.67a	2.78 ± 0.05abcd	2.81 ± 0.05abcd
ML8A2	03L550G1-2	47.00 ± 0.00b	43.33 ± 0.67a	2.85 ± 0.03abc	2.81 ± 0.04abcd
ML9A1	03L450G2-2	47.00 ± 0.00b	43.33 ± 0.88a	2.61 ± 0.11bcde	2.60 ± 0.11bcde
ML10A10	03L250G1-1	47.00 ± 0.00b	42.67 ± 0.33a	2.52 ± 0.02de	2.49 ± 0.06de
ML11A11	03L2501-11	47.00 ± 0.00b	41.33 ± 0.89a	2.87 ± 0.06abc	2.86 ± 0.08ab
C3A14	0	49.66 ± 1.45ab	43.00 ± 1.00a	2.91 ± 0.041ab	2.86 ± 0.04abc

Values along the same column with different superscript are significantly different at $p < 0.05$

Table 2: Yield parameters of M_4 generation of irradiated sesame lines

Mutants	Pedigree	Number Capsule per Axil		Number of capsules	
		Site1	Site 2	Site 1	Site 2
ML1A9	04E450G1-3	1.67 ± 0.33a	1.33 ± 0.33b	77.67 ± 2.60b	51.67 ± 8.11bcd
ML2A8	04E450G2-3	1.00 ± 0.00a	2.67 ± 0.00a	61.33 ± 2.60bc	38.00 ± 1.33cde
ML3A7	04E450G3-3	1.00 ± 0.00a	1.00 ± 0.00b	72.00 ± 8.50b	34.33 ± 2.19de
C1A12	0	1.33 ± 0.33a	2.67 ± 0.33a	32.00 ± 0.58d	86.00 ± 1.00a
ML4A6	01M350G2-22	1.67 ± 0.33a	3.00 ± 0.00a	123.67 ± 3.18a	60.33 ± 9.82bc
ML5A5	01M350G1-21	1.00 ± 0.00a	1.00 ± 0.00b	39.67 ± 5.21cd	25.67 ± 0.33e
ML6A4	01M550G2-2	1.00 ± 0.00a	1.33 ± 0.33b	75.00 ± 3.61b	39.33 ± 2.96cde
ML7A3	01M350G1-2	1.00 ± 0.00a	1.33 ± 0.33b	44.00 ± 3.79cd	42.00 ± 2.65cde
C2A13	0	1.00 ± 0.00a	1.00 ± 0.00b	45.67 ± 13.86cd	41.67 ± 2.33cde
ML8A2	03L550G1-2	1.00 ± 0.00a	1.00 ± 0.00b	79.00 ± 2.08b	51.33 ± 3.38bcd
ML9A1	03L450G2-2	1.00 ± 0.00a	1.00 ± 0.00b	46.00 ± 1.53cd	32.67 ± 1.45de
ML10A10	03L250G1-1	1.00 ± 0.00a	1.00 ± 0.00b	112.33 ± 3.84a	60.00 ± 1.73bc
ML11A11	03L2501-11	1.00 ± 0.00a	2.67 ± 0.33a	57.67 ± 2.03bc	44.33 ± 2.03bcde
C3A14	0	1.00 ± 0.00a	1.00 ± 0.00a	61.00 ± 3.79bc	65.33 ± 2.03ab

Table 2 cont.

Mutants	Pedigree	Gross yield (kg ha-1)	
		Site 1	Site 2
ML1A9	04E450G1-3	588.14	664.81
ML2A8	04E450G2-3	538.52	478.52
ML3A7	04E450G3-3	495.56	630.00
C1A12	0	383.70	412.97
ML4A6	01M350G2-22	305.92	578.52
ML5A5	01M350G1-21	471.11	389.63
ML6A4	01M550G2-2	681.11	542.97
ML7A3	01M350G1-2	534.44	425.19
C2A13	0	623.33	558.52
ML8A2	03L550G1-2	779.63	650.74
ML9A1	03L450G2-2	636.67	420.00
ML10A10	03L250G1-1	574.44	641.11
ML11A11	03L2501-11	672.58	501.11
C3A14	0	612.97	404.08

Values along the same column with different superscript are significantly different at $p < 0.05$