The Effects of Fast Neutron Irradiation on the Leaf Morphology of *Capsicum Annuum L*

Falusi, O.A., and Daudu, O. Y.

***Abstract*—**In order to assess the effect of fast neutron irradiation (FNI) on the leaf morphology of *Capsicum annuum,*), dry seeds of the varieties were exposed to fast neutron irradiation (FNI) from an Americium Beryllium source with a flux of 1.5 × 104 n.cm-2 s-1. Five irradiation treatments, 0, 30, 60, 90, and 120 min. have been tried. The treated seeds were sown with their respective controls and the effects on the leaf of the plants were studied. The results obtained showed that all irradiation treatments caused leaf morphological abnormalities, such as leaves with reduced size, leaves with invaginated or inverted margins, or with a blunt or bifurcated apex, when compared with control plants. There was an increase in leaf abnormalities with increase in the duration of fast neutron irradiation (FNI). 120 min was identified as the most effective irradiation period to induce leaf morphological abnormality in the plants .This information could be used by breeders to produce useful mutations for yield and other parameters in pepper.

***Keywords*—**Americium-Beryllium, *Capsicum annuum* ,Fast neutron, *leaf abnormalities*.

I. Introduction

CAPSICUM spp. belong to the nightshade family, *Solanaceae [1]*. The genus consists of over 100 species and even more botanical varieties [2,3].These include five domesticated species, namely *C. annuum*, *C. frutescens*, *C. baccatum*, *C. chinense* and *C. pubescens*, all believed to have originated from the New World[4,5]. *C. annuum* and *C. frutescens* are the most recognized species grown in commercial quantities all over Nigeria[6,7]. These two species form an important ingredient in people's diet the world over [1], due to the pungency of the fruits, resulting from the high concentration of capsaicinoid alkaloids [5]. In addition, *Capsicum* spp. are a rich source of vitamins A and C (ascorbic acid) [8,2]. *Capsicum* fruits are also popular as food spices, colouring agent, as well as pharmaceutical ingredients[9]. In African medicine, *Capsicum* spp. are used in treating sore throat[10]. Capsaicin is used mainly in topical medications in modern medicine as a circulatory stimulant and analgesic. These popular uses of *Capsicum* peppers have fuelled an increasing demand for the crop, and a search for simple but viable ways of increasing supply of the product, independent of man-power and the adequacy of farming conditions. Thus, attention has gradually shifted towards improving the genetic quality of the species through plant breeding and selection. One possible means is through radiation-induced genetic variability. The FAO [11] reported that 2008 marked the 80th anniversary of mutation induction in plants. The application of gamma rays and other physical mutagens such as fast neutrons has generated a vast amount of genetic variability and has played a significant role in plant breeding and genetic studies[12]. The widespread use of induced mutants in plant breeding programmes throughout the world has led to the official release of more than 2700 plant mutant varieties [11]. The present work aimed to investigate the response of three botanical varieties of *C. annuum* to different doses of fast neutron irradiation (FNI) for different time periods on leaf characteristics.

Falusi, O.A. is with the Dept of Biological Sciences, Federal University of Tech. Minna, Nigeria Daudu O.Y. is also with the Dept of Biological Sciences, Federal University of Tech. Minna, Nigeria . Corresponding author Phone : +2348036732588 E mail: falusiolamide@gmail.com.

II. Materials And Methods

Fresh fruit of three pepper botanical varieties (50 fruits each) were bought from a local farmer in Minna, Niger State, Nigeria. The fruits were maintained in separate polythene bags. The varieties were identified as *C. annuum* var.*accuminatum* Fingerh (MN/SH/001), *C. annuum* var. *abbreviatum* Fingerh (MN/AR/002), and *C. annuum* var.*grossum* Sendt (MN/AT/003) (Table 1) using a taxonomic aid provided by Simmond, [13], as well as morphological descriptions of Hutchinson and Dalziel [14], [15] and [10]. Each fruit of three *Capsicum* varieties were cut open and their seeds were removed, kept separately in three trays and sundried for 8 h. The dry seeds were irradiated with FNI at the Centre for Energy and Research Training (CERT), Ahmadu Bello University, Zaria, using an Americium- Beryllium source with a flux of 1.5 × 104 n.cm-2 s-1 for 0,30, 60, 90, and 120 min. The equipment used was a Miniature Neutron Source Reactor (MNSR) designed by the China Institute of Atomic Energy (CIAE) and licensed to operate at a maximum power of 31 kW [16].The sun-dried seeds were tested for viability using the floatation method [17] before FNI treatment. Treated seeds (100 from each treatment) were then sowed in nursery trays to obtain seedlings, and then transplanted into 3.5-L plastic pots containing garden soil, at a rate of three seedlings per pot after 4 weeks in the nursery. No fertilizer was applied although, when the crop began to flower, an insecticide (Pyrethroids cypermethrin at the rate of 10–15 l ha–1 with controlled droplet application using spinning disc sprayers) was applied to prevent insect-borne diseases. The planted seeds were watered once daily between 5.00 and 6.30 pm using borehole water. Each treatment was replicated four times using a completely randomized design (CRD). At maturity , leaves were collected from100 plants for each variety to assess the effect of the different doses of FNI on the leaf morphology.

TABLE I
DESCRIPTION OF THE PEPPER (*CAPSICUM* SPP.) VARIETIES USED IN THIS STUDY

Code number	Source	Local name	Botanical name	Description
MN/SH/001	Minna	Ata Shombo	*C. annuum* var. *accuminatum* Fingerh	Medium-sized annual plant, long pointed and pendant fruits with hot taste, one pedicel per node
MN/AR/002	Minna	Ata Rodo	*C. annuum* var. *abbreviatum* Fingerh	Medium-sized annual plant, small oblong and wrinkled fruits with hot taste, one pedicel per node
MN/AT/003	Minna	Ata Tatase	*C. annuum* var. *grossum* Sendt	Short annual plant, medium size, bell shaped fruits with mild taste, one Pedicel per node

III. RESULTS AND DISCUSSION

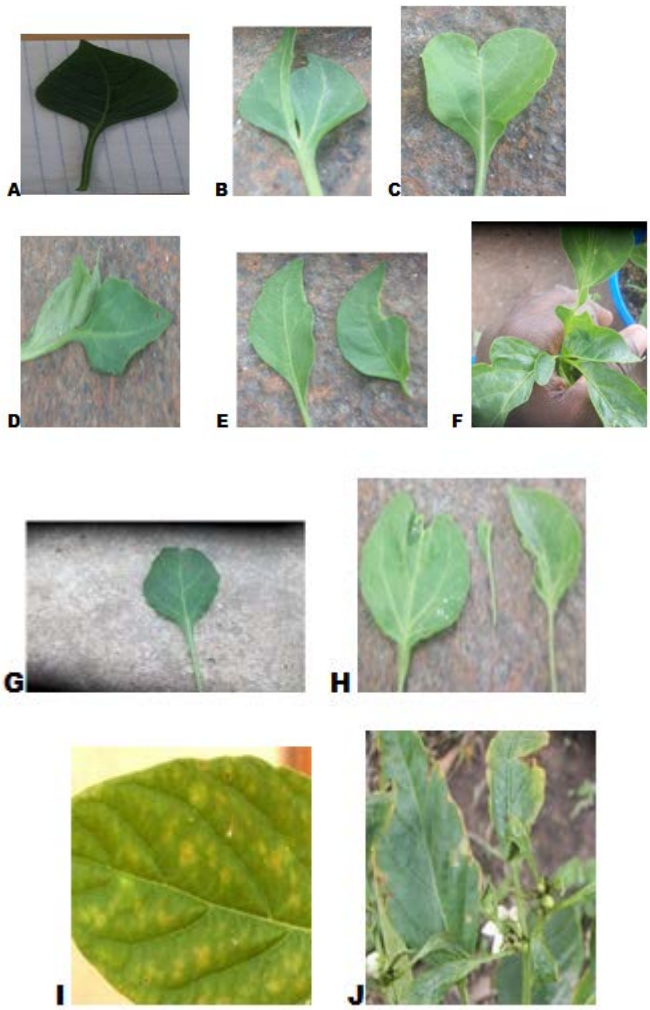
The leaf, one of the most conspicuous organs of higher plants, is the main site of primary productivity. In addition to their main role in light harvesting, leaves are also important for nutrient storage, defense, and stress responses. It was observed that all radiation treatments caused leaf morphological abnormalities, such as leaves with reduced size, leaves with invaginated or inverted margins, or with a blunt or bifurcated apex, when compared with control plants. Leaf abnormalities with different frequencies were observed in all treated plants. The frequencies of these anomalies have been presented in Table 2. While leaves with reduced size , leaves with invaginated margins and bifurcated apex were observed in high frequency, those with deformed leaves and necrotic margins were rare in all treated plants (Table 2).

The observed leaf morphological abnormalities among the different pepper plants are indications that fast neutron irradiation could affect plant leaves and productivity. This is similar to Shah *et al*., [18], Khan and Alam [19] and Islam *et al*.,[20] who reported leaf morphological abnormalities in *Crotalaria saltiana* and *C. juncea* treated with ionizing radiation. A similar result was also obtained by Adamu *et al*., [21] in Maize plants irradiated with thermal neutron.

TABLE II
INDUCED LEAF MORPHOLOGICAL ABNORMALITIES EXPRESSED AS PERCENTAGES IN CAPSICUM ANNUUM WITH DIFFERENT IRRADIATION TREATMENTS

Treatments Irradiation periods/min	No of leaves Observed	Shape of leaves				
		Invaginated or inverted margins	Blunt or bifurcated apex	Reduced size	Deformed	Bifoliage
0 (control)	300	-	-	-	-	-
30	300	0.14	0.18	0.22	0.10	0.05
60	300	0.46	0.38	0.40	0.24	0.27
90	300	0.52	0.66	0.55	0.42	0.36
120	300	1.02	1.22	1.04	0. 66	0.53

The frequency of leaf morphological abnormalities registers increase with increase in the duration of treatment. The highest frequency was recorded in 120 min FNI treatment. It emerges that the most potent FNI treatment for inducing leaf morphological abnormalities in *Capsicum annuum* pepper is 120 minutes. Further cytogenetic studies will help explain the immense diversity in leaf shape and leaf size observed in this study.



Plates A-J: A. Normal leaf of C annum var accuminatum, B. The leaf that turned bifoliage (30 min IEP), C Leaf with bifurcated apex, D. A leaf with another leafy outgrow at the petiole (90 min IEP), E. Leaves showing invaginated margins (120 min IEP), F.Leaves with dented margin, G. Leaf with bifurcated apex (60 min IEP), H. Leaf with curved apex, the middle leaf is small with dented margin, the third leaf has invaginated margin. (60 minutes irradiation exposure).,I. Leaf showing chlorophyll mosaic. J. Leaves showing necrotic margins

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