EFFECTS OF FAST NEUTRON IRRADIATION ON SELECTED NIGERIAN COWPEA (*Vigna unguiculata* (L.) Walp) LANDRACES

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Abstract

Induction of beneficial mutants was intended when different landraces of cowpea were exposed to different doses of fast neutron irradiation (FNI). Cowpea as an economically important crop in sub-saharan Africa was selected to broaden the available gene pool for selection and improvement of the crop. Six cowpea (Vigna unguiculata (L.) Walp) landraces namely Milki, Jan wake, Dan Shika, Kannanado, Black eye pea and Sampea7 were exposed to varying doses (3.44×10^{-2} μs, 6.88×10^{-2} μs, 10.32×10^{-2} μs and 13.76×10^{-2} μs) of fast neutron irradiation derived from an Americium-Beryllium source with a flux of 0.86×10^{-2} μsh^{-1}. Results on effects of the different irradiation treatments on plant growth characters (germination percentage, survival to maturity, number of leafs per plant and total leaf area) at M_1 generation were determined. Result showed that all irradiation treatments caused a general significant ($P \leq 0.05$) reduction in germination percentage, survival to maturity, number of leafs per plant and total leaf area of the plants used in the study irrespective of the landrace. There was a greater reduction of plant growth characters at higher doses of 10.32×10^{-2} and 13.76×10^{-2} μs compared to lower doses of 3.44×10^{-2} and 6.88×10^{-2} μs. This study revealed an inhibitory vegetative growth performance of the cowpea landraces when exposed to higher doses (10.32×10^{-2} μs and 13.76×10^{-2} μs) of FNI. It is therefore, assumed that such inhibitory effects on vegetative parameters may lead to reduction in certain yield attributes of the plant.

Keywords: Mutants, fast neutron irradiation(FNI), germination percentage, growth characters.

INTRODUCTION

Vigna is a member of the Phaseoleae tribe of the Leguminosae family (Timko *et al.*, 2007). The genus consists of 27 species and 27 accepted taxa (USDA). Four subspecies of cowpea are recognised of which three are widely cultivated (*Vigna unguiculata* ssp. *cylindrica* (L) Verdc -catjang, *Vigna unguiculata* ssp. *sesquipedalis* (L) Verdc -yardlong bean, *Vigna unguiculata* ssp. *dekindtiana* (Harms) Verdc- black-eyed pea and *Vigna unguiculata* ssp. *unguiculata*- southern pea). In Africa, cowpeas are the most economically important indigenous food legume (Geonaga *et al.*, 2008) serving as source of livelihood to millions of people and provides cheap and nutritious food for relatively poor urban communities (IITA, 1997; and JIRCAS, 1997).

Genetic variability as a result of induced mutation by various mutagens has contributed to modern plant breeding and has played a major role in the development of superior plant varieties (Kharkwal and Shu, 2009). In cowpea (Dhanavel *et al.*, 2008), soybean (Padmavathi *et al.*, 1999) and black gram (Thilagavathi and Mullainathan, 2009), mutational breeding has been shown to be an important tool in developing plant characters. Mutation breeding has been found to enhance limited genetic variability in cowpea (Achaya *et al.*, 2007) and irradiation has been found to produce good mutation in plants and consequently good yield. Fast neutron irradiation has shown to be a very effective mutagen and has been successfully reported in many plants including *Capsicum annuum*, *Capsicum frutescens*, sesame, wheat, rice, bambara nut, soy beans, barley, Arabidopsis. Therefore, it may be possible to broaden the spectrum of cowpea germplasm for future selection and improvement by inducing mutations in the crop. This study therefore aimed to assess the effects of fast neutron irradiation on morphological traits of six cowpea (*Vigna unguiculata* L. Walp) landraces namely Milki, Jan wake, Dan Shika, Kannanado, Black eyed pea and Sampea 7.

MATERIALS AND METHODS

Six cowpea landraces widely cultivated in Zaria were used in this study. Certified seed materials of five (5) local cowpea landraces (Milki, Jan wake, Dan Shika, Kannanado and Black eyed pea) which were obtained from Giwa market in Giwa local government area of Kaduna state and one improved variety (Sampea 7) which was obtained from Institute for Agricultural Research (IAR, Zaria). The fast neutron source is a miniature neutron source reactor (MNSR) designed by the China Institute of Atomic Energy (CIAE) and licensed to operate at maximum power of 31kw (SAR, 2005) situated at the Radiology department, Centre for Energy Research Training (CERT), Ahmadu Bello University, Zaria. Seed samples (each 50 seeds) packed in polythene pouches were exposed to fast neutron irradiation for 4 hours, 8 hours, 12 hours and 16 hours at 3.44×10^{-2} μs, 6.88×10^{-2} μs, 10.32×10^{-2} μs and 13.76×10^{-2}μs derived from an Americium-Beryllium source with flux of 0.86×10^{-2} μsh^{-1}. Seed samples packed similarly without irradiation served as control. Five seeds were planted in each polythene bag and were arranged in a completely randomized block design (CRBD) with three (3) replications. The polythene bags had 50 cm row to row spacing and 20 cm between plants. No fertilizer was applied and the seeds were watered daily between 5-6pm using tap water. Plant growth parameters such as germination percentage, survival to maturity, number of leafs per plant and total leaf area were measured from each FNI treatment and control. The data collected were subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) was used to separate the means where there was significant difference.

RESULTS AND DISCUSSION

Irradiation has shown to produce beneficial effects in many crops, it has widely been reported to enhance both quantitative as well as qualitative traits (Ravichandran and Jayakumar, 2014) but the rate at which these traits are enhanced differ among plant species. Results showed notable reduction in germination percentage with an increase in the dose of irradiation except in Kanannado, Jan wake and black eye pea landraces (Table 1). The reduction in seed germination was not consistent for the six cowpea landraces. Kanannado landrace showed significantly the same germination percentage in the control, 3.44×10^{-2} μs and 6.88×10^{-2} μs dose of irradiation and also, equal germination percentage at $10.32\times10^{-}$μs and at 13.76×10^{-2} μs. The Jan wake landrace also showed equal germination percentage in the control and at 3.44×10^{-2} μs while the black eye pea landrace showed a significantly higher germination percentage at 10.32×10^{-2} μs when compared to other doses of the irradiation treatment used except the control. Reduction in germination percentage of the irradiated cowpea landraces could be as a result of decreased photosynthetic pigment caused by irradiation, similar finding was reported by *Marcu et al*. (2013) who stated that irradiation impacts the probability of seed germination and might result in long term effects on seedling.

Notable reductions were also observed in survival to maturity and number of leafs per plant of the irradiated cowpea landraces and as the dose increases, the percentage survival and number of leafs per plant decreases. However, Jan wake landrace showed greater reduction in survival to maturity and number of leafs per plant at a lower dose of 3.44×10^{-2} μ□. Black eye pea showed higher survival to maturity at a high dose of $10.32\times10^{-}$μs as shown in table 1 and could be an effective dose for improvement of the landrace. Adebola and Esson (2017) however reported an increase in number of leaves in irradiated bambara nut.

Leaf area also decreased proportionately with increasing dose of fast neutron irradiation in all the landraces except in Jan wake and black eye pea landraces which showed greater reduction at a lower dose of 3.44×10^{-2} μs. Reduction in leaf area maybe as a result of irradiation. Falusi and Daudu (2014) reported that irradiation treatments cause leaf morphological abnormalities such as leaves with reduced size in pepper, however, Abubakar *et al.* (2017) reported increase in leaf area of irradiated spinach.

This study showed inhibitory growth performance of the landraces at various doses of FNI used which is in line with findings from Abdelfattah *et al.* (2014) who used gamma irradiation to study its impact on growth and yield of some cowpea cultivars and reported that high dose of gamma irradiation caused detrimental damage on some of the cultivars, three of which failed to grow to maturity. Conclusively, the doses of FNI used decreased the morphological characters examined in this study.

Table 1: Effects of fast neutron irradiation on morphological traits of selected Nigerian cowpea (*Vigna unguiculata* (L.) Walp) landraces

	TREATMENT (µs)	GP(%)	SM(%)	LPP	LA(cm^2)
Milki	CONTROL	86.67±6.67^{a}	66.67±13.33^{a}	35.78±7.98^{a}	66.27±4.13^{a}
	3.44×10^{-2}	80.00±20.00^{ab}	46.67±24.04^{ab}	24.61±12.33^{ab}	38.97±5.69^{ab}
	6.88×10^{-2}	66.67±3.33^{b}	33.33±17.64^{b}	20.66±2.87^{b}	24.60±12.53^{ab}
	10.32×10^{-2}	53.33±24.04^{c}	33.33±13.33^{b}	9.83±4.94^{c}	18.93±9.81^{b}
	13.76×10^{-2}	53.33±17.63^{c}	33.33±17.64^{b}	9.17±4.60^{c}	16.87±8.44^{b}
Janwake	CONTROL	80.00±11.55^{a}	60.00±20.00^{a}	38.67±1.45^{a}	76.88±18.93^{a}
	3.44×10^{-2}	80.00±11.55^{a}	40.00±20.00^{ab}	20.77±10.44^{ab}	47.22±28.44^{ab}
	6.88×10^{-2}	73.33±26.67^{a}	53.33±17.64^{ab}	30.77±0.49^{ab}	76.75±14.74^{a}
	10.32×10^{-2}	73.33±6.67^{ab}	60.00±0.00^{b}	26.22±2.35^{b}	57.98±11.93^{b}
	13.76×10^{-2}	46.67±24.04^{c}	46.67±6.67^{b}	20.66±1.00^{b}	52.08±13.88^{b}
Danshika	CONTROL	93.33±6.67^{a}	66.67±6.67^{a}	35.33±0.96^{a}	102.43±7.74^{a}
	3.44×10^{-2}	73.33±13.33^{ab}	46.66±24.04^{a}	32.50±1.32^{a}	85.81±2.75^{ab}
	6.88×10^{-2}	60.00±20.00^{ab}	40.00±20.00^{ab}	30.84±2.19^{a}	79.82±4.67^{ab}
	10.32×10^{-2}	46.67±26.67^{b}	33.33±17.64^{b}	18.89±9.68^{a}	52.86±26.43^{b}
	13.76×10^{-2}	46.67±17.64^{b}	26.67±6.67^{b}	13.59±6.81^{ab}	48.92±24.96^{b}
Kanannado	CONTROL	93.33±6.67^{a}	86.67±6.67^{a}	50.99±1.07^{a}	124.12±4.49^{a}
	3.44×10^{-2}	93.33±6.67^{a}	80.00±11.55^{a}	43.48±2.98^{a}	73.24±2.99^{b}
	6.88×10^{-2}	93.33±6.67^{a}	46.67±13.33^{b}	31.27±15.76^{a}	55.28±9.16^{bc}
	10.32×10^{-2}	46.66±29.06^{b}	46.67±29.06^{ab}	29.88±1.74^{ab}	39.10±19.57^{bc}
	13.76×10^{-2}	46.67±29.06^{b}	13.33±13.33^{c}	9.17±9.17^{b}	17.31±17.31^{c}
Black eye pea	CONTROL	80.00±11.55^{a}	66.67±17.64^{a}	47.66±0.96^{a}	84.53±4.77^{a}
	3.44×10^{-2}	60.00±11.55^{b}	53.33±17.64^{ab}	41.61±3.39^{a}	72.55±6.21^{a}
	6.88×10^{-2}	60.00±20.00^{ab}	46.67±13.33^{b}	39.71±6.26^{a}	82.68±1.35^{a}
	10.32×10^{-2}	73.00±6.67^{b}	60.00±11.55^{ab}	33.72±8.25^{a}	78.98±6.86^{a}
	13.76×10^{-2}	60.00±20.00^{ab}	33.33±13.33^{c}	28.00±6.66^{b}	74.64±1.23^{a}
Sampea 7	CONTROL	80.00±0.00^{ab}	53.33±6.67^{a}	37.11±2.41^{a}	104.43±5.76^{a}
	3.44×10^{-2}	80.00±11.55^{a}	46.67±17.64^{a}	36.28±3.91^{a}	82.84±2.47^{ab}
	6.88×10^{-2}	73.33±6.67^{ab}	46.67±13.33^{ab}	31.04±15.53^{b}	72.92±36.71^{a}
	10.32×10^{-2}	60.00±0.00^{b}	40.00±23.09^{a}	25.94±1.97^{ab}	68.19±16.76^{ab}
	13.76×10^{-2}	46.67±17.63^{b}	20.00±20.00^{b}	9.00±9.00^{c}	19.52±19.52^{b}

Values are mean±SEM, means along the same column with different superscripts are significantly different at (P▯ 0.05).
GP: germination percentage, SM: survival to maturity, LPP: leaf per plant, LA: leaf area

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