# Effects of Microwave Radiation on the Germination and early growth of Some Indigenous Cowpea (*Vigna unguiculata*) Varieties in Nigeria

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**Abstract:** The exact biochemical processes by which microwave affects the functioning of living organisms is not very well understood. A study was carried out to investigate the effect of microwave radiation on the germination and early growth of four local cowpea varieties. The experiment consisted of two factors (i) Variety (Oloyin, Drum, Sokoto white and Katsina white) and (ii) Time of exposure of seeds to microwave rays. (0, 0.5, 1.0, 1.5, 2.0, 2.5 and 3 minutes). The treatment combination was laid out in a Randomized complete block design with two replicates. Result showed that the time of exposure significantly affected germination percentage, number of leaves and plant height throughout the period of observation. Exposure of seeds for 0.5min consistently had the highest germination from 4 days after planting (DAP), also there was a decline in germination with increase in exposure time above 1 minute. At 8 DAP, 0.5min exposure time had 23.0% better germination percentage than the untreated control. Furthermore, there was a 72.9% reduction in germination percentage for seeds that were exposed for 3 minutes compare with the control. Similar trend was observed for number of leaves and plant height. There was also significant (P< 0.05) difference among the varieties with Katsina white having the best germination percentage and drum having the least. These results are suggestive that exposure of cowpea seeds to microwave rays beyond 1 minute can be detrimental to the germination and early growth of cowpea seeds.

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## Introduction

Cowpea (*Vigna unguiculata* L. Walp,) is one of the important food legumes and a useful component of the traditional cropping systems in the semiarid tropics (Ayisi *et al.,* 2000; Singh *et al*., 2002). Cowpea adapts to harsh environments including extreme temperatures, drought and poor soil fertility. In poor environments it yields comparatively better than other food legumes (Shimelis and Shringani, 2010).

Several efforts to improve cowpea in Nigeria has lead to increase in yields per unit area, however these varieties are sometimes less-preferred by farmers due to their proneness to damages caused by insect pests such as aphids, thrips and storage pests particularly weevils. The yield level in the country is below the achievable yield of 1500 to 3000 kg/ha such as reported in Egypt and Malawi (Adeola *et al*., 2011). Therefore, there is utmost need of cowpea germplasm development and enhancement towards high yield, insect and pest resistance, and drought tolerance in the country. Despite the rich germplasm collections available by various national breeding programs and the IITA, the genetic base for most self-pollinating crops including cowpea is narrow for economic traits such as grain yield, yield components, drought and insect pest tolerance (Mudibu *et al*., 2012). Mutation breeding is helpful in pre-breeding or genetic enhancement aimed to develop suitable germplasm. Artificial mutagenesis may bring about fast and direct results to select useful traits unlike the conventional methods in which up to ten years of selections after extensive crosses are required in genetic advancement (Novak and Brunner, 1992). Mutations are the ultimate source of genetic variation, and provide unique germplasm, the raw material for plant breeders (van Harten, 1998). Mutation breeding has been used for generating genetic variation and breeding new varieties during the past decades (Ahloowalia *et al*., 2004; Tambe and Apparao, 2009). Recently the technique is being applied to generate mutants with altered agronomic traits for genetic studies and to predict the gene function through identification of an allelic series by Targeting Induced Local Lesions IN Genomes (Till *et al*., 2003).

Mutations can be induced in various ways, such as exposure of plant propagules, including seeds, tissues and organs, to physical and chemical mutagens (Mba et al., 2010). Physical mutagens are mostly electromagnetic radiations such as gamma rays, X-rays, UV light and particle radiation including fast and thermal neutrons as well as beta and alpha particles. Gamma irradiation is one of the main physical mutagens used to induce genetic variation. The effectiveness of a mutagenic treatment in inducing genetic variations in crop plants depends on the genetic constitution of test varieties and treatment dose, among others (Mba *et al.,* 2010). High doses of mutagenic treatment may destruct growth promoters, increase growth inhibitors and metabolic status of the seed and induce various chromosomal aberrations. Thus high radiation doses would be lethal rendering few plants for selection. This in turn limits the success of artificial selection in the subsequent mutation generations to identify useful mutants. Conversely, low radiation dose are accompanied by early emergence, increased percent germination and field survival with healthy and vigorous seedlings. However, this would possibly be associated with low mutation frequency with reduced selection response towards target mutants. Tshilenge – Lukanda *et al*., (2012) reported that normally genetic mutations occur spontaneously at low frequencies (10-5 to 10-8 per locus). Limited data is available that evaluated the response of different cowpea varieties at various gamma irradiation doses. Therefore, an appropriate dose of radiation should be established on target genotypes before large scale mutagenesis is undertaken (Tshilenge – Lukanda *et al*., 2012).

Tshilenge–Lukanda *et al*. (2012) described that the optimum mutation doses can be determined by recording the percentage seed germination, epicotyl and hypocotyl lengths, among others. In seed propagated crops such as cowpea. Microwaves are part of the electromagnetic Spectrum and are considered to be that radiation ranging in frequency from 300 million cycles per second (300 MHz) to 300 billion cycles per second (300 GHz), which correspond to a wavelength range of 1 m down to 1 mm. This nonionising electromagnetic radiation is absorbed at molecular level and manifests as changes in vibrational energy of the molecules or heat (Banik *et al*., 2003). The exact biochemical processes by which microwaves could affect the functioning of living organisms are not very well understood and the various experiments that microwave can affect plant growth and the prolonged exposure to microwave affects seed germination (Hamada, 2007; Aladjadjiyan, 2010; Salama et al., 2011). Oprica (2008) indicated that microwaves determined variations of catalase and peroxidase activities in *Brassica napus* depending on the microwave exposure time, age of the plants, and condition of seeds (germinated or non-germinated). It was noted that weak intensity of microwaves did not affect plant growth but increased doses slowed seed germination (Oprica, 2008).

Ponomarev *et al.* (1996) studied the direct effect of electromagnetic radiation of the microwave range (wavelength $\lambda$ = 1 cm, irradiation time up to 40 min) on the germination of cereals (winter and spring wheat, spring barley, oats). They established increased germination rate in all the tested seeds and reached optimal stimulating effect at 20 min exposure time. Therefore, the objective of this study was to determine the effect of microwave radiation on germination of four indigenous cowpea seeds at different exposure time.

**Material And Methods**

The experiment was conducted In the Laboratory of The Department of Crop, Soil and Environmnetal Science and the Teaching and Research Farm of the Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti during the early season of 2014.

The location lies between the latitude of $5^{o}45$'E and the longitude $8^{o}15$'N, in a tropical rainforest agro-ecological zone of Nigeria.

Seeds of *Vigna unguiculata* were collected from a popular local market (Oja-oba) in Ado-Ekiti and was exposed to radiation with the use of microwave i-wave LG set at low (300 MHz) per second. The experiment consisted of two factors variety; Oloyin, Drum, Sokoto white and Katsina white and time of exposure of the seeds to microwave rays (0, 0.5, 1, 1.5, 2, 2.5, and 3 min). The 28 treatment combination was laid out in a randomized complete block design and replicated three times to give a total of 84 experimental units. Fifty seeds were used for each experimental unit. After the exposure treatments, seeds were sown in plastic pots and kept under screen house condition. Data were collected on the following parameters: Germination rate (%), Number of leaves, Plant height. These variables were collected on day 3, 4, 5, 6, 7 and 8 of the experiment on all the experimental units. The data on the parameters measured were analyzed using analysis of variance (ANOVA) and where significant, means were separated by Duncan multiple range Test at 5% level of probability.

**Results And Discussion**

The results in Table 1 below shows the effect of the duration of exposure of four local cowpea varieties to microwave rays on the germination. Seeds that were exposed for 1.5 min has the highest germination rate in the first four days, subsequently seeds exposed to 0.5 minutes of microwave were consistently the highest from the 5th to the 8th day of observation. Also seeds exposed to 3 min of radiation consistently had the least germination. There appear to be a decline in the germination percentage with increase duration of exposure beyond 1 min. this result indicated that the radiation from microwave may have a detrimental effect on the viability of the cowpea seeds the findings of Aladjadjiyan, 2010 and Salama *et al*., 2011 corroborated these results.

Furthermore, on varietal basis, Kastina white variety has the highest germination percentage compared to other varieties. The percentage germination was 120.00% higher in katsina white compared with drum also at day 4 which there was 82.13%, at day 5 it gives

70.28% and at day 8 it gives 54.23%. Time and varieties are significantly different compared to control.

The result in Table 2 below shows the effect of microwave radiation on the number of leaves and plant height of 4 local varieties cowpea. All the varieties are significantly different compared to the control. sokoto and katsina varieties has the highest number of leaves compared to oloyin and drum varieties. sokoto variety gave the highest number of leaves at day 4, 5, 7 compared to oloyin.

With reference to the plant height, Sokoto and Katsina also gave the highest plant height compared to drum and oloyin at the percentage of 33.11% at day 4, 11.87% at day 5. Drum has the lowest plant height. The result in Table 3 below shows the effects of duration on exposure of four local cowpea varieties to microwave rays on the number of leaves and plant height. The seed that was exposed to 1.0 min duration has the highest number of leaves at the 4, 5, 6, 7 and 8 day and also the control. Also for plant height based on the duration of time, the plant height for the control, 0.5, 1.0, 1.5 and 2.0 follows the same trends compared to 2.5 and 3.0 minutes duration at the $4^{th}$ day while 1.0 minute duration has the highest plant height at the 5, 6, 7 and $8^{th}$ day respectively. These results showed the negative effect of mocrwave on the growth of cowpea, the result of Oprica (2008) on *Brassica napus* also indicated that microwaves determined variations of catalase and peroxidase activities of crops which depends on microwave exposure time.

TABLE 1: Effects of the duration of exposure of four local cowpea varieties to microwave rays on the germination.

| | Days after Planting | | | | | |
|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 |
| Time (Min) | Time of Exposure (T) | | | | | |
| 0 | $38.25^{c}$ | $51.75^{b}$ | $56.25^{b}$ | $60.75^{b}$ | $65.25^{b}$ | $62.25^{b}$ |
| 0.5 | $49.50^{b}$ | $58.50^{a}$ | $62.25^{a}$ | 72.00a | $76.50^{a}$ | $76.50^{a}$ |
| 1.0 | $31.50^{d}$ | $45.00^{cd}$ | $47.25^{c}$ | $49.50^{c}$ | $51.75^{d}$ | $51.75^{d}$ |
| 1.5 | $54.00^{a}$ | $58.50^{a}$ | $58.50^{b}$ | $58.50^{b}$ | $58.50^{c}$ | $58.50^{c}$ |
| 2.0 | $31.50^{d}$ | $47.25^{c}$ | $47.25^{c}$ | $47.25^{c}$ | $47.25^{a}$ | $47.25^{e}$ |
| 2.5 | $36.00^{c}$ | $42.75^{d}$ | $42.75^{d}$ | $42.75^{d}$ | $42.75^{f}$ | $42.75^{f}$ |
| 3.0 | $24.75^{e}$ | $36.00^{e}$ | $36.00^{e}$ | $36.00^{e}$ | $36.00^{g}$ | $36.00^{g}$ |
| | Variety (V) | | | | | |
| Drum | $25.71^{c}$ | $36.00^{c}$ | $38.57^{c}$ | $41.14^{c}$ | $42.43^{d}$ | $42.43^{d}$ |
| Katsina White | $56.57^{a}$ | $65.57^{a}$ | $65.57^{a}$ | $65.57^{a}$ | $65.57^{a}$ | $65.57^{a}$ |
| Oloyin | $28.29^{c}$ | $37.29^{c}$ | $39.85^{c}$ | $42.43^{c}$ | $45.00^{b}$ | $45.00^{b}$ |
| Sokoto White | $41.14^{b}$ | $55.29^{b}$ | $57.85^{b}$ | $60.43^{b}$ | $63.00^{a}$ | $63.00^{a}$ |
| T × V | ** | ** | ** | ** | ** | ** |

**: significantly different at ($p<0.01$)

Table 2: Effect of duration microwave radiation on the number of leaves of four local cowpea varieties

| | Days After Planting | | | | | |
|---|---|---|---|---|---|---|
| | | 4 | 5 | 6 | 7 | 8 |
| Time (Min) | Time of Exposure (T) | | | | | |
| 0 | | $1.21^{b}$ | $1.50^{c}$ | $1.67^{c}$ | $1.70^{d}$ | $1.72^{e}$ |
| 0.5 | | $1.21^{b}$ | $1.61^{b}$ | $1.87^{b}$ | $1.87^{c}$ | $2.01^{d}$ |
| 1.0 | | $1.46^{a}$ | $2.02^{a}$ | $2.43^{a}$ | $2.56^{a}$ | $2.78^{a}$ |
| 1.5 | | $0.72^{c}$ | $1.35^{d}$ | $1.72^{c}$ | $2.05^{b}$ | $2.33^{c}$ |
| 2.0 | | $0.81^{c}$ | $1.15^{e}$ | $1.52^{d}$ | $2.00^{b}$ | $2.50^{b}$ |
| 2.5 | | $0.65^{d}$ | $1.37^{d}$ | $1.61^{c}$ | $1.86^{c}$ | $1.97^{d}$ |
| 3.0 | | $0.40^{e}$ | $0.73^{f}$ | $1.12^{e}$ | $1.26^{e}$ | $1.46^{f}$ |
| | Variety (V) | | | | | |
| Drum | | $0.32^{d}$ | $0.94^{d}$ | $1.46^{c}$ | $1.82^{b}$ | $2.12^{a}$ |
| Katsina White | | $1.33^{b}$ | $1.57^{b}$ | $1.80^{a}$ | $1.99^{a}$ | $2.20^{a}$ |
| Oloyin | | $0.58^{c}$ | $1.36^{c}$ | $1.71^{b}$ | $1.83^{b}$ | $2.10^{a}$ |
| Sokoto White | | $1.45^{a}$ | $1.69^{a}$ | $1.85^{a}$ | $1.95^{a}$ | $2.02^{b}$ |
| T × V | | ** | ** | ** | ** | ** |

**: significantly different at ($p<0.01$)

**Table 3:** Effects of the duration of exposure of four local cowpea varieties to microwave rays on the plant height

| | Days after Planting | | | | |
|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 |
| Time (Min) | Time of exposure (T) | | | | |
| 0 | 1.80c | 3.39c | 4.72b | 5.62b | 6.52b |
| 0.5 | 1.80c | 5.17b | 6.30a | 7.08a | 7.87a |
| 1.0 | 1.80c | 5.85a | 6.52a | 7.20a | 7.87a |
| 1.5 | 1.80c | 5.28b | 6.30a | 7.20a | 8.10a |
| 2.0 | 1.80c | 2.60d | 4.72b | 5.85b | 6.52b |
| 2.5 | 2.25a | 3.15e | 4.05c | 4.95c | 5.28c |
| 3.0 | 2.02b | 2.70f | 3.60d | 4.38d | 5.06c |
| Variety (V) | | | | | |
| Drum | 1.67c | 4.24b | 5.27a | 5.91b | 6.55b |
| Katsina White | 2.31a | 4.69a | 5.46a | 6.23a | 7.07a |
| Oloyin | 1.54d | 3.79c | 4.69b | 5.78b | 6.36b |
| Sokoto White | 2.05b | 4.24b | 5.27a | 6.23a | 7.00a |
| T x V | ** | ** | ** | ** | ** |

**: significantly different at ($p<0.01$)

**References:**


1. Adeola S. S., Folorunso S. T., Gama E. N., Amodu M. Y., Owolabi J. O. (2011). Productivity and profitability analyses of cowpea production in Kaduna State. Adv. Appl. Sci. Res. 2:72-78.
2. Ahloowalia B. S., Maluszynski M., Nichterlein K. (2004). Global impact of mutation-derived varieties. Euphytica 2:187-204.
3. Aladjadjiyan A. 2010. Effect of microwave irradiation on seeds of lentils (*Lens culinaris* med.). Romanian Journal of Biophysics, 20 (3): 213–221.
4. Ayisi K. K., Nkgapele R. J., Dakora F. D. (2000). Nodule formation and function in six varieties of cowpea (*Vigna unguiculata* L. Walp.) grown in a nitrogen rich soil in South Africa. Symbiosis 28:17-31.
5. Banik S., Bandyopadhyay S., Ganguly S. 2003. Bioeffects of microwave a brief review. Bioresource Technology, 87: 155–15 http://dx.doi.org/10.1016/S0960.
6. Hamada E. 2007. Effects of microwave treatment on growth, photosynthetic pigments and some metabolites of wheat. Biologia Plantarum, 2: 343–345.
7. International Institute of Tropical Agriculture (IITA) (2004). IITA Crops and Farming Systems [online]. Available from: <http://www.iita.org/crop/cowpea.htm>. [Accessed November 10, 2012].
8. Mba C., Afza R., Jain S. M. (2010). Induced mutagenesis in plants using physical and chemical agents. Plant Cell Culture. Essential methods DOI: 10.1002/9780470686522. ch7.
9. Mudibu J., Kabwe K. C., Nkongolo, Adrien Kalonji – Mbuyi, Roger V. K. (2012). Effect of gamma irradiation on morpho-agronomic characteristics of soybean (*Glycine max* L.). Am. J. Plant Sci. 3:331-337.
10. Novak F. J., Brunner H. (1992). Plant breeding: Induced mutation technology for crop improvement. IAEA Bull. 4:24-33.
11. Oprica L. 2008. Effect of microwave on the dynamics of some oxidoreductase enzymes in *Brassica napus* germination seeds. Sectiunea Genetica si Biologie Moleculara, 9: 99–104.
12. Pachomov, 1998 Current state and implications of research on biological effects of millimeter waves. Bioelectromagnetics, 19: 393–413.
13. Salama H. M. H., Watban A. A. A., Al-Fughom A. T. 2011. Effect of ultraviolet radiation on chlorophyll, carotenoid, protein and proline contents of some annual desert plants. Saudi Journal of Biological Sciences, 18: 79–86 http://dx.doi.org/10.1016/j.sjbs.2010.10.002.
14. Shimelis H., Shiringani R. (2010). Variance components and heritabilities of yield and agronomic traits among cowpea genotypes. Euphytica 176:383-389.
15. Singh B. B., Ehlers J. D., Sharma B., Freire-Filho F. R. (2002). Recent progress in cowpea breeding. In: Fatokun C. A., Tarawali S. A., Singh B. B., Kormawa P. M., Tamo M. (eds) Proceedings of the world cowpea conference III, challenges and opportunities for enhancing sus-

tainable cowpea production. IITA, Ibadan, Nigeria, pp. 22-40.
16. Tambe A. B., Apparao B. J. (2009). Gamma ray induced mutations in soybean [*Glycine max* (L.) Merill] for yield contributing traits. In: Shu Q. Y. (ed) Induced plant mutations in the genomics era, Joint FAO/IAEA Programme, Vienna, Austria, pp. 95-96.
17. Tshilenge - Lukanda L., Funny – Biola C., Tshiyoyi - Mpunga A., Mudibu J., Ngoie – Lubwika M., Mukendi - Tshibingu R., Kalonji – Mbuyi A. (2012). Radio-sensitivity of some groundnut (*Arachis hypogaea* L.) genotypes to gamma irradiation: indices for use as improvement. Brit J. Biotechnol. 3:169-178.
18. Till B. J., Reynolds S. H., Greene E. A., Codomo C. A., Enns L. C., Johnson J. E., Burtner C., Odden A. R., Young K., Taylor N. E., Henikoff J. G., Comia L., Henikoff S. (2003). Large-scale discovery of induced point mutations with high-throughput. Genome Res. 13:524-530.

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