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Effects of Radio Frequency Radiation on Growth of Pepper around Mobile Base Transmitter Stations in Ogbomoso, Nigeria

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ABSTRACT

Plants are very sensitive to radiation and environmental changes. With the rapidly increasing number of artificial sources of radio-frequency radiation (RFR), there is the need for research on their effects on living organisms. The aim of this study was to determine whether RFR from mobile phone masts affect seed germination and growth of pepper. Pepper (scotch bonnet) seeds were planted in a cut vegetable kings oil container. One sample was exposed to RFR within 0.007 km (near field) in the vicinity of mobile Base Transmitter Stations (BTS), and the other sample was a control, within 1.250 km (far field) from the BTS. The RFR level around the exposed sample was 295.4 $\mu W/m^2$ and this level was higher than the RFR level in the control site which was 47.0 $\mu W/m^2$. Data were collected on seed germination and plant growth. Exposure of the bonney pepper to BTS radiation caused a delay in the germination of seeds, discoloration of leaves and reduced plant vigor. From the 15^{th} day upward, the height of the control sample was more than the exposed whereas, throughout the experiment, the weight of the control sample was more than the exposed. The study concludes that RFR within the vicinity of BTS inhibits seed germination and growth of pepper. Even though the level of the power density for generating BTS in the study areas were observed to fall below the recommended limit set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), there is an urgent need for biological based limit.

Keywords: *Radio-frequency radiation, power density, pepper, exposed, control*

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I. INTRODUCTION

Non-ionizing radiation includes the spectrum of ultraviolet (UV), visible light, infrared (IR), microwaves (MW), radio frequency (RF), and extremely low frequency (ELF). RF radiation from non-ionizing electromagnetic radiation is found in a wide range of occupational settings and can pose a considerable health risk to potentially exposed workers if not properly controlled. Halil, (2021) showed the effects of base station as an electromagnetic radiation source on flower and cone yield and germination percentage in pinus brutia ten.

Research was carried out by Alattar, *et al.,* on the effects of magnetic fields on plants growth, the result showed that many part aspects of plants growth, seed germination, yield, quality and water was affected by magnetic fields (MF) as investigated [1].

Research was carried out on plant responses to high frequency electromagnetic fields (EMFs) Vian, *et al.,* [14] and an increasing number of reports highlight biological responses of plants after exposure to high frequency electromagnetic radiation (HF-EMR) at the molecular and whole plant level.

Nam, *et al.,* [14] examined the effects of RF-EMF radiation on lettuce plant (Lactuca sativa) in both indoor and outdoor environments using the frequency ranges of 1890-1900 MHz (DECT) at 2.4 GHz and 5 GHz (Wi-Fi). It was observed that under greenhouse conditions, RF-EMF exposure had only a minor impact on fast chlorophyll fluorescence kinetics and no effect on plant flowering time. In contrast, lettuce plants exposed to RF-EMF in the field showed a significant and systematic decrease in photosynthetic efficiency and accelerated flowering time compared to the control groups.

Alattar and Radwan investigated the effects of radio frequency water treatment on the growth of pepper

(Capsicum annuum) plants [2, 5]. The results showed that changes of growth characters of plant watered with electromagnetic water. The length of pepper plants is significantly affected by the treated water than those grown without treated water, where the length of pepper plants is significantly higher than that of the treated plants. Furthermore, the length of the root was lower in plants grown under the effect of treated water than those grown without treated water.

Chandni and Transhit [3] explored the exposure effects of non - ionizing radiation (radio waves) on the antimicrobial planets. Results showed changes in the antimicrobial potential of the plants after exposure to radio waves, potentially impacting their medicinal uses.

El-zawily, *et al.,* [4] explored the effects of magnetic fields on tomato plants irrigated with mix of fresh and agricultural drainage water. The study found that applying a magnetic field to the irrigation water improved tomato plant growth, yield and fruit quality. The results showed that magnetic field treatment helped tomato plants tolerate the salinity stress associated with agricultural drainage water leading to better growth and productivity.

Nam and Luca [8] studied the effects of RF-EMF radiation on lettuce plants in both indoor and outdoor environments. The researchers used frequency ranges of 1880-1900 MHz (DECT), 2.4 GHz and 5 GHz (Wi- Fi) to investigate the effects of RF - EMF on lettuce plants. Results showed that RF-EMF exposure significantly decreased photosynthetic efficiency in lettuce plants exposed to RF-EMF in outdoor environments showed accelerated flowering time compared to control groups.

Nibedita, *et al.,* [9] Studied the spatial distribution in a peace lily plant model under different electromagnetic exposure scenarios by quantifying microwave energy absorption rates (SAR values) and spatial distribution in a peace lily plant model under various electromagnetic exposure scenarios. A 3D peace lily plant model was designed using CST (Computer Simulation Technology) microwave studio electromagnetic solver and exposed to linearly polarized plane waves at frequencies of 947.50 MHz, 1842.50 MhHz and 2450 MHz. Results showed significant variation in maximum local point SAR (MLP SAR), 1 g averaged SAR and 10 g averaged SAR values for different combinations of direction of arrival and incident wave polarization.

Nyakane *et al.,* [10] Reviewed the effects of magnetic fields on plants growth. The review discusses how magnetic fields can influence plant growth, including seed germination, root development and overall plant productivity.

Radhakrishnan's [11] studied magnetic field regulates plant functions, growth and enhances tolerance against environmental stress. The research explored how magnetic fields impact plant development and stress resilience. The study suggests magnetic field therapy as a potential tool for improving crop resilience and productivity in challenging environments.

Sergey, *et al.,* [12] discusses the impact of ionizing radiation on plant biology. Results showed that plants respond to ionizing radiation by activating stress-related genes, producing antioxidants and modifying signals pathways. Furthermore, ionizing radiation can damage plant cells, alter photosynthesis and disrupt nutrient uptake leading to changes in growth and development.

Tran, *et al.,* [13] explored the effects of RF-EMF on lettuce plants. Results showed that RF-EMF exposure decreased photosynthetic efficiency in lettuce plants, lettuce plants exposed to RF-EMF showed accelerated flowering time. The study suggests that RF-EMF exposure may interfere with plant stress responses making them more susceptible to environmental stressors.

II. MATERIALS AND METHODS

The materials used are radio-frequency radiation from GSM masts, pepper plants, perforated improvised bowl (Two kegs of V king oil container were cut at the top to a suitable size), loamy soil, 0.3 kg of water, digital weighing balance, tape rule and electrosmog meter (50 MHz-3.5 GHz). In the experiment, we planted the seeds of pepper (scotch bonnet, bonney pepper which Yoruba name is “Ata rodo” the species name is Capsicum Chinese) into two identical perforated improvised bowls. The same content of sand was filled to the bowls, which weighed 4 kg each and the same content of pepper (“Ata rodo”) seeds were nursed to the bowls. The first sample, sample A was placed in an environment with minimal effect of radio-frequency radiation from GSM mast with the transmission frequency of 900 MHz to 1800 MHz and distance of 1.250 km, the second sample, say sample B was placed in an uncompleted building, in close proximity of the GSM mast, radio-frequency radiation with the transmission frequency of 900 MHz to 1800 MHz and distance of 0.007 km from the GSM mast, both bowls were kept in an open headed place, they were secured under the same conditions of daylight, watered every morning with the same quantity of water, during the following 25 days received both plants the same amount (quantity) of water 0.3 kg each day in the morning, at almost the same time, weeding was done by hand pulling.

2.1 Materials used for the experiment

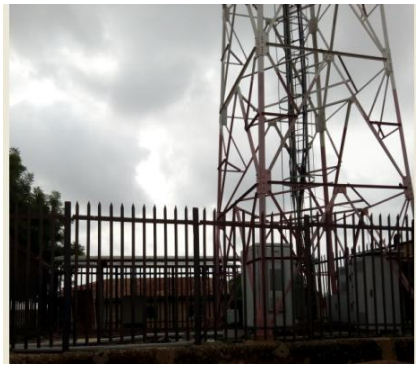
Radio-frequency radiation from GSM Mast, Pepper plants, improvise bowl (Two keg of V king oil container were cut at the top to a suitable size), loamy soil, 0.3kg of water, 0.1kg of cup, Digital scale weigh (weigh balance), groundnut seed (Kampala) and Hausa groundnut (or SAMNUT 23) seed and Electro-smog meter (50MHz-3.5GHz).

Location for each group of GSM mast are shown in Table 1 below.

Table 1: Location for each group of GSM mast

Group	Location	Distance from GSM Mast (m)	Geo-coordinate	Radio-Frequency Radiation Level ($\mu W/m^2$)	Motivation for choice of location for each group
Control	Rehoboth Nursery and Primary School, Iwagba area, Ogbomoso, Nigeria	1.250	8º 9' 4" N 4º 14' 6" E	47.0	Minimal exposure of radiation from GSM mast
Exposed	Close to Miracle Clinic junction, Iwagba area, Ogbomoso, Nigeria	0.007	8º 9'11" N 4º 14'17" E	295.4	The GSM mast is very close to a Clinic

(a) Digital weigh balance



(b.) GSM mast

(c.) A Cup

(d.) A bowl of sand

(e.) A bowl of Pepper

(f.) A ruler

(g.) Electrosmog meter 50 MHz – 3.5 GHz

(h.) Tape rule

III. RESULTS AND DISCUSSION

Sample A. **Sample B.**

Fig. 4.1 First Day Experiment

Sample A. **Sample B.**

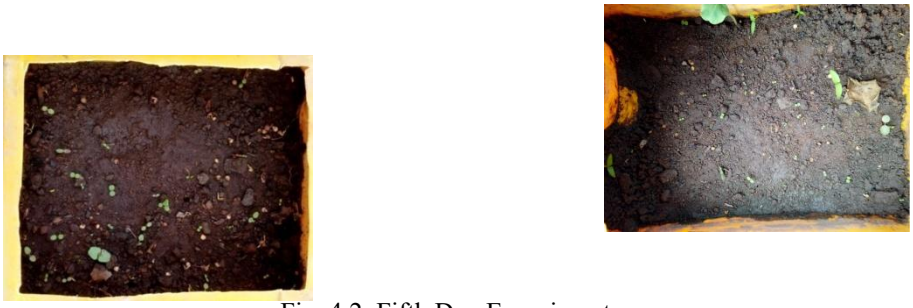


Fig. 4.2 Fifth Day Experiment

Sample A. **Sample B.**

Fig.4.3 Tenth Day Experiment

Sample A. **Sample B.**

Fig.4.4 Fifteenth Day Experiment

Sample A. **Sample B.**

Fig.4.5 Twentieth Day Experiment

Sample A. **Sample B.**

Fig. 4.6 a Week and Three Days after Twentieth Day Experiment

Sample A. **Sample B.**

Fig. 4.7 Three Weeks after Twentieth Day Experiment

Measurements were carried out as follows: first day, fifth day, tenth day, fifteenth day and twentieth day. Up till day fifteenth of the experiment, the plant showed small differences of germination and growth. After the twentieth day a large part of seeds placed near GSM mast has not germinated. Many of these seeds were yellowish color and dead, which was significantly different from the seeds in the second perforated improvised bowl. Figures 4.1 to 4.7 show the pepper from the 1st day to the 41st day after planting. The germinating sprouts near the GSM mast radiation were shorter and weaker. This corroborated the work of Magda and Sheena (2016) which showed that radiation from a Wi-Fi router adversely affects growth of plants under controlled conditions and at levels well below international guidelines for microwave radiation.

On the twentieth day and upward of the experiment, plants near to the GSM mast which germinated, had problem with growth and their length has not changed. Also, there was reduced water intake of these plants and there was difference in weight between the first and second sample. The measured weight and height of the two improvised bowls during the experiment are shown in Appendices 1 and 2.

Pepper planted outside the radio frequency radiation from GSM mast, sample A was visually vital and had clearly green color. Sample B was withered and the vegetation was less dense compared to sample A**,** which agreed with Vian *et al.*, 2016**.**

IV. CONCLUSION

In conclusion, the influence of radio-frequency radiation due to the internal temperature increase of plants can cause the physiological and metabolic changes that influence their growth, adverse changes in the

green part of the plant and delay in seed germination. With effect of radio-frequency radiation from GSM mast and other electromagnetic microwave radiation we can vividly see and observe that the experiment has demonstrated the negative effects of GSM mast radiation on the pepper plant. The result was the slowing of plants growth, adverse change in coloration, physiological and metabolic changes, and genetic mutations that can lead to death of the plants.

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APPENDIX A

Table 1: Sample weight for pepper

	Weight (kg)	
Day of the experiment	**Sample A (Control)**	**Sample B (Exposed)**
1	4.00	4.00
5	4.50	4.30
10	4.35	4.10
15	4.30	4.00
20	4.20	3.85

APPENDIX B

Table 2: Sample height for pepper

	Height (cm)	
Day of the experiment	**Sample A (Control)**	**Sample B (Exposed)**
1	9.50	6.00
5	17.50	11.00
10	20.50	13.00
15	24.00	16.00
20	27.50	21.00