IMAGE: A MAP OF THE STARS OF THE ORION CONSTELLATION

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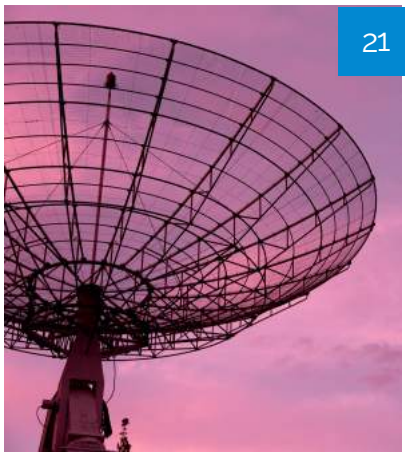

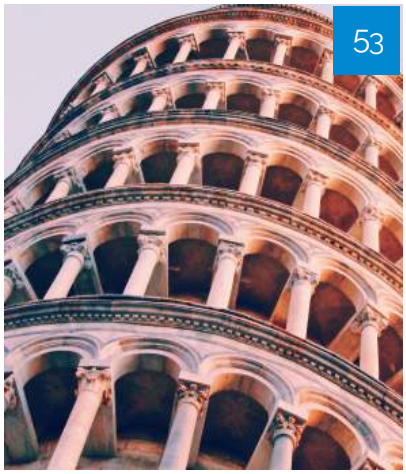

Multiwave Processes in Chiral Medium

A.N. Volobuev

Samara State Medical University

ABSTRACT

The principle of calculation of a plate from a metamaterial with inductive type chiral inclusions is submitted. It is shown that distribution of an electromagnetic wave in such substance can be investigated with the help of using of a chiral parameter and on the basis of a detailed method of calculation. With the help of a detailed method the nonlinear differential equation for potential on the chiral plate is found. It is shown that this equation has multiwave solutions as traveling solitary waves and standing waves but not traveling sine waves. The analysis of the received solutions of the nonlinear equation is carried out. Transition from the multiwave solution to the solution as standing waves is graphically shown at reduction of distance between the chiral elements.

Keywords: metamaterial, chiral parameter, inductive inclusions, multiwave solution, standing waves.

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Keywords: metamaterial, chiral parameter, inductive inclusions, multiwave solution, standing waves.

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I. INTRODUCTION

Now the materials (Greek. "meta" outside), i.e. composite materials with the various inclusions distributed both chaotically, and periodically are widely applied in particular in a radio engineering, at designing of space devices, in medicine, etc., [1, 2, 3, 4]. Due to these inclusions the received materials have many useful physical, electric, optical and other properties which are not present at natural substances. Among metamaterials are allocated the substances with chiral properties [5] which are capable to rotate a plane of polarization of electromagnetic waves. In optics as analogue of similar substances are the optical active substances, for example, quartz, a glucose solution etc.

However methods of calculation of metamaterials are enough limited [6]. Basically all calculations are based on the solving of the Maxwell's equations and the material equations selected according to a problem.

The existing method has restrictions since average characteristics of metamaterials are usually used only, for example, a chiral parameter.

In the present work attempt of more detailed approach to properties of chiral inclusions into metamaterials is made; the analysis of influence of these properties on interaction of chiral elements with the electromagnetic wave falling on a plate from a metamaterial is carried out.

II. STANDARD METHOD OF CALCULATION OF A METAMATERIAL WITH AN ELECTROMAGNETIC WAVE INTERACTION

At research of metamaterials with chiral inclusions on the basis of the Maxwell's equations usually use the material equations including so-called chiral parameter χ. In [5, 6, 7] the material equations in the following kind are offered:

$$\boldsymbol{D} = \varepsilon_a \boldsymbol{E} \mp i\frac{\chi}{V}\boldsymbol{H}, \quad (1)$$

$$\boldsymbol{B} = \mu_a \boldsymbol{H} \pm i\frac{\chi}{V}\boldsymbol{E}, \quad (2)$$

where $\boldsymbol{D}$ and $\boldsymbol{B}$ there are an induction of electric and magnetic fields in the electromagnetic wave propagating in a chiral medium, $\boldsymbol{E}$ and $\boldsymbol{H}$ – strength of the electric and magnetic components in wave, ε_a and μ_a - absolute electric and

magnetic permeability of a chiral medium, V – velocity of an electromagnetic wave in a chiral medium, χ - a chiral parameter, in this case dimensionless size.

In [7] it is shown that the material equations (1) and (2) can be written down in more simple kind:

$$\boldsymbol{D} = (1 \pm \chi)\varepsilon_a \boldsymbol{E} , \tag{3}$$

$$\boldsymbol{B} = (1 \pm \chi)\mu_a \boldsymbol{H} . \tag{4}$$

In formulas (1) - (4) top signs define the right-turning chiral element, bottom signs – left-turning.

Using (3) and (4) it is possible to show [7] that if a chiral medium has only reactive resistance, the electromagnetic wave in it submits to the wave equations:

$$\Delta \boldsymbol{D} = \left(\frac{1 \pm \chi}{V}\right)^2 \frac{\partial^2 \boldsymbol{D}}{\partial t^2} , \tag{5}$$

$$\Delta \boldsymbol{B} = \left(\frac{1 \pm \chi}{V}\right)^2 \frac{\partial^2 \boldsymbol{B}}{\partial t^2} , \tag{6}$$

where t there is time.

III. DETAILED METHOD OF CALCULATION OF METAMATERIAL WITH ELECTROMAGNETIC WAVE INTERACTION

Let's consider a plate of the metamaterial with chiral inclusions of the inductive type. The plate consist of the dielectric in which are included the current-carrying chiral elements as spirals which axis is directed across a plate. The chiral elements are distributed periodically

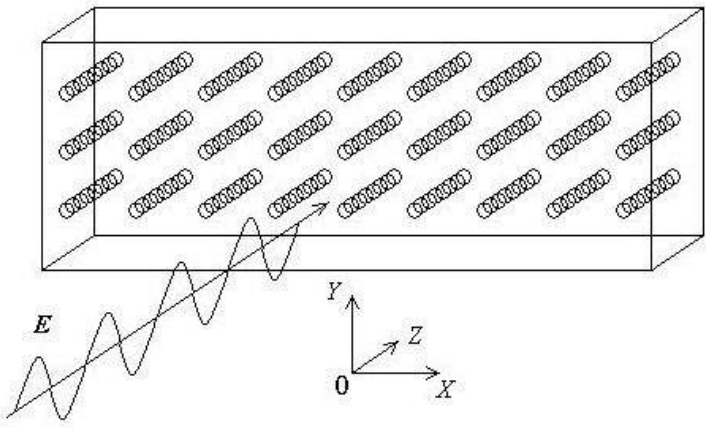

Figure 1: The plate of metamaterials irradiated by an electromagnetic wave

On fig. 1 the irradiation of a plate by an electromagnetic wave is shown. We assumed that chiral inclusions have no active resistance. The chiral element completely penetrates a plate.

Feature of a plate is the capacity distributed on its surfaces at dot inductive inclusions. Therefore to examine the interaction of separate chiral element having inductance and capacity with an electromagnetic wave is incorrectly.

Let's consider a plate consisting of chiral elements one lines, fig. 2.

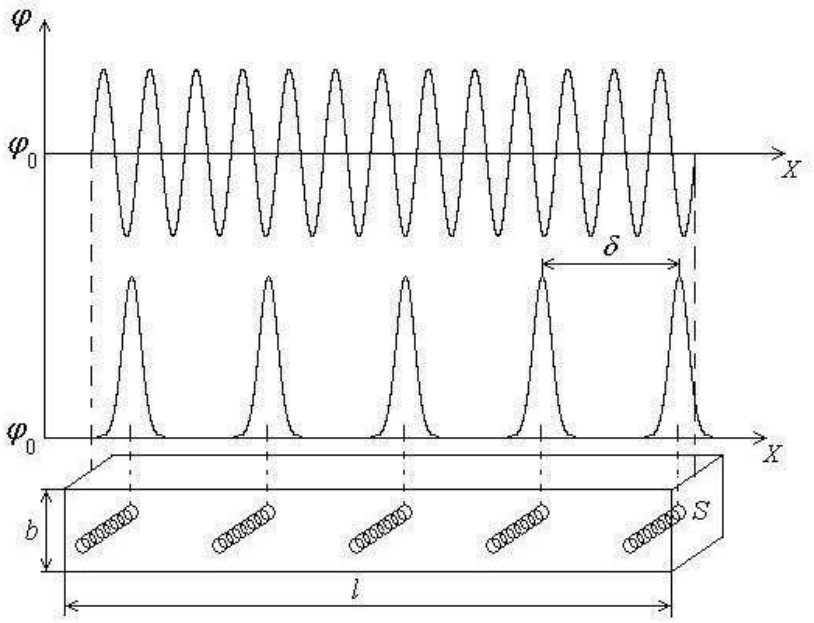

Figure 2: The single-row chiral plate

In [8] it has been shown that the potential φ on a plate submits to the nonlinear differential equation:

$$V^2(\varphi-\varphi_0)\frac{\partial^2\varphi}{\partial X^2}=\left(\frac{\partial\varphi}{\partial t}\right)^2-(\varphi-\varphi_0)^2\omega_0^2 \quad (7)$$

where φ_0 there is an origin of potential, V – a velocity of an electromagnetic field along a plate, ω_0 - natural frequency of the chiral system.

Let's notice that the nonlinear equation similar (7) arises at research of a self-induced transparency in substance [9].

The nonlinear equation (7) has solution as a solitary traveling wave:

$$\varphi-\varphi_0=\varphi_{\max}\exp\left(-\frac{(k_0(X-X_0)\pm\omega_0(t-t_0))^2}{2}\right). \quad (8)$$

where $k_0=\frac{\omega_0}{V}$ there is a wave number of a natural traveling wave in the chiral medium, $\varphi_{\max}$ - a peak value of potential $\varphi-\varphi_0$, X_0 - coordinate of the chiral element center, and accordingly a maximum (center) of a wave impulse, t_0 - a time of achievement of this maximum. The sign a minus concerns to a wave spreading from left to right, and sign plus from right to left.

Growth of potential above chiral inclusions, fig. 2, is caused by proportionality of the chiral inclusions reactance their inductivities.

From the analysis of both curves it is possible to conclude that the top curve, fig. 2, concern to often enough inclusions of the chiral elements in a plate, and bottom to more rare. Therefore into the solution (8) to enter a chiral parameter it is irrational.

Obviously for the nonlinear equation (7) there should be a multiwave solution. Multiwave

solutions are found for very much limited circle of the nonlinear wave equations [10, 11]. The multiwave solution should depend on concentration of the chiral elements in a plate. Only with its help it is possible to understand under what conditions it is possible is proved to enter the chiral parameter, i.e. to understand borders of the material equations (1) - (4) applicability.

The equation (7) supposes the multiwave solution as:

$$\varphi = \varphi_0 + \varphi_{\max} \sum_{n=1}^{N} \exp\left(-\frac{(k_0(X - X_{0n}) - \omega_0(t - t_{0n}))^2}{2} \right), \tag{9}$$

where N there are quantity of the waves-impulses kept within a length l of a plate, fig. 2, equal to number of the chiral elements, n - current number of an impulse, X_{0n} - coordinates of waves-impulses maxima, t_{0n} - times of these maxima achievement.

Substituting (9) in (7) we shall find:

$$V^2 \left(\frac{\partial^2 \varphi}{\partial X^2} \right) \sum_{n=1}^{N} \varphi_n + \omega_0^2 \left(\sum_{n=1}^{N} \varphi_n \right)^2 = \left(\frac{\partial \varphi}{\partial t} \right)^2. \tag{10}$$

where it is designated:

$$\varphi_n = \exp\left(-\frac{(k_0(X - X_{0n}) - \omega_0(t - t_{0n}))^2}{2} \right). \tag{11}$$

Finding the derivatives on coordinate X:

$$\frac{\partial^2 \varphi}{\partial X^2} = \sum_{n=1}^{N} \left(\varphi_n (k_0(X - X_{0n}) - \omega_0(t - t_{0n}))^2 k_0^2 + \varphi_n k_0^2 \right) =$$

$$= k_0^2 \sum_{n=1}^{N} \varphi_n (k_0(X - X_{0n}) - \omega_0(t - t_{0n}))^2 + k_0^2 \sum_{n=1}^{N} \varphi_n \quad , \tag{12}$$

and on time t:

$$\frac{\partial \varphi}{\partial t} = -\omega_0 \sum_{n=1}^{N} \varphi_n (k_0(X - X_{0n}) - \omega_0(t - t_{0n})) \quad , \tag{13}$$

we substitute (12) and (13) in the equation (10)

and taking into account $k_0 V = \omega_0$ we have:

$$\left(\sum_{n=1}^{N} \varphi_n (k_0(X - X_{0n}) - \omega_0(t - t_{0n}))^2 + \sum_{n=1}^{N} \varphi_n \right) \sum_{n=1}^{N} \varphi_n =$$

$$= \left(\sum_{n=1}^{N} \varphi_n \right)^2 + \left(\sum_{n=1}^{N} \varphi_n (k_0(X - X_{0n}) - \omega_0(t - t_{0n})) \right)^2 . \tag{14}$$

Reducing in the left and right parts (14) the identical addends $\left(\sum_{n=1}^{N}\varphi_n\right)^2$ we shall find:

$$\sum_{n=1}^{N}\varphi_n\sum_{n=1}^{N}\varphi_n\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)^2=$$
$$=\left(\sum_{n=1}^{N}\varphi_n\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)\right)^2, \quad (15)$$

Let's consider two one after the other going the identical impulses $n=1,2$. Writing down for this case the formula (15) we shall find:

$$\left(\varphi_1+\varphi_2\right)\left(\varphi_1\left(k_0\left(X-X_{01}\right)-\omega_0\left(t-t_{01}\right)\right)^2+\varphi_2\left(k_0\left(X-X_{02}\right)-\omega_0\left(t-t_{02}\right)\right)^2\right)=$$
$$=\left(\varphi_1\left(k_0\left(X-X_{01}\right)-\omega_0\left(t-t_{01}\right)\right)+\varphi_2\left(k_0\left(X-X_{02}\right)-\omega_0\left(t-t_{02}\right)\right)\right)^2. \quad (16)$$

Transforming the formula (16) we shall receive:

$$k_0\left(X_{02}-X_{01}\right)-\omega_0\left(t_{02}-t_{01}\right)=0. \quad (17)$$

The formula (17) shows that distance between chiral elements $\delta=\left(X_{02}-X_{01}\right)$, fig. 2, an electromagnetic impulse propagates in time $\left(t_{02}-t_{01}\right)$ with a speed $V=\frac{\omega_0}{k_0}$. The size $\frac{1}{\delta}$ characterizes linear concentration of the chiral elements in a plate.

Using in (15) $t_{0n}=\frac{X_{0n}}{V}=\frac{k_0X_{0n}}{\omega_0}$, we receive that expressions in brackets $\left(k_0\left(X-X_{0n}\right)-\omega_0\left(t-t_{0n}\right)\right)^2=\left(k_0\left(X\right)-\left(\omega_0t\right)\right)^2$ do not depend from *n* they can be taken out for a symbol of the sum and to reduce. In result (15) turns to identity.

Hence (9) is the multiwave solution of the nonlinear equation (7).

The most simple kind the multiwave solution (9) has in occasion of identical distance between all impulses and accordingly between of the chiral elements. In this case coordinates of maxima of impulses are $X_{0n}=n\delta$, and times of achievement of maxima $t_{0n}=\frac{k_0X_{0n}}{\omega_0}=\frac{k_0n\delta}{\omega_0}$.

On fig. 3 for an illustration the some impulses following one after another plotted under the formula (9) are shown under conditions of the dimensionless sizes: $V=0$ - absence of dependence on time (the figure fixed in time) $\varphi_0=0$, $\varphi_{\max}=1$, $k_0=2$, $\delta=4$.

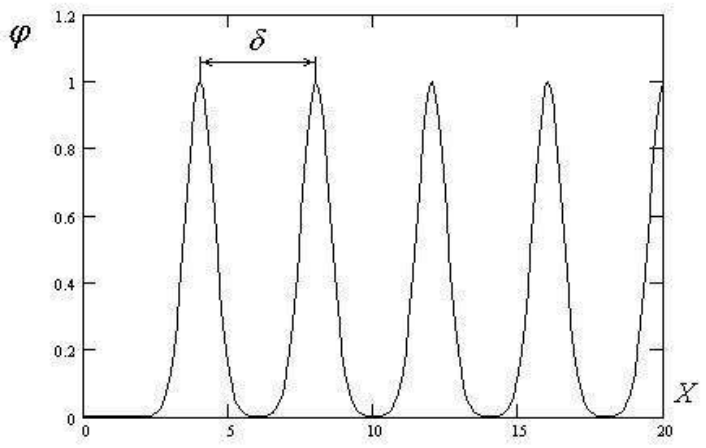

Figure 3: The impulses following one after another in the multiwave solution

Thus the formula (9) under condition of uniform distribution of identical impulses is the multiwave periodic solution of the nonlinear equation (7).

IV. THE SOLUTION AS STANDING WAVES

Let's consider in more detail another kind of the wave arising on single-row chiral plate at falling on it of an electromagnetic wave.

Standing waves are formed in linear systems as a result of superposition (interference) of the direct and reflected traveling waves more often. However it is known that standing waves can arise in nonlinear systems [12]. Many physical processes have essentially nonlinear character and process of standing waves occurrence in such systems is nontrivial. We shall examine an opportunity of standing waves occurrence in researched chiral medium.

The nonlinear equation (7) can be solved by a method of the Fourier variables division [13]. We search the solution of the equation (7) as:

$$\varphi - \varphi_0 = \varphi(X)T(t). \tag{18}$$

where $\varphi(X)$ there is function only coordinates X, $T(t)$ - a function only time t.

Having substituted (18) in (7) we shall find:

$$V^2\varphi(X)T^2(t)\frac{\partial^2\varphi(X)}{\partial X^2} = \left(\varphi(X)\frac{\partial T(t)}{\partial t}\right)^2 - \varphi^2(X)T^2(t)\omega_0^2 . \tag{19}$$

Let's divide both parts of the equation on $\varphi^2(X)T^2(t)$. In result we shall receive:

$$V^2\frac{1}{\varphi(X)}\frac{\partial^2\varphi(X)}{\partial X^2} + \omega_0^2 = \left(\frac{1}{T(t)}\frac{\partial T(t)}{\partial t}\right)^2 = -\omega^2 . \tag{20}$$

where ω there is a constant.

The equation (20) breaks up to two independent equations. The equation dependent on X looks like:

$$\frac{\partial^2\varphi(X)}{\partial X^2}+\left(k_0^2+\frac{\alpha^2}{V^2}\right)\varphi(X)=0 \quad . \tag{21}$$

Designating $k_S^2=k_0^2+\frac{\omega^2}{V^2}$ the solution of the equation (21) we shall write down as:

$$\varphi(X)=\varphi(0)\exp(ik_S X) . \tag{22}$$

where $\varphi(0)$ there is value of function $\varphi(X)$ in the beginning of coordinates.
The second equation of equality (20) looks like:

$$\frac{\partial T(t)}{\partial t}=i\omega T(t) . \tag{23}$$

Solving this equation we shall find:

$$T(t)=T(0)\exp(i\omega t) , \tag{24}$$

where $T(0)$ there is initial value of function $T(t)$.
Using (18), (22) and (24) we shall find the solution of the equation (7) as:

$$\varphi-\varphi_0=\varphi_A\exp(i\omega t)\exp(ik_S X) , \tag{25}$$

where it is designated $\varphi_A=T(0)\varphi(0)$ there is a peak value of potential $\varphi-\varphi_0$ on a plate.

The function $\varphi-\varphi_0$ should not have imaginary addends, the potential is real size. Use an exponents with imaginary parameters is entered for convenience of transformations. Really in these exponents it is necessary to take into account only real items. Therefore the formula (25) describes the solution of the equation (7) as standing waves:

$$\varphi-\varphi_0=\varphi_A\cos\omega t\cos k_S X=\varphi_A\cos\omega t\cos\frac{2\pi X}{\delta} , \tag{26}$$

where φ_A there is a peak value of standing waves, δ - length of a wave.
Condition of the nodes occurrence in a standing wave $X_{\text{ns}}=\pm(2n+1)\frac{\delta}{4}$, where $n=0,1,2,\ldots$.
On the ends of the single-row chiral plate, fig. 2, should be nodes of a standing wave. If excitation of a wave occurs in the center of a plate the number of the maximal distant node from a center of a plate can be found under the formula

$$\pm\frac{l}{2}=\pm(2n_{\max}+1)\frac{\delta}{4} \quad \text{or} \quad n_{\max}=\left(\frac{l}{\delta}-\frac{1}{2}\right) .$$

It is necessary to note that running waves $\varphi-\varphi_0=\frac{\varphi_A}{2}\cos(k_S X\pm\omega t)$ with account $k_S^2=\frac{\omega_0^2+\omega^2}{V^2}$ are not the solution of the equation (7) therefore the formula (26) from the physical point of view cannot be presented as a sum of the direct, and reflected from borders plate waves though mathematical this procedure is simple for making. It is consequence of the equation (7) nonlinearity.

It is interesting to track graphically a transition of the multiwave solution (9) in the solution as standing waves (26). This transition is carried out at rapprochement of impulses, fig. 2, 3, i.e. at reduction of size δ .

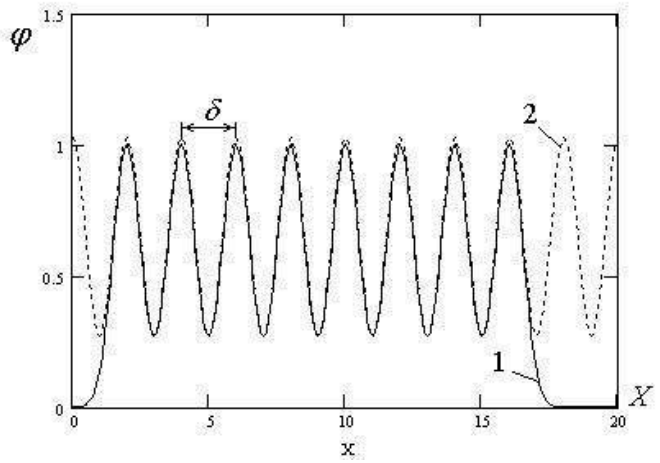

Figure 4: Transition of the multiwave solution in the solution as a standing wave: 1 - the multiwave solution, 2 - a standing wave

On fig. 4 the two curves are shown. Curve 1 is plotted under the formula (9) under conditions: $V = 0$, $\varphi_0 = 0$, $\varphi_{\max} = 1$, $k_0 = 2$, $\delta = 2$ for $N = 8$ impulses. Curve 2 is plotted (dotted line) under the formula (26) under conditions $\varphi_0 = 0{,}65$ and $\varphi_A \cos \omega t = 0{,}38$ for some moment of time *t*.

V. CONCLUSION

Distribution of potential to a plate from a metamaterial with inductive chiral inclusions is investigated as with use of the material equations together with the Maxwell's equations, and on the basis of a detailed method of calculation of the chiral elements and an electromagnetic wave interaction. Comparison of two approaches has allowed to find out that introduction of the chiral parameter is correct only at enough high concentration of the chiral inclusions. At use of a detailed method of calculation the nonlinear equation for the potential having solutions as standing waves and solitary waves is received. Traveling waves are not the solution of this equation. Existence of the multiwave solution of the nonlinear equation is shown. At reduction of distance between chiral elements the process of transition of the multiwave solution of the nonlinear equation in the solution as a standing wave is investigated.

REFERENCES

1. Slusar V. Metamaterials in the antennas techniques: a history and main principles. Minsk, Electronics, NTB. 2009, No. 7, P. 70-79.
2. Capolino F. Theory and Phenomena of Metamaterials. Boca Raton, Taylor & Francis, 2009. 992 p.
3. Vendik I.B., Vendik O.G. Metamaterials and its Application in Technique of Ultrahigh Frequencies. S-Petersburg. Tech. Phys. 2013, V. 58, No. 1, P. 1-24.
4. Davidovich M.V. Hyperbolic Metamaterials: Production, Properties, Applications, and Prospects. Uspekhi Fizicheskikh Nauk, 2019, V. 189, No. 12, Pp. 1249-1284.
5. Neganov V.A., Osipov O.V. Reflecting, Waveguiding, and Emitting Structures with Chiral Elements. Moscow, Radio i Svyaz, 2006, 280 p.
6. Katsenelenbaum B.Z., Korshunova E.N., Sivov A.N., Shatrov A.D. Chiral Electrodynamics Objects. Moscow, Uspekhi Fizicheskikh Nauk, 1997, V. 167, No. 11, Pp. 1201-1212.

7. Volobuev A.N. Electrodynamics of Circular Dichroism and its Application in the Construction of a Circular Polaroid. S-Petersburg. Tech. Phys. 2016, V. 61, No. 3, P. 337-341.
8. Volobuev A.N. The Nonlinear Analysis of Chiral Medium. Ed. Takashiro Akitsu "Chirality from Molecular Electronic Ststes". IntechOpen. 2018. P. 1-10.
9. Volobuev A.N. Spreading of Pulse of Electromagnetic Field in Dielectric for Conditions Self-Induced Transparency. Mathematical Models and Computer Simulations, 2006, V. 18, No. 3, P. 93-102.
10. Ablowitz M.J., Segur H. Solitons, and the Inverse Scattering Transform. Philadelphia: SIAM, 1981.
11. Dodd R.K., Eilbeck J.C., Gibbon J.D., Morris H.C. Solitons and Nonlinear Wave Equation. London, New York, Tokyo: Academic Press, Inc., 1984.
12. Krasilnikov V.A., Krylov V.V. Introduction in physical acoustics. M.: Nauka, 1984. 403 p.
13. Tikhonov A.N., Samarski A.A. Equipments of Mathematical Physics. Moscow, Nauka, 1972. 736 p.

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Adsorption and Desorption Equilibrium Moisture Content for Roselle Calyx

Saher Gaafar Ahmed, Adam Bush Adam & Eman Abdu Abdalla

University of Khartoum

ABSTRACT

Under the acceleration of climate variability of Sudan, food storage should be undertaken seriously the moisture content and temperature which significantly affected the product quality. The objective of this study was to determine the adsorption and desorption equilibrium moisture content for Roselle Calyx. The study was carried out at the Faculty of Agriculture, University of Khartoum, Shambat, Sudan. Three adsorption isotherms (10°C, 30°C and 50°C) and two desorption (30°C and 50°C) were used to determine equilibrium moistures content (EMC) of whole and broken Roselle calyx. Regression technique showed that no difference between adsorption and desorption equilibrium moisture content values for both whole and broken Roselle calyx. As relative humidity (RH%) increases up to 85% equilibrium moisture content will be increased, while Above 85% of relative humidity no equilibrium moisture content values were detected due to the growth of mould on the tested sample. On the other hand, temperature was found to have negative relationship with equilibrium moisture content. No hysteresis effects between adsorption and desorption equilibrium moisture content. The study recommended that whole or broken Roselle calyx could be stored safety at 10°C - 50°C air temperature and at a relative humidity below 85% to avoid mould growth on food stored.

Keywords: adsorption; desorption; equilibrium moisture content; roselle calyx.

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Keywords: adsorption; desorption; equilibrium moisture content; roselle calyx.

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I. INTRODUCTION

Roselle (*Hibiscus sabdariffa L.*) belongs to the family *Malvaceae*. It originated in India and it is widely distributed in tropical and subtropical regions as a potential new food crop of considerable economic potential as mentioned by Jitka *et al.* (2013). Sudan is categorized as one of the largest exporters of Roselle (Karkade or Ingara) worldwide. The crop is grown as a cash crop in the rainfed areas. According to the commercial terminology used in Sudan, there are two main types of Karkade calyx, namely El Rahad and El Fashir types. Grain storage is important especially for developing countries where food grain stuff constitutes the staple food for human beings. Safe storage must maintain grain quality and quantity. This means protecting it from weather, mould microorganism resulting from addition of moisture, destructive high temperature, insects, rodents and birds. During storage different factors bring about losses in food grain and they may be grouped into biological and non-biological factors such as temperature, moisture content and relative humidity which have a great impact on grain quality and storability as mentioned by Krishnamurthy et al. (1989). Adsorption isotherm can be used for establishing a storage method, while desorption isotherm data is useful in the drying analysis as reported by Kingsly and Ileleji (2009) and Aroraet al. (2011). Hysteresis refers to the difference between the adsorption and desorption curves isotherms for biological materials have generally sigmoid shapes (S-shaped) and approach very high moisture content as the relative humidity approaches 100%. Adsorption moisture content describes the equilibrium moisture content

(EMC), which is the limit of the moisture that can be attained when food is exposed to air at a given temperature and water activity as stated by Alakali et al. (2010). Equilibrium moisture content depends on the relative humidity and temperature of environment as well as the product characteristics as revealed by Luampon and Charmongkolpradit (2019). The rate of respiration increases with increasing temperature up to 40°C., while above this temperature viability of the grain as well as the rate of respiration significantly decreased at temperature above 50°C as mentioned by Chakaverty (1981) and supported by Jiang and Yuan (2013). Effect of 40°C storage temperature on the anthocyanin content was significant ($p < 0.05$) while there was no significant difference between 4 and 25°C as mentioned by Turker et al. (2004). In Sudan, food storage cannot be undertaken seriously the moisture content and temperature, therefore the objective of this study was to determine the adsorption and desorption equilibrium moisture content for Roselle Calyx.

II. MATERIALS AND METHODS

The study was conducted at the Department of Agricultural Engineering, Faculty of agriculture, University of Khartoum, Sudan. Roselle (*Hibiscus sabdariffa* L.) var. Sabdariffa was used as indicator plant. Calyces of flowers were traditional harvested, collected, treated and tested with static method that controlled temperature by incubator (Heraeus Electronic Make, temperature range 0-100°C) and controlled relative humidity with saturated salt solution in closed system, as it convenient and low cost. Saturated salt solutions usually have good properties to control relative humidity that depends on temperature. Salt saturated solutions in this experiment were (LiCl, MgCl2.6H2O, NaBr, Nacl, CaCl2, NH4Cl, K2CO3, K2CrO7, K2SO4, KI and KNO3). The initial moisture content of Roselle calyx was determined in triplicate according to the association of official analytical chemists' procedures (Association Official Analytical Chemists, 1990).

2.1 Equipments

The following equipments were used in the experiments:

- Sample containers for the determination of the moisture content of the calyx.
- Aluminum foil to warp the conditioned samples until they were weighed or tested.
- Plastic bags to hold the product.
- An oven (Memmert) makes for the determination of the moisture content of calyx.
- A sensitive balance of (Meller) make with an accuracy of ±0.01 g.
- Conical flask (250ml) for the preparation of the saturated salt solutions.
- A graduated cylinder for measuring the volume of distilled water that was used in the preparation of the saturated salt solutions.
- Three incubators of Heraeus Electronic make with a temperature range of 0 - 1000C.
- A thermometer to measure the temperature.
- A glass rod to stir the saturated salt solutions.
- Desiccators in which samples of calyx were tested for EMC determination.
- A hygrometer to check the relative humidity (RH) of the saturated solutions.
- Petri dishes in which the sample were put on the perforated plates of the desiccators.

2.2 The sample weight

The sample weight containing moisture content 6.6% was described by Pixton (1983) as follows:
B =

Where:
B = final weight of the sample after drying (g).
A = initial weight of the sample, (g).
a = initial moisture content (MC) of the sample, (w.b).
b = desired find moisture content (MC) of the sample, (w.b).
Determination of equilibrium moisture content (EMC) values

Samples were used for the determination of equilibrium moisture content (EMC) for adsorption and desorption at 10°C, 30°C, and 50°C). The samples were weighed everyday and

placed back in the incubator until the weight was constant. Then the Roselle samples were removed from the incubator and put in the moisture content balance (accuracy±0.01g) to evaluate the equilibrium moisture content. The above mentioned procedure was repeated with incubator temperature of 10, 30, and 50 °C for determining adsorption isotherm. Sample tested in desiccators containing salts with a relative humidity (RH) above 90% mould development was observed. To determine desorption EMC, samples were conditional to have moisture consent of 20% (w.b.) by putting the samples in desiccators containing saturated salt solution of potassium sulphate (K_2SO_4). The desiccators were placed inside incubator at 5°C. The exerted relative humidity of the salt was measured to be 98.6%.

III. RESULTS AND DISCUSSION

Relative humidity of the surrounding air (RH %), temperature of the surrounding air (T) and particles size of the Roselle calyx were used to determine the equilibrium moisture content (EMC) for Roselle calyx. A polynomial function is found to fit both the adsorption and desorption equilibrium moisture content (EMC) values satisfactorily. Graphical representations and regression technique showed that as RH increases EMC will be increased as shown in Figs 1, 2, 3 and 4. The range of the regression equation of relative humidity and temperature were 11.2% - 96% and 10°C - 50°C, respectively. At a relative humidity above 85%, both the adsorption and desorption EMC values of the Roselle calyx could hardly be determined because of mold growth on the tested samples. The results were in agreement with the results obtained by Ashaye (2013) who mentioned that equilibrium moisture content (EMC) increased as relative humidity increased in all Roselle calyces irrespective of the temperature regimes. On the other hand, graphical representations and regression technique indicated that as temperature increases equilibrium moisture content (EMC) will be decreased. The results showed that, the temperature affects the adsorption and desorption EMC values. The results agreed with the results obtained by Jiang and Yuan (2013) and supported by Jitka et al. (2013) who reported that, the equilibrium moisture content EMC decreases with increasing temperature, at constant Aw.

Hysteresis effect and particle size dose not affecting the equilibrium moisture content (EMC) values for both adsorption and desorption EMC values for both whole and broken Roselle calyx as presented in Tables 1 and 2. This trend agrees with published study of Alakali et al. (2010).

Table 1: Adsorption isotherm for whole and broken Roselle calyx

Adsorption isotherm		95% confidence interval for μ1 - μ2	μ1 = μ2 VS μ1 = μ2			
Whole	Broken		to	t1	P	d.f
10°C	10°C	(-44.8, 37.0)	-0.24	2.571	0.82	5.0
30°C	30°C	(-14.7, 13.2)	-0.14	2.571	0.97	5.0
50°C	50°C	(-9.10, 11.0)	0.48	4.303	0.66	3.0

Table 2: Desorption isotherm for whole and broken Roselle calyx

Desorption isotherm		95% confidence interval for μ1 - μ2	μ1 = μ2 VS μ1 = μ2			
Whole	Broken		to	t1	P	d.f
30°C	30°C	(-14.7, 13.2)	-0.14	2.571	0.90	5.0
50°C	50°C	(-9.10, 11.0)	0.48	4.303	0.66	3.0

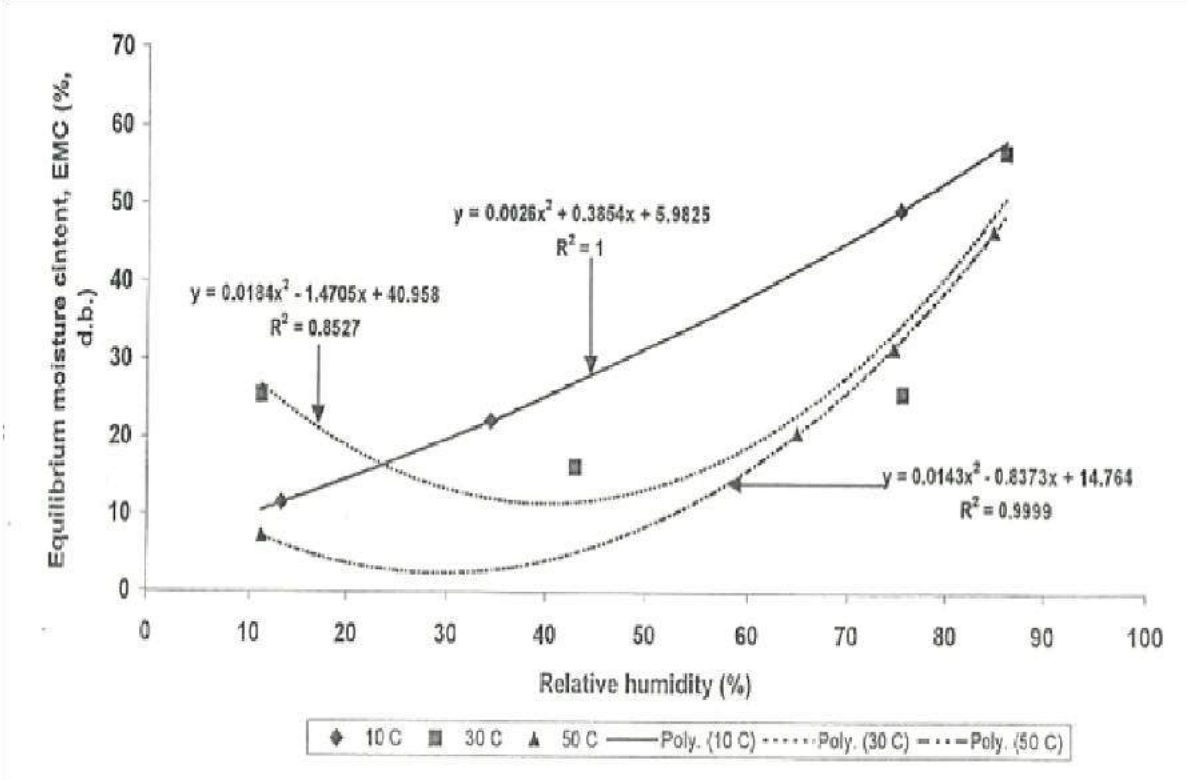

Fig.1: Adsorption isotherm of whole Roselle calyx

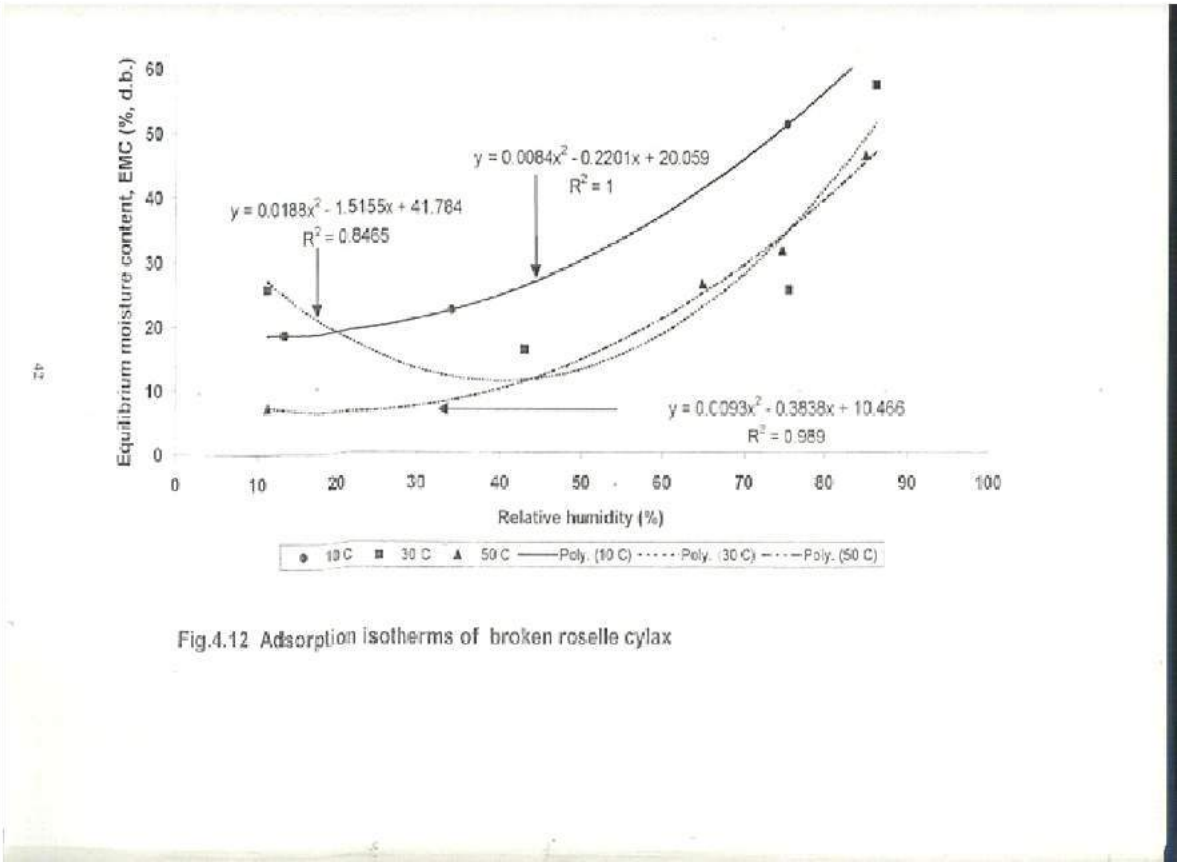

Fig.4.12 Adsorption isotherms of broken roselle cylax

Fig.2: Adsorption isotherm of broken Roselle calyx

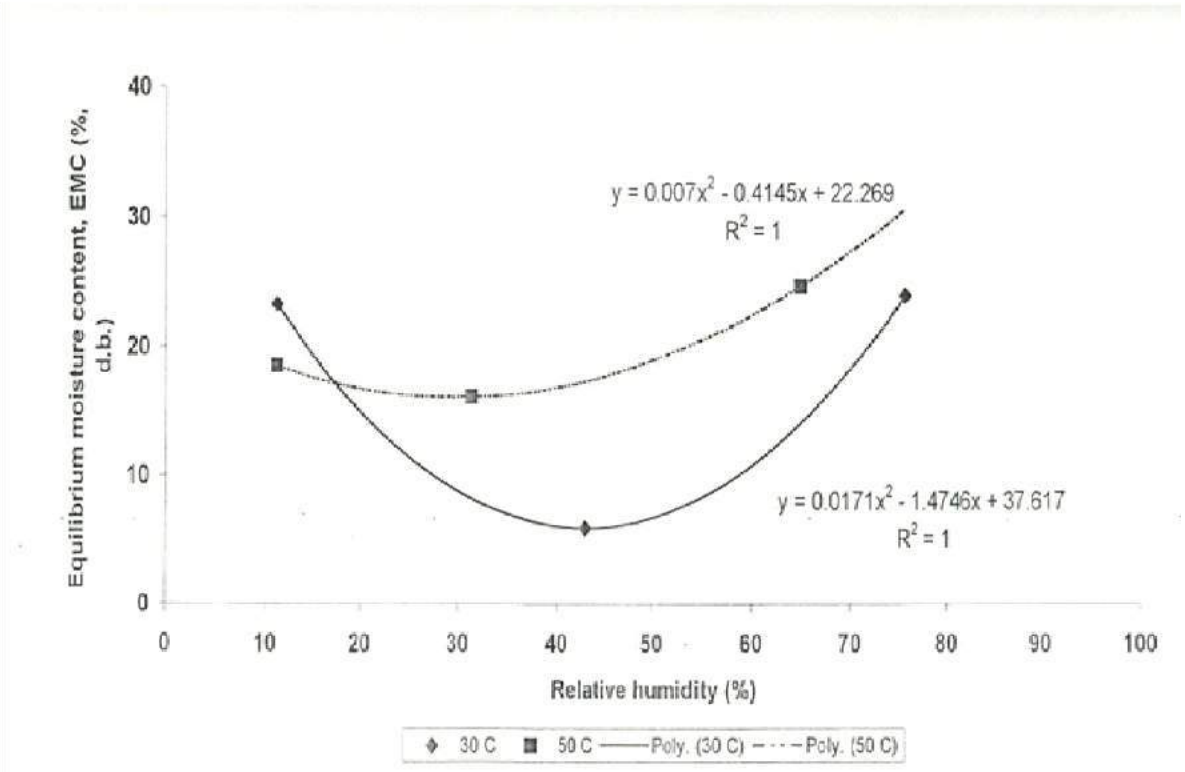

Fig.4.13 Desorption isotherms of whole roselle cylax

Fig.3: Desorption isotherm of whole Roselle calyx

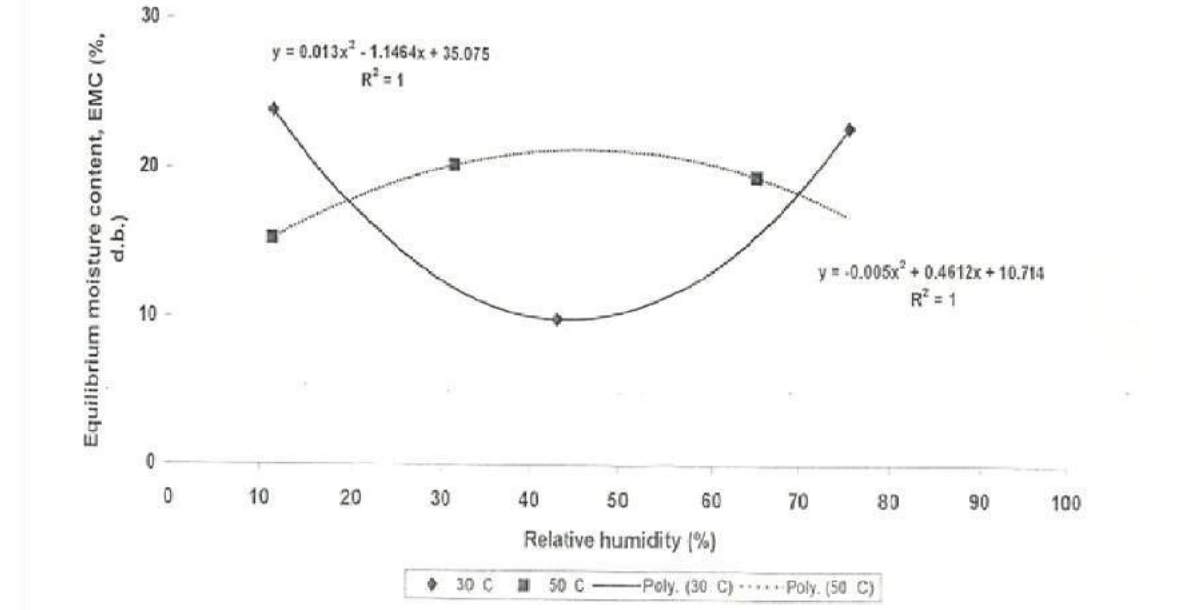

Fig.4.14 Desorption isotherms of broken roselle cylax

Fig.4: Desorption isotherm of broken Roselle calyx

IV. CONCLUSION

Under the acceleration of climate variability of Sudan, food storage should be undertaken seriously the moisture content and temperature to avoid the growth of mould on the food storage which significantly affected the product quality. As relative humidity (RH%) increases up to 85% equilibrium moisture content will be increased, while Above 85% of relative humidity no equilibrium moisture content values were detected due to the growth of mould on the tested sample. On the other hand, temperature was found to have negative relationship with equilibrium moisture content.

REFERENCES

1. Alkali, J.S., Irtwange, S.V. and Agbali, F.A.(2010). Physico thermodynamic properties of soy-gari. Journal of Food Processing and Preservation, 34: 470-489.
2. Ashaye, O.A. (2013). Studies on moisture sorption isotherm and nutritional properties of dried Roselle calyces. International Food Research Journal, 20(1): 509-513.
3. Chakaverty, A. and De, D.S. (1981).postharvest technology of cereals and pluses. Bombay, Calcutta, p 7.
4. Jiang, J. and Yuan, Y. (2013). Relationship of moisture content with temperature and relative humidity in concrete. Magazine of concrete research, 65(11), 685-692.
5. Jitka L.; Donludee J.; Ratiya T.; Charotorn P.; Jiři Š.; Danijela J.; Jiři F. and Vaclav V. (2013). Modelling the Moisture Sorption Isotherms of Roselle (Hibiscus Sabdariffa L.) in the Temperature Range of 5–35 °C. Acta Universitatis Agriculturae Et Silviculturae Mendelianae Brunensis, 195:1769-1777.
6. Kingsly, A. R. P. and Ileleji, K. E. (2009). Modeling moisture sorption isotherms of corn dried distillers grains with solubles (DDGS) using artificial neural network. Transactions of the ASABE, 52(1), 213-222.
7. Krishnamurthy, K.; Medani, H. H. and Mohammed, M. E. (1989). Manual on storage of food grains. FAO Project on Improvement of Storage and Pest Management Procedures for Food Security. FAO, Rome, Italy. pp 111.
8. Luampon, R. and Charmongkolpradit, S. (2019). Temperature and relative humidity effect on equilibrium moisture content of cassava pulp. Research in Agricultural Engineering, 65(1), 13-19.
9. Pixton, S.W. (1983). The importance of moisture and equilibrium relative humidity in stored products. Tropical Stored Products Information, 43: 16-29.
10. Turker, N.; Aksay, S. and Ekiz, H. İ. (2004). Effect of storage temperature on the stability of anthocyanins of a fermented black carrot (Daucus carota L.) beverage: shalgam. Journal of Agricultural and Food Chemistry, 52(12), 3807-3813.

The Birth of the New Theoretical System of Physics in the 21St Century! it will Speed up the Pace of Mankind from the "Earth Civilization Era" to the "Cosmic Civilization Era"! A

Jiang Hua Zhou

ABSTRACT

In 2000, the author presented a new discovery about the same material friction to produce the same charge at the ninth electrostatic conference of Chinese physical society. Through this important new discovery, the author puts forward a new theoretical system of physics in the 21st century. According to the theory and experimental facts of inter satellite repulsion in the new theoretical system, the author puts forward a design scheme for developing a new type of interplanetary spacecraft. I hope that mankind will speed up the pace from "earth civilization era" to "cosmic civilization era"!.

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I. INTRODUCTION

Published by IOP in Journal of Physics: conference series, Vol. 1634. At the Fourth International Conference on mechanics, mathematics and Applications (ICMMAP 2020), the author published an article entitled "new theoretical system of physics in the 21st century" 【1】.

At the Fifth International Conference on innovation in information and Education (ICIEI2020) held in London, UK, the author published an article entitled "the revolution of basic research in physics will usher in a new era in the study of interplanetary spacecraft"【2】.

At the "Sixth Symposium on new photoelectric detection technology and its application" held in Beijing, China in 2019, the author published an article entitled "revealing the causes of the formation of the earth's gravity" 【3】.

The publication of these three articles will accelerate the pace of mankind from the era of earth civilization to the era of cosmic civilization with the breakthrough of theoretical research of natural science! The theoretical system puts forward the unified field theory of gravitational field, electric field and magnetic field from a new perspective! This paper reveals the causes of the formation of the universal gravitation in the material world, specifically expounds the causes of the formation of the earth's gravity, the formation of the high-temperature liquid phase transition in the earth's core, the formation of the earth's rotation, and the formation of the N, S poles of the geomagnetic ! In addition, the reasons for the formation of the repulsive force between the stars in space, such as the formation of the relationship between the main satellites of the planets around the stars, the formation of the balance of each star in the universe, the formation of the plane system structure of the galaxy, the change of comet structure and the formation of elliptical orbit around the sun wait! A new theoretical understanding of the formation of black hole gravity in the universe is also proposed! The origin of the "new theoretical system of physics in the 21st century" is based on the in-depth study of the new discovery of the same material friction to generate the same-sex charge. He puts forward a new understanding of all electrostatic phenomena, and then puts forward a new understanding of the atomic model. From a new perspective of the basic understanding of the

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material world, a new understanding of the "new theoretical system of physics in the 21st century" is proposed Watch! This "new theoretical system of physics in the 21st century" reveals that the existing theories are difficult to explain many important scientific problems that perplex mankind! "The new theoretical system of physics in the 21st century" has added a brand-new concept of cognition for us to seek the truth of natural science! With the birth of the "new theoretical system of physics in the 21st century" in 2020, "the revolution of basic research in physics will usher in a new era in the study of interplanetary spacecraft" and "revealing the cause of the formation of earth's gravity". The publication of the three articles will certainly accelerate the pace of mankind's stride from the "earth civilization era" to the "cosmic civilization era"!

II. THE BIRTH OF THE NEW THEORETICAL SYSTEM OF PHYSICS IN THE 21ST CENTURY!

The following is the International Journal of Physics: Conference Series (ISSN: 1742-6588), Vol. 1634, which published the new theoretical system of physics in the 21st century【1】Abstract of the article:

In 2000, the author presented a new discovery about the same material friction to produce the same charge at the ninth electrostatic conference of Chinese physical society. For this important new experimental discovery, the author puts forward a new understanding of "positive and negative charges", and finds a new theory to explain all electrostatic effects. Based on the subversive new understanding of "matter", "entity" and "heat energy", a new understanding of "dynamic atomic model of particle charge" has been initiated. The relationship between "entity" and "heat energy" is the source of gravitation and repulsion between matter, and the law of equilibrium distance between gravitation and repulsion between matter (between atoms and between planets) is proposed. This paper reveals the cause of the earth's gravitation and the causes of many phenomena of gravitation and repulsion in the universe. In the fields of gravitational field, magnetic field and electric field, a series of important scientific problems have been revealed! The establishment of the new theoretical system of physics provides a new vision for solving "all physical problems"! The new theoretical system consists of six parts: the first part introduces the reasons for the establishment of the "new theoretical system"; the second part puts forward the new basic epistemology of the material world; the third part is the new epistemology of gravitational repulsion field; the fourth part is the new epistemology of magnetic field; the fifth part is the new epistemology of electric field; the sixth part expounds the scientific significance of the new theoretical system. From the new perspective of the basic composition of "entity" and "heat energy" in the material world, this paper makes a new understanding of matter, entity, heat energy, atom, element, gravity, repulsion, magnetic field and electric field, and establishes a new theoretical system of physics in the 21st century: the "unified field theory" constructed by "entity" and "heat energy". Scientific research needs a new vision to expand people's subjective thinking of the objective nature. The establishment of this new theoretical system may lead to a new physics revolution in the 21st century.

III. PRACTICAL APPLICATION OF THE NEW THEORETICAL SYSTEM OF PHYSICS IN THE 21ST CENTURY

The following is an abstract of an article entitled "the revolution of basic research in physics will usher in a new era of interstellar spacecraft research"【2】 at the Fifth International Conference on innovation in information and Education (iciei 2020) held in London, UK :

In 2000, the author presented a new discovery about the same material friction to produce the same charge at the ninth electrostatic conference of Chinese physical society. This new discovery is of great significance. It opens an excellent window for us to understand the mysteries of Natural Science in the material world, opens up a new research field for human beings to seek the truth of natural science, and explores a new theoretical system for physical research. Under the guidance

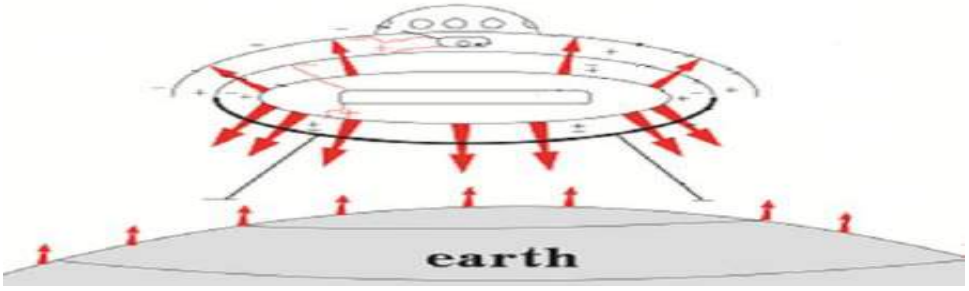
of the new theoretical system, the experimental results of a high-voltage discharger which generates ground lift by discharge have important application value. Based on the new theory of repulsion between satellites, the development idea of electromagnetic propulsion "space flying saucer" is put forward. See the author's experimental videos, research papers, invention patents and related materials. In order to speed up the research process of "space flying saucer" driven by electromagnetic propulsion, the author seeks the cooperation of international intellectual circles! I hope the miracle of human space will come soon!

IV. SPEED UP THE PACE OF MANKIND FROM THE "EARTH CIVILIZATION ERA" TO THE "COSMIC CIVILIZATION ERA"!

The article "the revolution of basic research in physics will usher in a new era in the study of interplanetary spacecraft" published at the London International Conference is the first time that human beings put forward the research article on "space flying saucer" with electromagnetic propulsion power at the international academic conference!

The following is an excerpt from part of the article "the revolution of basic research in physics will usher in a new era in the study of interplanetary spacecraft"【2】:

The birth of the new theoretical system of physics in the 21st century! It will speed up the pace of mankind from the "earth civilization era" to the "cosmic civilization era"! Under the guidance of the theory that each planet "emits electromagnetic field" into outer space in the new theoretical system, the author designs the experimental results of the lifting force produced by the high-voltage discharge body on the earth discharge, which has important significance and application value. The experiment is based on the lifting force caused by the repulsion between the earth's "electromagnetic field" discharging into "outer space" and the high-voltage discharge body. This is a way to overcome the gravity of the earth by using the "law of equilibrium distance between gravitation and repulsion" between planets. It is a kind of spacecraft which uses the "inter satellite repulsion theory" as its dynamic performance. This kind of spacecraft will be able to fly freely between planets by using the dynamic performance of "inter satellite repulsion theory".



Schematic diagram of space flying saucer prototype

In the future, with the improvement of discharge energy of high-voltage discharge vehicles, when mankind successfully develops a "space flying saucer" driven by high-power discharge driven by electromagnetic propulsion and roaming in interstellar space, it will be more convenient for human to travel to and from various planets. It will usher in a new era of interstellar space vehicles! With the development of human beings to the depth of the universe, it will accelerate the pace of mankind from the era of earth civilization to the era of universal civilization! At that time, mankind will move from the "earth civilization era" to the "cosmic civilization era"!

REFERENCE

1. Jiang Hua Zhou . 2020 J. Phys.: Conf. Ser. 1634 012103.DOI:https://doi.org/10.1088/1742-6596/1634/1/012103.
2. Jiang Hua Zhou .ICIEI 2020: Proceedings of the 5th International Conference on

Information and Education Innovations July 2020 Pages:89–95. DOI: https://doi.org/10.1145/3411681.34116870.
3. Jiang Hua Zhou "Reveal the cause of the formation of gravity", Proc. SPIE 11455, Sixth Symposium on Novel Optoelectronic Detection Technology and Applications, 114554L (17 April 2020).DOI: https://doi.org/10.1117/12.2564978.

A Design Study of Printed Moxon Antenna

Aladdin Assisi

ABSTRACT

A Moxon antenna is a special case of Yagi-Uda antenna with folded dipole and single folded reflector. It is a simple antenna with no side or back lobes .It has a moderate gain and a high front-to-back ratio. It can be designed for different frequency bands, starting from HF up to centimetric and even millimetric bands. It can be built as a wire antenna or printed on a dielectric substrate. In this paper we are going to study the development of Moxon antenna from simple dipole antenna and the design and optimization of printed Moxon antennas on different substrates, trying to investigate the effects of substrate material on the antenna performance.

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A Design Study of Printed Moxon Antenna

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ABSTRACT

A Moxon antenna is a special case of Yagi-Uda antenna with folded dipole and single folded reflector. It is a simple antenna with no side or back lobes. It has a moderate gain and a high front-to-back ratio. It can be designed for different frequency bands, starting from HF up to centimetric and even millimetric bands. It can be built as a wire antenna or printed on a dielectric substrate. In this paper we are going to study the development of Moxon antenna from simple dipole antenna and the design and optimization of printed Moxon antennas on different substrates, trying to investigate the effects of substrate material on the antenna performance.

I. INTRODUCTION

The Yagi-Uda antenna is a widely used radiating structure for a variety of applications in commercial and military sectors [3]. The Moxon antenna was created by British Ham Radio operator Les Moxon, as a means of reducing the size of a typical 2 element Yagi [5]. It is a special case of Yagi-Uda antenna with folded dipole and single folded reflector, where the horizontal spans of the reflector and the dipole are equal. The main advantage of the Moxon antenna is its high front-to-back ratio. Moreover, it has no side lobes. A Moxon antenna can be a wire antenna or a printed antenna. It is difficult to find published papers about Moxon antennas. Chougale et al designed a simple UHF Moxon antenna [5]. Q. Lui et al proposed a printed UHF Moxon antenna with miniature size using meanderline structures in the dipole and the reflector. They achieved a 70 x 150 degrees beamwidth, a 4.48 dB gain and a 17.7 dB front to back ratio at 900 MHz with 80 x 60 mm antenna dimensions [10]. and a 4. . The first published Moxon antenna array was proposed by Suad Başbuğ [11]. He has synthesized a four element array pattern of Moxon elements, using a proposed hybrid method [11].

In this paper we apply some numerical optimization techniques to get the best possible antenna design in different cases.We have selected the Trust Region Framework Algorithm recommended by CST electromagnetic simulator. This technique was discussed and explained by Yuan [7]. In most antenna optimization problems, several goals must be satisfied simultaneously in order to obtain an optimal solution. As these objectives are often conflicting, no single solution may exist that is best regarding all considered goals [6]. Solving antenna optimization problems is a conflicting problem where fast methods only carry local guarantees while robust methods are prone to have very slow convergence [6]. X. L. Travassos, D. A. G. Vieira and A. C. Lisboa introduced an excellent study of antenna design optimization with solved examples [6]. Fortunately, optimizing Moxon antenna design with a single objective function has been successful as we shall see in this paper.

A single director, or even multiple directors, may be inserted in front of the dipole to increase the antenna gain and decrease its beamwidth. If there is a director, its geometrical parameters affect the antenna gain and radiation pattern. They may also affect the frequency response. Therefore, the antenna design should be re-optimized after adding a director. This case will not be studied in this paper.

In the following sections we shall study the following:

a. Developing a Moxon antenna, starting from a simple printed dipole.
b. The electric field flux lines of a Moxon antenna in free space and on different substrates to see the effect of dielectric constant on electric flux.

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c. Study and optimization of main antenna performance parameters; namely insertion loss, bandwidth, gain, radiation efficiency, total efficiency and front-to-back ratio on different substrates.

II. A FREE SPACE DIPOLE ANTENNA

Figure 1a shows a simple printed dipole antenna in free space with dipole length = 212 mm. It resonates at 653.23 MHz as shown in Figure 1b.

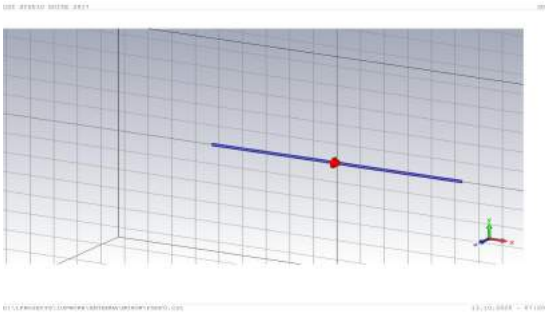

Figure 1a:

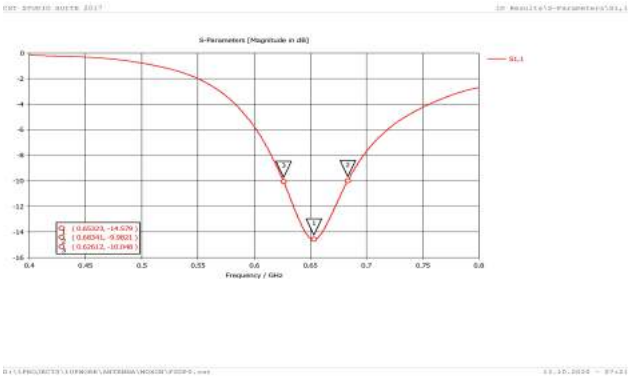

Figure 1b:

A dipole antenna resonates at frequency f_0, given by:

$$f_0 = \frac{3x10^8}{wavelength} \cdot K \qquad (1)$$

where K is a correction factor < 1 due to the end effect of the dipole. It depends on the dipole cross section area and the frequency band.

Driven element is usually kept 0.475 times of wavelength because only 95% of the dipole antenna radiates [4]. The theoretical resonance frequency would be:

$$f_{0th} = \frac{3x10^8}{wavelength} = \frac{3x10^8}{0.424} = 707.55\ [\text{MHz}]$$

The ratio K between the actual and theoretical resonance frequencies is 653.23/707.55 = 0.9232.

The electric field intensity vector of an electric dipole in polar coordinates is give by [1]:

$$\mathbf{E} = \frac{Qd}{4\pi\epsilon_0 r^3}(2\cos\theta\,\mathbf{a}_r + \sin\theta\,\mathbf{a}_\theta) \qquad (2)$$

where Qd is the dipole moment

θ is the vertical angle measured from the z axis

r is the distance from coordinates origin

$\boldsymbol{a}_r$ *and* $\boldsymbol{a}_\theta$ unit vectors in the r and θ *directions, respectively.*

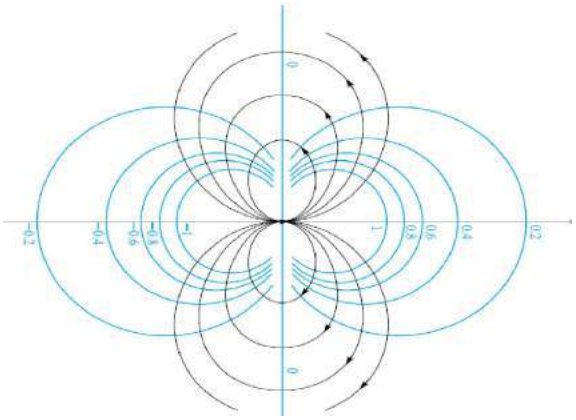

Figure 2a

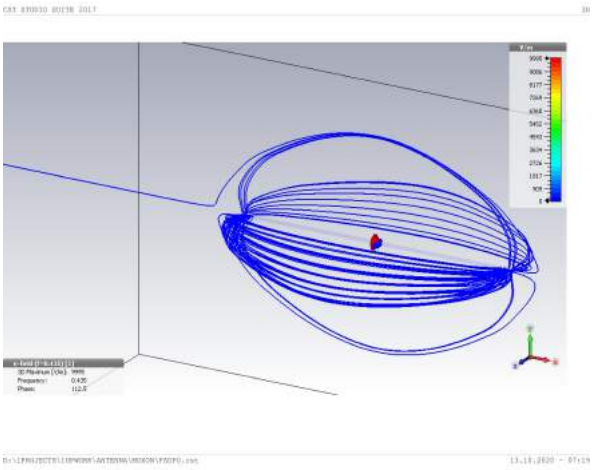

Figure 2b

Figure 2a shows the calculated electric flux lines (black) of an electrostatic dipole, while Figure 2b shows the simulated 3D electric flux lines of the free space dipole antenna. The blue lines in figure 2a are the equipotential surfaces of the electrostatic dipole. The simulated radiation pattern is a symmetrical omni-directional pattern with 2.28 dB gain and very high radiation efficiency at 653.23 MHz.

III. A PRINTED DIPOLE ANTENNA

Figure 3a shows a simple UHF printed dipole antenna with dipole length = 212 mm.

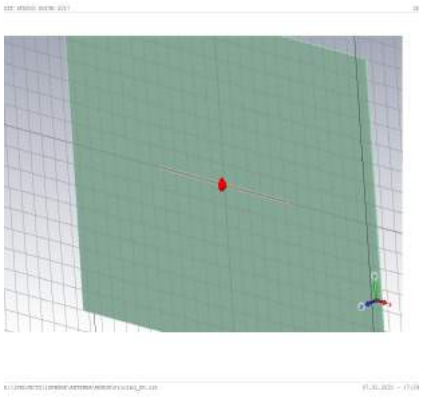

Figure 3a

If we consider that the dipole length $L = k\lambda_G/2$; the guided wavelength is

$$\lambda_G = \frac{2L}{k} = \frac{2x212}{0.9232} = 459.27 \text{ mm.}$$

Figure 3b shows the S11 of the printed dipole antenna. It resonates at 567.2 MHz with a 56.89 MHz bandwidth.

Since the dipole resonates at 0.5672 GHz; its free space wavelength is

$$\lambda_o = \frac{300}{0.5671k} = 573 \text{ mm.}$$

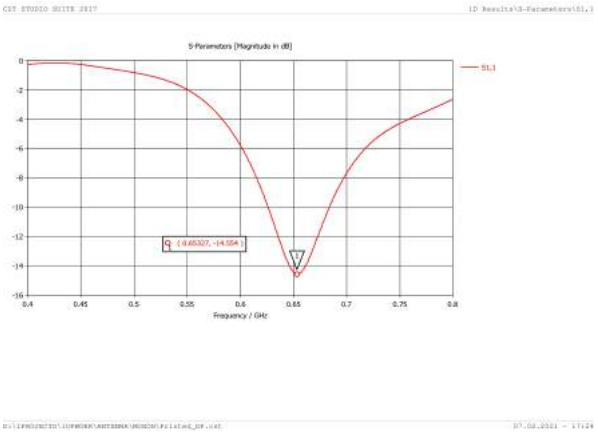

Figure 3b

Due to the substrate dielectric constant, a 210 mm dipole resonates at this frequency. Therefore, we can estimate the effective dielectric constant as

$$\sqrt{\varepsilon_{eff}} = (\lambda_o/\lambda_g) = \frac{573}{459.27} = 1.2477 \text{ and } \varepsilon_{eff} \approx 1.1557.$$

Figure 4 shows the omni-directional antenna radiation pattern of the simple printed dipole at 567.2 MHz with a 2.237 dB gain

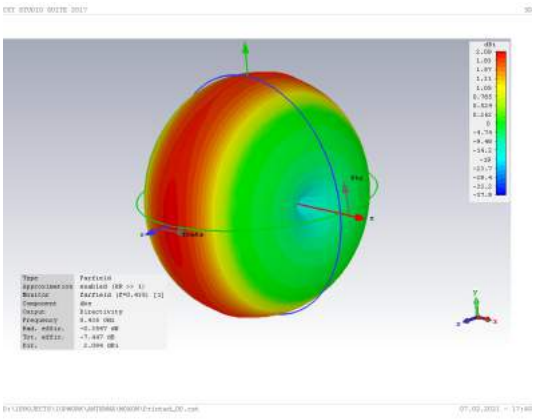

Figure 4

IV. FOLDED PRINTED DIPOLE ANTENNA

Figure 5a shows the same dipole antenna after the addition of two 31 mm perpendicular extensions.

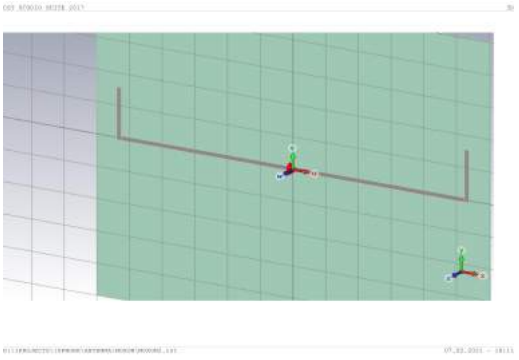

Figure 5a

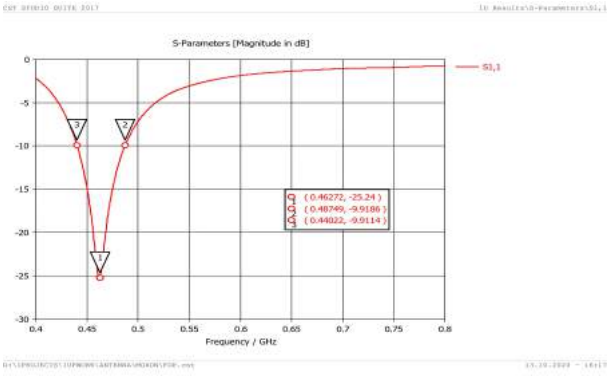

Figure 5b

As the dipole length is extended, the resonance frequency decreases to 462.72 MHz, as it appears in Figure 5b. The electric flux lines of the folded dipole antenna are shown in Figure 6, while the 3D antenna pattern is shown in Figure 7. They are similar to those of the unfolded dipole.

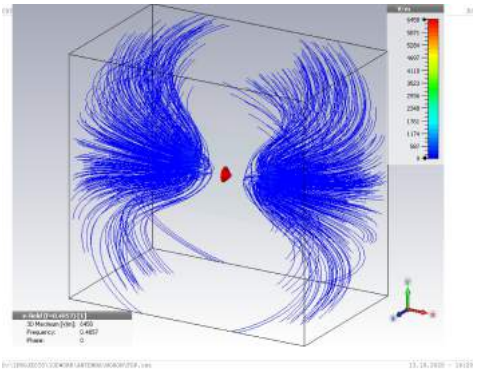

Figure 6

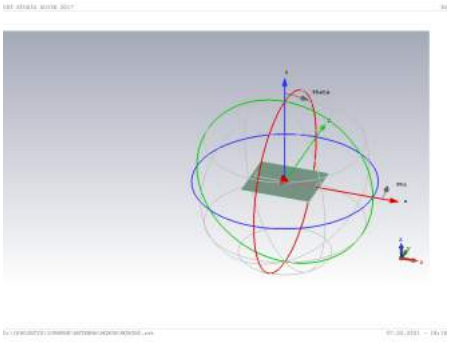

Figure 7a

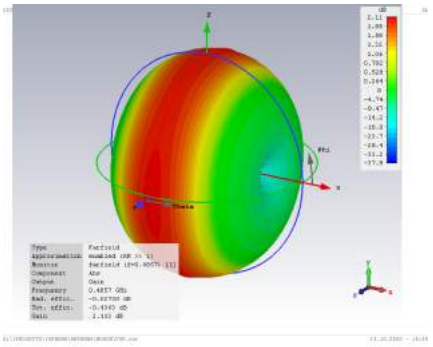

Figure 7b

V. FOLDED DIPOLE WITH REFLECTOR

A simple dipole has an omnidirectional toroidal radiation pattern. It can be directed by placing a reflector parasitic element. A rod of equal or slightly longer length is placed a quarter wave away from a half wavelength long vertical antenna. The current induced in it will be in phase or lag behind. This effect will make this rod a 'wave reflector' [4]. Figure 8 shows the same folded dipole with a reflector. A folded dipole with such a reflector is called Moxon Antenna. The reflector has the same lateral length of the original dipole (212 mm) with folded arms such that there is a certain gap between each arm of the reflector and the corresponding arm of the folded dipole. This gap is subject to control and optimization; since it affects the Moxon antenna performance. Perhaps the most critical dimension is the gap [5].

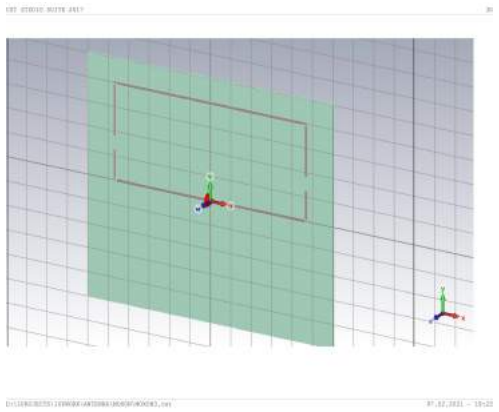

Figure 8a

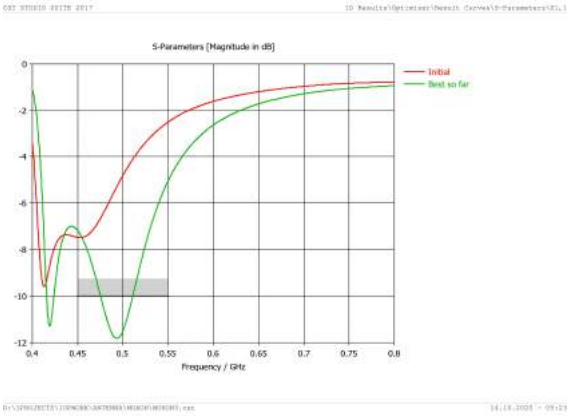

Figure 8b

Figure 8b shows the S11 of this Moxon antenna. It resonates at a smaller frequency with distorted frequency response. Its parameters need optimization.

Figure 9a shows the 3D antenna pattern of this Moxon antenna. It is evident that the reflector directed the pattern in the negative y direction. The pattern is no more omni-directional. The maximum gain has been increased from 2 dB to 4.87 dB. The total efficiency is increased from -1.789 dB (66.237%) to -0.7617 dB (83.9%) and the radiation efficiency from -0.53 dB (88.5%) to -0.01761 dB (99.6%).

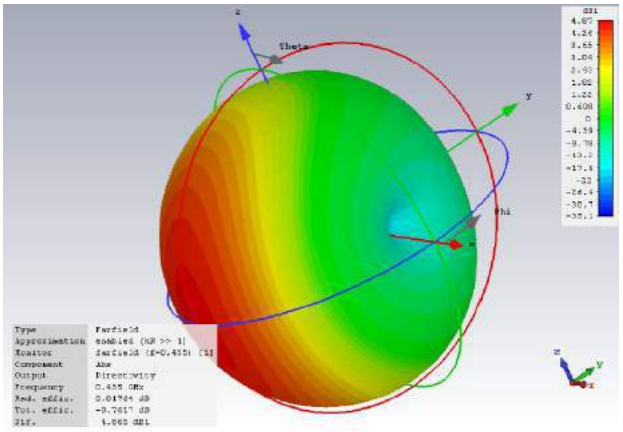

Figure 9a

Figure 9b shows the 2D antenna pattern of the same Moxon antenna. It is evident that the pattern has neither a back lobe nor side lobes. The front-to-back ratio is 5.698 + 7.841 = 13.539 dB.

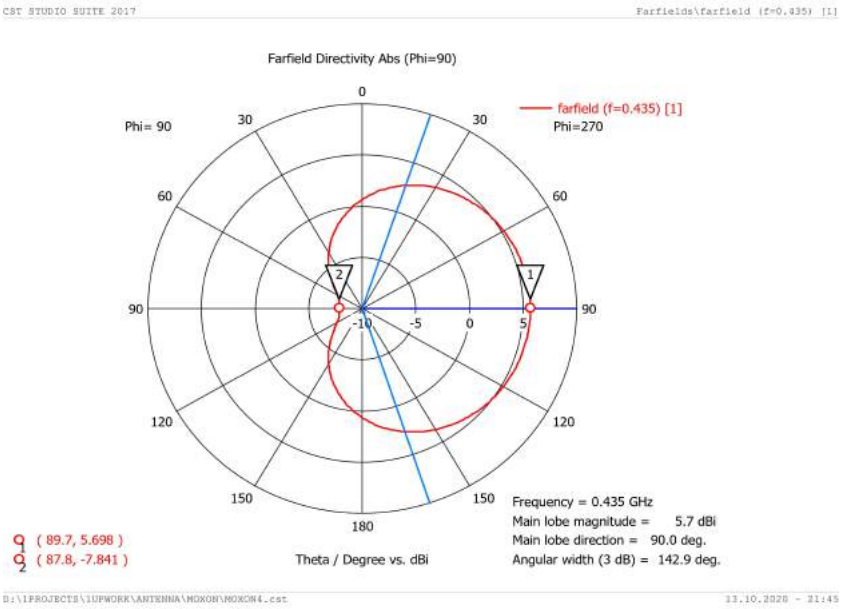

Figure 9b

VI. A 2.4 GHz FREE SPACE MOXON ANTENNA

The total length of a dipole antenna at 2450 MHz is estimated as

$$L_o\,[\text{mm}] = \frac{150k}{f_{GHz}} = \frac{150x\ 0.9232}{2.45} = 56.52\ [\text{mm}].$$

The Moxon antenna was modeled as 0.036 mm thick copper lines in free space. Figure 10 shows the designed antenna. Let us start with a 0.2 folding ratio and optimize the antenna dimensions to maximize the insertion loss at 2450 MHz. Being a time / frequency domain electromagnetic simulator that indirectly extracts radiation patterns from simulation results, the CST Microwave Studio cannot take radiation pattern parameters as optimization goals. We have optimized for maximum insertion loss around the resonance frequency. The optimization variables were the dipole arm width, the dipole arm length, the folding ratio, the gap

between the dipole arm and the reflector and the reflector depth. The optimization for maximum resonance insertion loss enhanced all the antenna performance parameters. The S11 of the optimized antenna is shown in Figure 11.

Figure 12a shows the electric field intensity distribution of the free space Moxon antenna. In this figure we can see that the field peaks lie at the dipole edges and that the electric field is minimum at the dipole center. The same phenomenon can be observed at the reflector: The electric field intensity is minimum at the reflector center. When the electric field display is animated, it is noted that the field starts from the dipole, travels to the reflector where it is reflected back and radiated to the negative y direction. In this way the reflector enhances the front radiation and, consequently, the radiation efficiency, and the main lobe antenna gain.

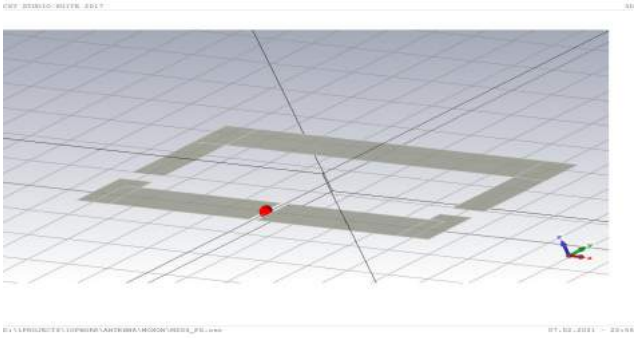

Figure 10

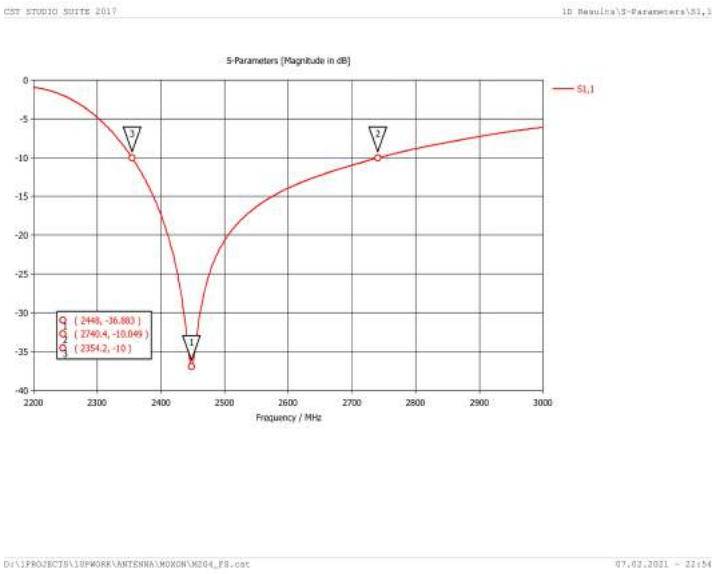

Figure 11

If we observe the electric flux lines in Figure 12b, we can see that they start at one dipole edge and end at the other edge as expected. Another group of flux lines start at the dipole edge and ends at the reflector edge, while a third group of flux lines go through the gap between the dipole and the reflector. It can be noted that the 3D electric field flux lines pass outside the horizontal plane where the metallic lines of the antenna lie. The most important remark is that no flux lines pass at the geometric centerline of the antenna.

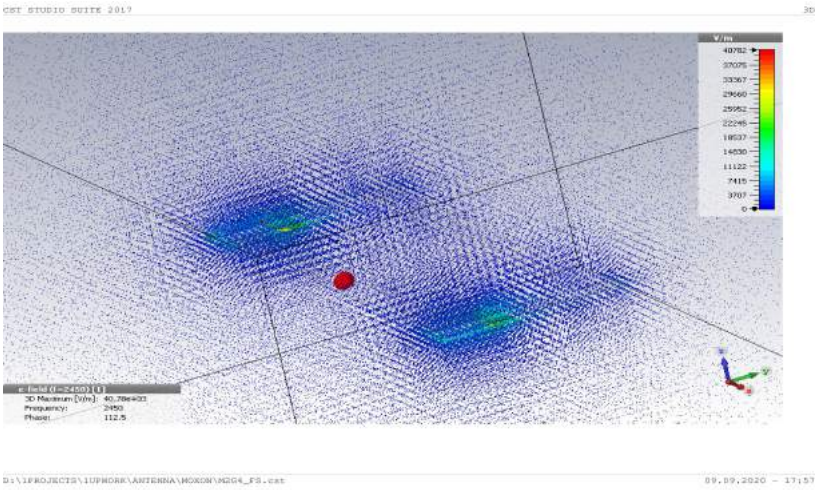

Figure 12a

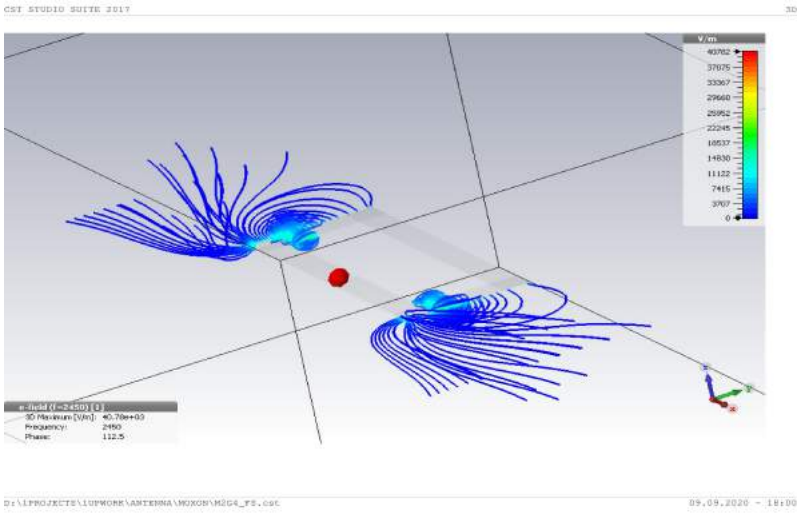

Figure 12b

Figure 13a shows the 3D antenna gain pattern of the optimized free space 2.4 GHz Moxon antenna at 2.5 GHz. We can note that the antenna gain in the negative y direction is 5.562 dB, while in the positive y directions it decreases to about -11 dB. This will be seen more clearly in the 2D antenna plot (Figure 5). The antenna has a good radiation efficiency -0.01011 dB) and an excellent total efficiency (-0.008993 dB). Figure 13b shows the 2D radiation pattern plot; where it is very clear the absence of any back or side lobe. We can measure the front-to-back ratio = 5.562 - (-11) = 16.562 dB.

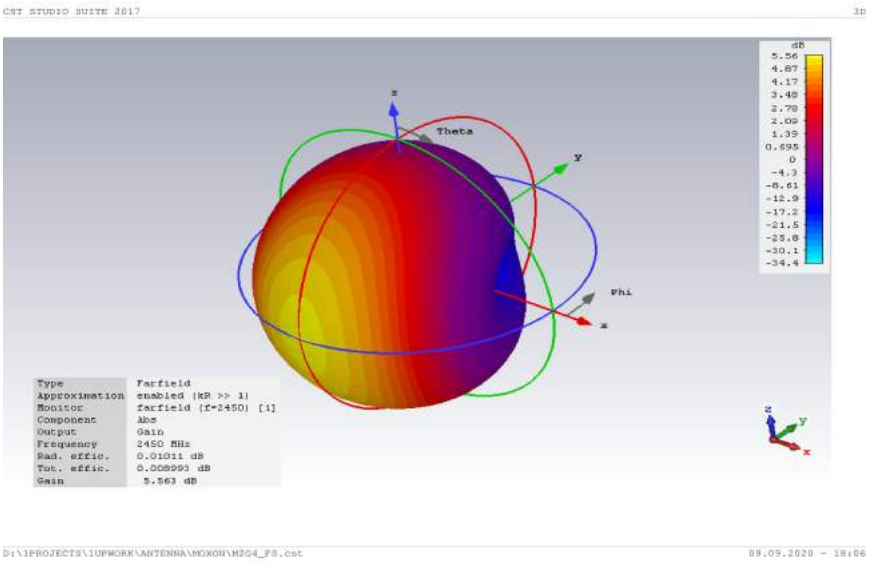

Figure 13 a

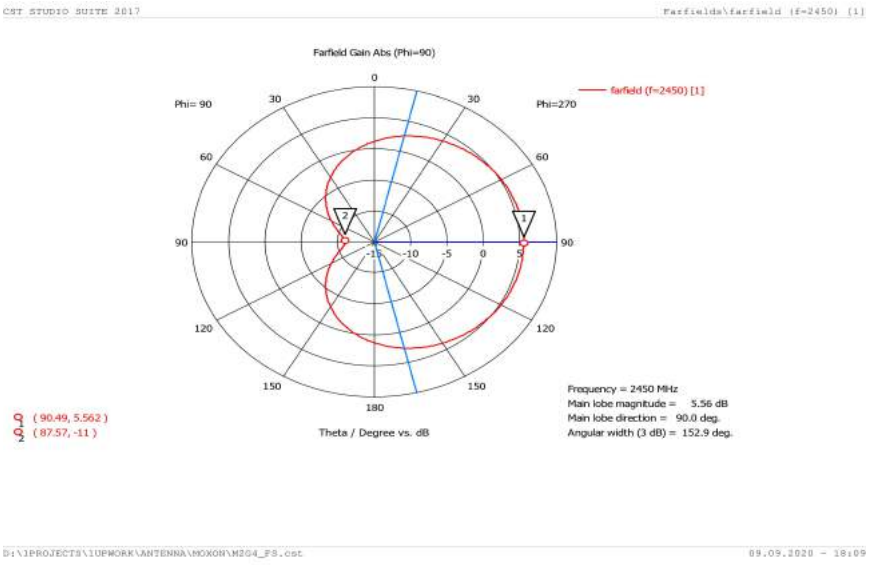

Figure 13 b

VII. 2.4 GHz MOXON ANTENNAS ON TWO DIFFERENT SUBSTRATES

A Moxon antenna was designed as printed copper lines on a 1.6 mm thick TACONIC HT-1.5 substrate with a 2.35 dielectric constant and a 0.0025 dissipation factor.

The first simulation showed an acceptable match and a shifted resonance frequency. The optimization resulted in a well matched antenna, resonating at 2440.5 MHz with a peak return loss of 42 dB and 366 MHz bandwidth. The S11 of the original and optimized antenna areshown in Figure 14. The Moxon antenna was re-designed and optimized as printed copper lines on a 1.6 mm thick FR4 with a 4.3 dielectric constant and a 0.025 dissipation factor. The frequency response of the optimized FR4 antenna is shown in Figure 15.

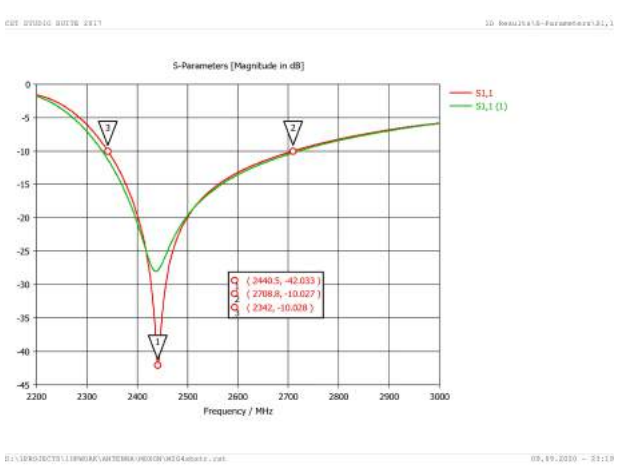

Figure 14

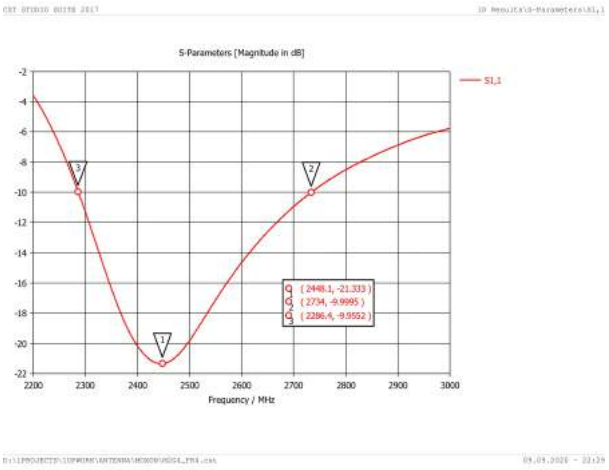

Figure 15

The far field 3D patterns of the two antennas are shown in Figures 16 and 17 respectively, while the 2D patterns are shown in Figures 18 and 19.

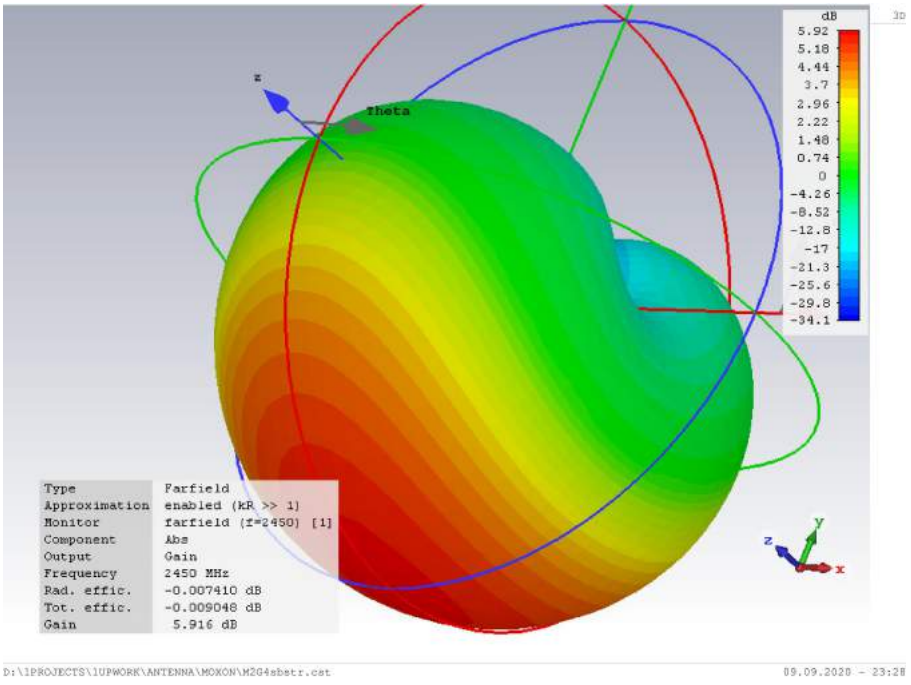

Figure 16: 3D Pattern of the HT-1.5 antenna

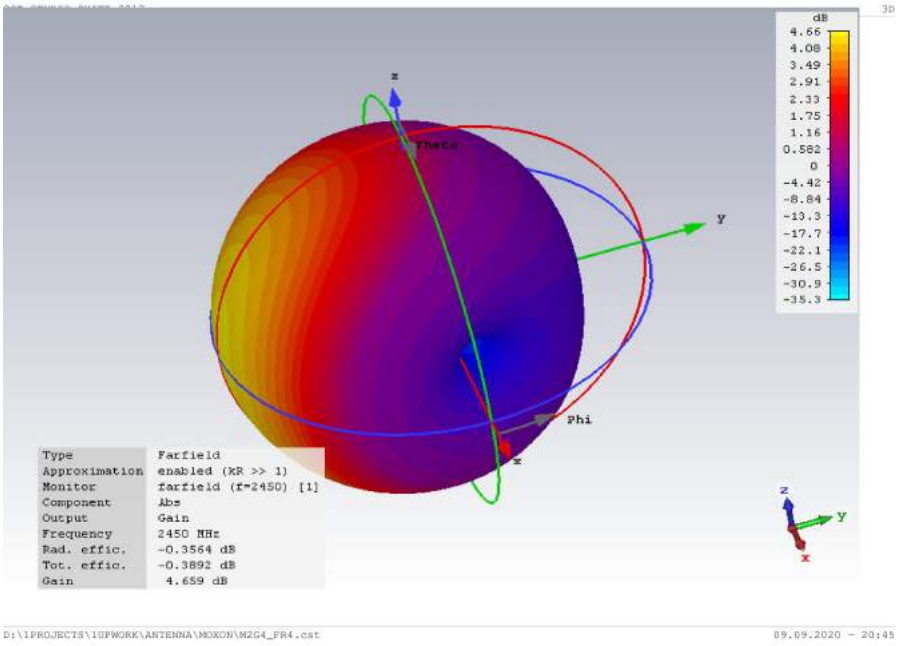

Figure 17: 3D Pattern of the FR4 antenna

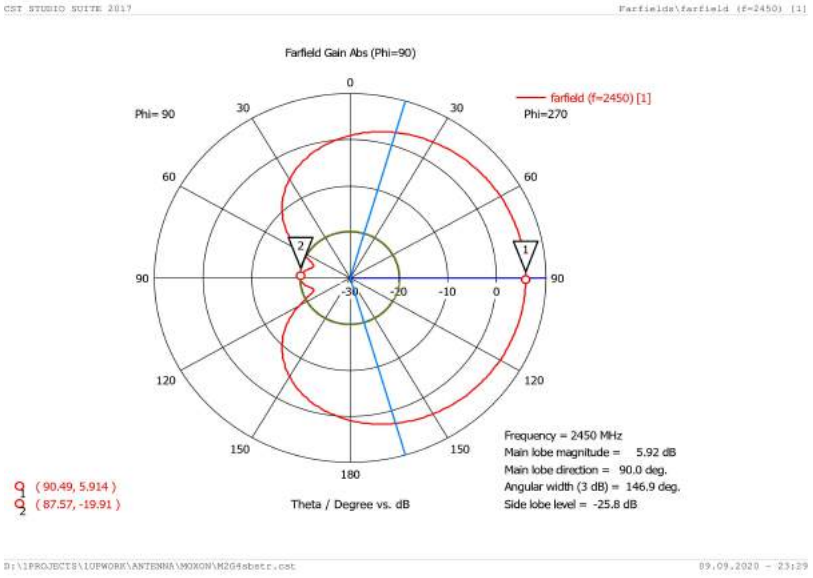

Figure 18: 2D Pattern of the HT-1.5 antenna

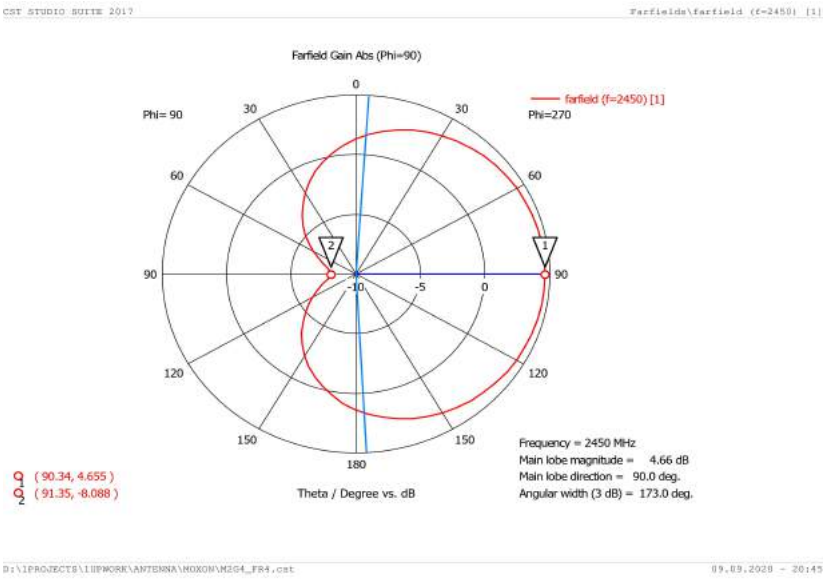

Figure 19: 2D Pattern of the FR4 antenna

VIII. EFFECT OF DIELECTRIC CONSTANT ON THE ELECTRIC FLUX

The electric field flux lines of printed Moxon antenna for three different dielectric constant values are displayed with equal scales in Figure 20 (**a** for free space, **b** for TH-1.5 with $\varepsilon_r = 2.35$ and **c** for FR4 $\varepsilon_r = 4.3$).

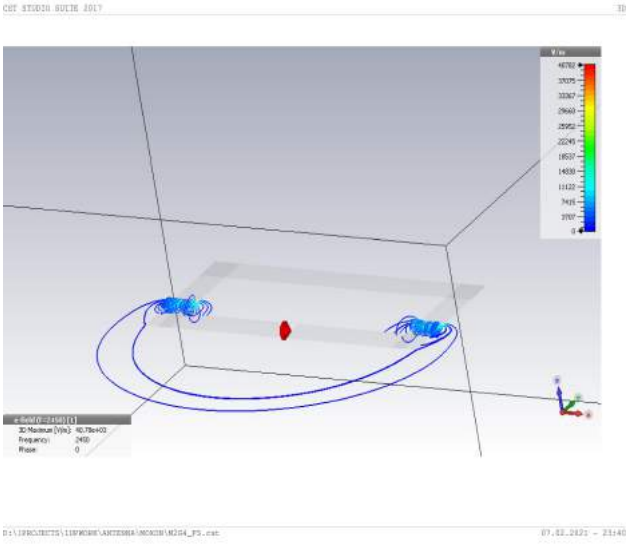

Figure 20 a.

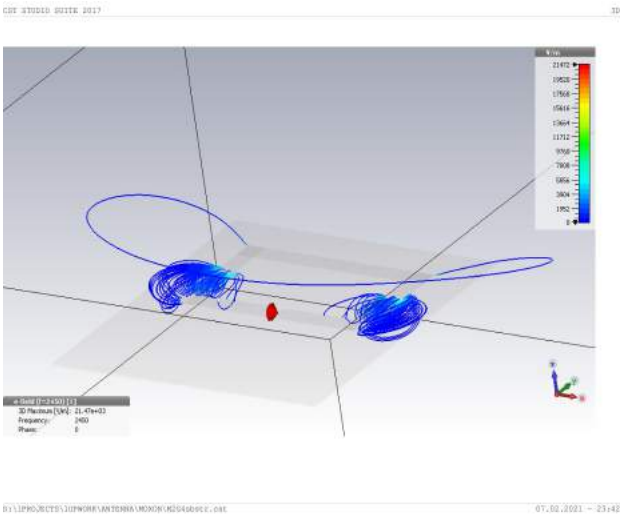

Figure 20 b

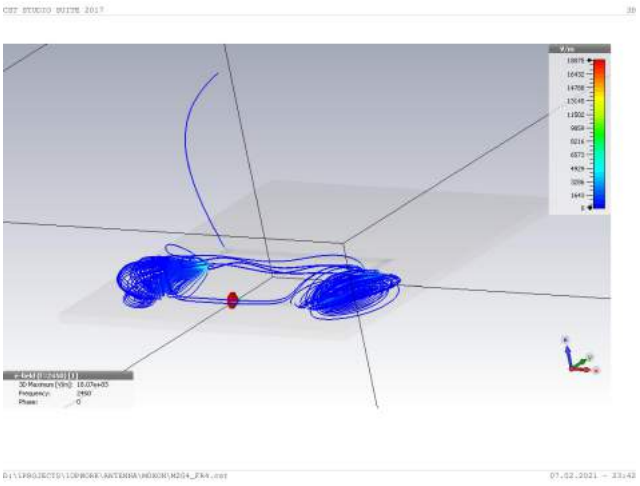

Figure 20 c

it can evidently be seen that increasing the dielectric constant concentrates electric flux lines in a smaller volume. We can expect that a 10.2 dielectric constant substrate would shrink the electric field to a smaller volume than that of the FR4 Moxon antenna. This conclusion will help to locate metallic bodies in the vicinity of a printed Moxon antenna without affecting its performance.

IX. COMPARISON OF ANTENNAS ON DIFFERENT SUBSTRATES

The following table summarizes the antenna performance parameters of 2.4 MHz Moxon antennas designed and optimized on different substrate materials.

The free space Moxon antenna with 0.036 mm copper thickness is only considered for reference. It cannot be practically implemented. The actual comparison is between the HT-1.5 and FR4 substrates.

TABLE 1

DIELECTRIC		FREE SPACE	TACONIC HT-1.5	FR4
Dielectric constant		1	2.35	4.3
Resonance frequency	GHz	2.45	2.4405	2.48
Bandwidth	MHz	386	366	448
Radiation Efficiency	dB	-0.01011	-0.0047	-0.3564
	%	99.77	99.89	92.12
Total Efficiency	dB	-0.008993	-0.009	-0.3892
	%	99.79	99.79	91.428
Maximum Gain	dB	5.562	5.916	4.655
Front-to-back Ratio	dB	16.562	25.826	12.743

Although the optimized HT-1.5 antenna has a higher radiation efficiency, a higher total efficiency, a higher maximum gain and a much higher front-to-back ratio than the optimized FR4 antenna, the corresponding performance parameters of the optimized FR4 antenna are still very good. If we consider its wider bandwidth and much smaller price, we would recommend the FR4 for building printed Moxon antennas in the ISM 2.4 GHz frequency band.

X. CONCLUSION

The front-to-back ratio is mainly affected by the dipole-reflector separation. The antenna resonance frequency is mainly controlled by the total length of the folded dipole. However, it can be affected by the reflector dimensions. Special attention should be paid to adjust the resonance frequency and maximize the in-band return loss, the bandwidth and the radiation and total efficiencies. All these performance parameters can be affected by the geometric parameters of the reflector and the folding ratio of the dipole. Optimizing the antenna dimensions for maximum resonance return loss may enhance all its performance parameters, such as bandwidth, beamwidth, radiation and total efficiencies, gain and front-to-back ratio.

In a printed Moxon antenna, the substrate parameters also affect the antenna performance. Increasing the dielectric constant compresses the electric flux lines to smaller volumes and makes it easier to locate metallic bodies in the antenna vicinity without degrading its performance.

REFERENCES

1. W. H. Hyte, Jr and J. A. Buck, Engineering Electromagnetics, *Eight edition, McGraw-Hill, 2006.*
2. C. A. Balanis, Antenna Theory. Analysis and Design, *Wiley, New York, 3rd Edition, 2005.*
3. A.Hemalatha and G. Gandhimathi, Design Optimization of Yagi - Uda Antenna using Antenna Toolbox, *International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by, www.ijert.org CONFCALL - 2019 Conference Proceedings.*
4. Prachi Jain and Zohaib Hasan, Analysis of the Effects of Reflector and Director on a Half Wave Dipole's Directivity, *International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol. 5 Issue 04, April-2016.*
5. N. A. Chougale, S. K. Magdum, S. D. Patel, T. D. Dongale, P. N. Vasmbekar, Design and Development of UHF Moxon Antenna, *National Journal of Science and Information, Special Issue, pp. 93-95, ISSN: 2229-5836, 2012.*

6. X. L. Travassos, D. A. G. Vieira and A. C. Lisboa, Antenna Optimization Using Multi-objective Algorithms, *International Scholarly Research Network ISRN Communications and Networking Volume 2012, Article ID 369293, 8 pages, doi:10.5402/2012/369293.*
7. Yuan, Y., A review of trust region algorithms for optimization, Proceedings of the *Fourth International Congress on Industrial and Applied Mathematics, pp. 271–282 (1999).*
8. Mohammad Tareq, et al, Simple Half-Wave Dipole Antenna Analysis for Wireless Applications by CST Microwave Studio, *International Journal of Computer Applications (0975 – 8887) Volume 94 – No.7, May 2014.*
9. K. Streelkshmi et al, Linear Array Yagi-Uda Antenna for Vehicular Application, *International Journal of Engineering & Technology, 7 (1.1) (2018) 513-517*
10. *Liu, Qi & Zhang, Shuai & Xu, Bo. (2014). A miniaturized unidirectional moxon antenna for UHF RFID tags, Progress In Electromagnetics Research Symposium Conference at Guangzhou, Conference Paper· August 2014. 612-615.*
11. *Liu, Qi & Zhang, Shuai & Xu, Bo. (2014). A miniaturized unidirectional moxon antenna for UHF RFID tags, December 2019, Academic Platform Journal of Engineering and Science 7(3):424-429*

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Strengthening the Crop Water Productivity of Tomato Under the Environmental Control of Greenhouse Technology

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University of Khartoum

ABSTRACT

Improving crop water productivity of vegetable crops under the environmental control of greenhouses conditions is one of the main problems facing the crop production in the hot climate of Sudan. Two experiments were carried out at the Faculty of Agriculture, University of Khartoum, Shambat, Sudan during the two seasons (2009/2010) with the objective of enhancing crop water productivity of tomato (Lycopersicon esculentum) under controlled environment of greenhouse and open field conditions. Five tomato cultivars imported from the National Agricultural Research Centre (Egypt) namely; Bashair 1, 2, 3, 4 and 5 and two varieties Po262 and Po265 from Sudan. Greenhouse was monitored and adopted to avoid overheating air temperature inside the greenhouse. The parameters tested were irrigation efficiency (%), crop water requirements (mm/day), crop productivity (kg/m^2) and water productivity (kg/m^3). SAS Statistical Package was used to analyze the data, while the variations among the means were checked by LSD. The results showed that crop water productivity significantly (≤ 0.05) increased under greenhouse conditions ($9.3kg/m^2$ - $19.8\ kg/m^3$) as compared to open field conditions ($3.1kg/m^2$ - $4.2\ kg/m^3$) in both seasons. The increases percentage of crop water productivity reached up to 63% as compared to open field conditions. It is recommended that, greenhouses should be monitored and adopted to control the environmental impact inside greenhouse which leads to increase the crop water productivity.

Keywords: strengthening; crop water productivity; tomato; greenhouses.

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I. INTRODUCTION

Greenhouse crop production systems require the use of complex management and control tools in order to maximize the grower profits. Several decisions must be performed at different hierarchical levels and time basis, such as crop planning and greenhouse climate control. The need for increasing productivity is causing the quality of the structure to grow so much that the financial investment must be retrieved through multi-year use, with the challenge of also growing protected crops during the summer, when solar radiation heats the crop inside the structure and the cover prevents adequate exchange with the colder outside atmosphere. Getting rid of the heat load is the major concern for greenhouse climate management in such conditions (Luo *et al.*, 2005). Crop production in greenhouses has great importance, as it gives us an advantage over open field production as well as providing a barrier between the external environment and the culture. High crop water productivity can be achieved only through proper control of the greenhouse environment because it creates near optimal microclimate conditions for growing crops, protecting them from adverse conditions and controlling factors, namely temperature,

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radiation, CO_2 concentration and relative humidity (Martínez-Ruíz *et al.,* 2012). The yield performance inside the greenhouse was higher than that of the open field crop. The fruit yield inside the greenhouse was nearly two times more than in the open field conditions as mentioned by Abbouda (2019). Ganesan (2002) found that height of the plant, number of nodes, internodes length, total dry matter production and average fruit weight increased under greenhouse conditions as compared to open field conditions. Tomato (*Lycopersicon esculentum*) is the most important vegetable crop in the world, being used in both fresh and processed presentations (Gad and Hassan, 2013; Mehdizadeh *et al.,* 2013). Considering the importance of tomato, it is necessary to achieve its efficient management, particularly with respect to the use of water under greenhouse conditions. In Sudan, vegetable crops have undergone major expansion during the last two decades because of the increasing demand for local consumption and export. The country is self-sufficient except for the scarcity during the hot summer period (June – September). Protected vegetables production under cooled greenhouses could be one of the alternatives to solve the problem as mentioned by Abbouda (2019). Tomato is an important vegetable crop in Sudan which ranks second to onion among vegetable crops based on cultivated area (Ahmed *et al.*, 2005). It is grown throughout the country where irrigation water and arable land are available and is mainly grown by small holders who employ relatively poor crop management practice and low productivity (Bush *et al.*, 2016). It requires moderate temperature for best production. Fruit setting may not occur if the flowers open for pollination when temperature is below 15°C for several hours or day temperature above 37°C, this may result in failure of fruit setting (Elhussien, 2008). The high temperatures during summer accompanied by low humidity as well as diseases infestations are notorious factors that reduce the crop yields (Abdalla and Verkerk, 1986). Elhussien (2008) observed that tomato style elongated abnormally under low soil moisture conditions. The maximum yields of tomatoes were obtained when soil moisture was maintained close to field capacity (Waistewr and Hudson, 1970). Low crop productivity in addition to high production costs, low prices and high taxes had all resulted in a general deterioration of the agricultural sector are represent the major problems facing agricultural production in Sudan (Bush *et al.,* 2017). Improving crop water productivity of vegetable crops under the environmental control of greenhouses conditions is one of the main problems facing the crop production. Therefore the objective of this study was to attain sustainable production and strengthening the crop water productivity of tomato (*Lycopersicon esculentum*) under the environmental control of greenhouse conditions.

II. MATERIAL AND METHODS

2.1 Experimental Work

The experimental work were carried out at the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Shambat, Sudan in two seasons (2009 and 2010) under the environmental control of greenhouse and open field conditions. Five tomato cultivars imported from the National Agricultural Research Centre (Egypt) namely; Bashair 1, 2, 3, 4 and 5 and two varieties namely; Po262 and Po265 from Bahri market, Sudan. The experimental work was carried out in order to collect some environmental factors such as temperature, relative humidity and air velocity inside the greenhouse and in the open field in the morning at 8:00 am, afternoon at 12:00 and at 15:00 pm. The climate is semi-arid with low relative humidity and daily mean maximum and minimum temperature are 36°C and 22°C, respectively. The annual rainfall is limited and usually occurs in the form of short intense thunder storms. This means that water is deficient and crop production must be based on irrigation.

2.2 Experimental design

A completely randomized design (CRD) with three replicates was adopted in greenhouses and open field during the two seasons (2009/2010).

Materials:

a. Greenhouse

The tomatoes were sown in a modified arch shape greenhouse. The arch shaped greenhouse covered an area of 20 × 9 m (180 m²) with 3 m in height and 200 – 220 µm thick of the cover plastic film and orientation of the greenhouse was north south. The greenhouse was made from galvanized pipe with aluminum extrusion. The cover was made from plastic film and the house was cooled by fan and pad evaporative cooling system. The wetted pad was fixed along the south wall of the greenhouse and was 6 × 2 m in dimension. The drip system of the greenhouse had single lateral lines. It provides by water from a well and pumped to a storage tank (2m height). Water moves from the tank by gravity to supply another tank (sub-tank) near the greenhouse (Plate 1.).

b. Open field

In the open field, seeds were sown in the nursery of the Faculty of Agriculture, University of Khartoum, Shambat a month before transplanting. Plastic cell trays were used to grow the seedlings. The trays were filled with mixed soil. Pre-watering was applied and then tomato seeds were sown. Soil was ploughed, harrowed, leveled and ridged. Every ridge was 4.2 m in length in the first season and 7.5 m in the second season. Furrows were located north to south direction; spacing between plants was 30 and 45 cm for the first and second seasons, respectively. One a heavy irrigation was applied before transplanting and the second was applied directly after transplanting.

Plate 1: Greenhouse shape

c. Thermo-hygrometers

Thermo-hygrometer HI 91610 range RH% 5.0 – 95.0 °C – 40 – 0 – 140.0: from HANNA Instruments made in Romania was used for measuring temperature and relative humidity.

d. Anemometer

AG – test 0– 435 made in Germany series No. 01357135/704 was used for measuring air velocity.

e. Personal Computer (PC)

A personal computer was used for the computer programme, which simulates the measured environmental factors in the greenhouse.

III. METHODOLOGY

Evaporative cooling system; evaporative cooling system is mainly based on the process of heat absorption during the evaporation of water. It consists of cooling pads and extracting fans. A

cross fluted cellulose pad was mounted in a vertical fashion at the end of the greenhouse. A PVC pipe (1 inch diameter) suspended immediately above the cooling pads. Holes drilled each 10cm long throughout the length of PVC pipe, and the end of this pipe was capped. A water sump mounted under the pads to collect the water and return it into the water tank (1000 liters), from which it can be recycled to the cellulose pads by means of the water pump. In order to bring the cold air onto the plants throughout the growth period, the cooling pads were located 20cm above the ground surface of the greenhouse. Two extracting fans (single speed, direct drive and 90cm diameter) located on the leeward side of the greenhouse and the pads on the aid toward prevailing wind (opposite side of the extracting fans). Evaporative cooling system efficiency (η) is normally defined as the ratio of the actual dry-bulb temperature reduction to the theoretical maximum at 100% saturation as mentioned by Boulard and Baille (1993) as follows:

$$\eta\% = \frac{Todb - Tidb}{Todb - Towb} \times 100 \qquad (1)$$

Where:

Todb = dry-bulb temperature of outside air °C.

Tidb = dry-bulb temperature of inside air °C.

Towb = wet-bulb temperature of outside air °C.

Environmental parameters; environmental parameters are generally recognized to have a major impact on the production of protected cropping. These parameters have been included ambient air temperature and air relative humidity. Temperature and relative humidity inside, outside greenhouses were measured using ISOLAB Laborgerate GmbH, ambient (outside, inside) temperature and relative humidity were recorded. Data was collected at each 4 hour (8:00am, 12:00pm, 4:00pm, and 8:00pm).

Crop water requirement (mm/day); crop water requirement (ETc) is derived from crop evapotranspiration (100% crop water use) which is the product of the reference evapotranspiration (ETo) and the crop coefficient Kc (FAO, 2010).

$$ETc = ETo \times Kc \times Ks \times Kr \qquad (2)$$

Where:

ETc = Crop evapotranspiration (mm/day)

ETo = Reference evapotranspiration (mm/day).

Kc = Crop Coefficient (dimensionless)

Ks = Soil water availability factor = 0.9 due to the soil type (clay loam)

Kr = A reduction factor.

Reference crop evapotranspiration (ETo) was determined by the following equation mentioned by Smith *et al.* (1998) as follows:

$$ETo \frac{0.408\Delta(Rn-G)+\gamma\left(\frac{900}{T}+273\right)U2(es-ea)}{\Delta+\gamma(1+0.34U2)} \qquad (3)$$

$$\frac{0.408\,\Delta\,(Rn-G)+\gamma\left(\frac{900}{T}+273\right)U2\,(es-ea)}{\Delta+\gamma\,(1+0.34\,U2)}$$

Where:

ETo = Reference crop evapotranspiration (mm day^{-1})

R_n = Net radiation at crop surface ($Mjm^{-2}day^{-1}$)

T = Average temperature at 2m height (°C)

e_s= SvpkPa

e_a = Actual vp (kPa)

(e_s $-e_a$) = Saturation pressure deficit for measurement at 2m height (kPa)

U_2 = Wind speed at 2m height (ms^{-1})

Δ = Slope of vapor pressure curve (k Pa°C)

γ = Psychometric constant (k Pa°C)

900 = Coefficient for reference crop (Kj Kg day^{-1})

0.34 = Wind coefficient for the reference crop (S m^{-1})

G = Soil heat flux (Mj m^{-2} day^{-1})

IV. WATER MEASUREMENT

The amounts of irrigation water were measured by flow meters, which were fixed in the sub main lines to read the cumulative amount of water before and after each irrigation event. The drip distributers were adjusted before irrigation. To calibrate flow meters, stop watch was used for recording the time required to fill a reservoir of a known volume (Michael 2009).The furrow irrigation water was measured volumetrically using a V-notch 90° weir. The discharge over the weir was calculated using the following equation as stated by Michael (2009).

$$Q = 0.0138\ H^{5/2} \quad (4)$$

Where:

Q = discharge over the weir in l/s.

H = the head over the weir in cm.

Depth of Applied Water; applied depth of irrigation water was calculated by using the following equation as mentioned by Parameshwarareddy*et al.* (2018) as follows:

$$Q \times T = dg \times A \quad (5)$$

Where:

Q = applied discharge from the drip system (cm^3/min.)

T = time of irrigation (min.),

A = wetted area (cm^2)

Dg = applied depth of water (cm).

The wetted area under the emitter was assumed to be circle in a shape.

The wetted area under the emitter was assumed to be circle in a shape.

Irrigation Efficiency; the term of irrigation efficiency (IE) was used to define the effectiveness and the irrigation system in delivering all the water beneficially used to produce the crop (Hamza and Almasraf, 2016) as follows:

$$IE = \frac{Totalwaterrequirements}{Totalappliedwater} * 100$$

$$IE = \frac{Totalwaterrequirements}{Totalappliedwater} * 100 \quad (6)$$

$$IE = \frac{Totalwaterrequirements}{} * 100$$

Yield and Crop Productivity; the sum of all pickings crop's production was expressed as a total fruit yield. It is important in all areas of plant production. The yield (in kg/m^2) was expressed as described by Mady and Derees (2007) as follows:

$$Yield = \frac{\text{The accumulation of fresh weight of the harvested fruit (kg)}}{\text{Total area of crop (m2)}}$$

$$Yield = \frac{\text{The accumulation of fresh weight of the harvested fruit (kg)}}{\text{Total area of crop (m2)}} \quad (7)$$

Additionally, the crop water productivity is the outcome of an entire suite of plant and environmental processes operating over the life of a crop to determine both yield and water use. Or the yield is a measure of crop's capacity to convert water into plant biomass or grain. The following equation was used for calculating the crop water productivity (kg/m^3) as mentioned by FAO (1982).

$$\text{Crop Productivity} = \frac{\text{Yield (kg/m2)}}{\text{Total depth of applied water (m)}}$$

$$\text{Crop Productivity} = \frac{\text{Yield (kg/m2)}}{\text{Total depth of applied water (m)}} \quad (8)$$

V. DATA ANALYSIS

A computer program (SAS statistical package) was used to analyze the data, while the variations among means were checked by the least significant difference (LSD).

VI. RESULTS AND DISCUSSION

Environmental parameters are generally recognized to have a major impact on the production of protected cropping during the two seasons. As shown in Figs. 1, 2, 3 and 4, air temperature inside the greenhouse was found to be lower than outside conditions, while relative humidity was found to be higher near the pad as compared to the area near or around the exhaust

fans due to the variations in air velocity. Air temperatures significantly ($P \leq 0.05$) increased in outside conditions as compared to inside greenhouse conditions. The results were in agreement with the result obtained Diyana (2009) who reported that the temperature increased from the evaporative pad towards exhaust fans, while air velocity decreased at the middle of the greenhouse.

In the hot climate of Sudan, evaporative cooling systems have been commonly employed to reduce the interior ambient air temperature of greenhouses; under these conditions the evaporative cooling system provided a cooling effect (air temperature difference between outside and inside the greenhouse) of 10 °C or more. The higher evaporative cooling systems were recorded in the second season (87%) while, the lowest mean values were given in the first season (70.1%). The results agreed by the results obtained by Boulard and Baille (1993) who mentioned that evaporative cooling systems were reduce the problem of excess heat in greenhouse.

In Sudan, tomato crop irrigates with the conventional furrow irrigation system and the quantity of irrigation water applied depends on the experience and judgment of the farmer's (not on scientifically-based). Therefore, tomato either receives irrigation water in excess or less than required. Crop water requirements of tomato were varied within the growing season due to the variation in climate conditions e.g. mean temperature, relative humidity, sunshine....etc. The use of crop water requirement technique inside the greenhouses resulted on saving the amount of water applied by 30% compared with the open field conditions. The variations in crop evapotranspiration were due to change in weather parameters inside and outside the greenhouses as reported by El Mamoun *et al.* (2019). Effectiveness and the irrigation system in delivering all the water beneficially used to produce the crop were increased in drip irrigation system (90%) as compared to conventional furrow irrigation system (47%).

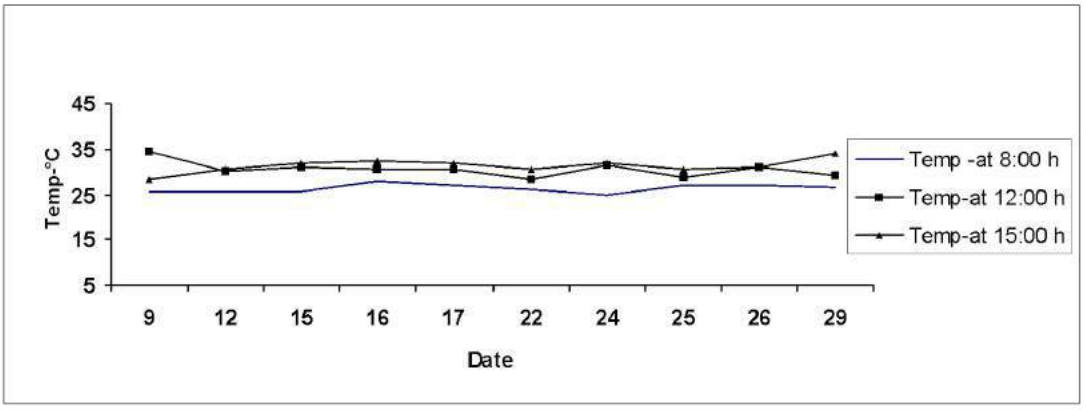
Crop water productivity significantly ($P \leq 0.05$) increased under greenhouse conditions as compared to open field conditions as presented in Table 1. Tomato varieties significantly increased the crop productivity when grown under the control of greenhouse conditions compared to open field condition. The reduction in water productivity in open field conditions was attributed to the variations in weather conditions as well as an excessive quantity of water losses by conventional furrow system such as evaporation, surface runoff and deep percolation. The results agreed with the result obtained by Adam (2014) who mentioned that, water productivity is influenced by management practices, irrigation systems, location of the farm, local weather conditions of the irrigated schemes, soil texture, water applied, distance of water resource from farm, water logging, timeliness of planting date, planting depth, quality of tillage practices, new seed varieties, applied fertilizers, experience of farmers and extension services which affect plant growth and development and ultimately yield.

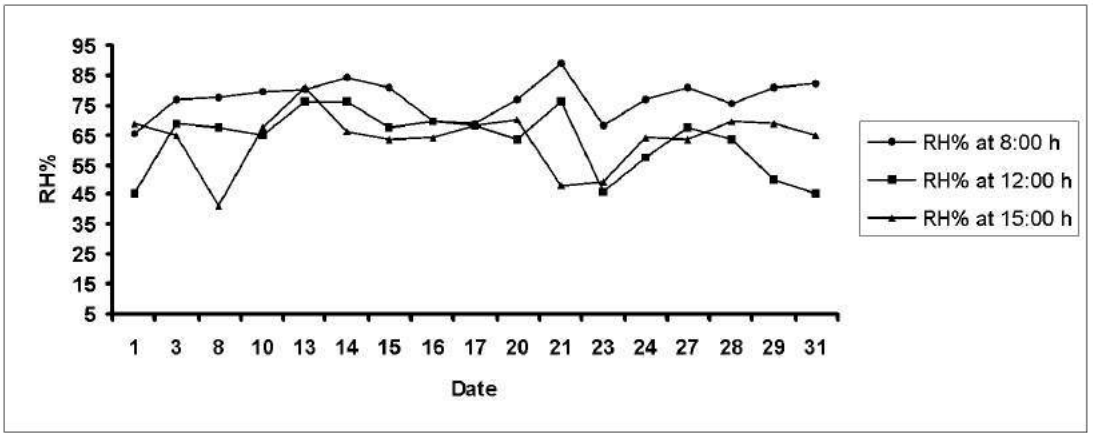
Table 1: Crop water productivity under greenhouses and open field conditions

First season (2009)							
Greenhouse conditions				Open field conditions			
Varieties	Applied water (m)	Yield (kg/m^2)	CWP (kg/m^3)	Applied water (m)	Yield (kg/m^2)	CWP (kg/m^3)	Increase of CWP in greenhouse compared to open field
Bashair1	0.53	7.4^{c}	14.0^{c}	0.68	3.4^{c}	5.0^{b}	64%
Bashair2	0.50	8.2^{b}	16.4^{b}	0.67	3.8^{b}	5.7^{b}	65%
Bashair3	0.48	8.7^{a}	18.1^{a}	0.59	4.5^{a}	7.6^{a}	58%
Bashair4	0.51	8.0^{b}	15.7^{b}	0.70	3.7^{b}	5.3^{b}	66%
Bashair5	0.47	9.3^{a}	19.8^{a}	0.55	4.8^{a}	8.7^{b}	56%
Po262	0.51	7.3^{c}	14.3^{c}	0.67	3.2^{c}	4.8^{c}	66%

Po265	0.50	7.0 [c]	14.0 [c]	0.68	3.1 [c]	4.6 [c]	67%
LSD		0.40	0.50		0.30	0.70	
Average							63.1%
Second season (2010)							
Bashair1	0.57	7.2 [b]	12.6 [d]	0.69	3.1 [b]	4.5 [b]	64%
Bashair2	0.55	7.7 [a]	14.0 [b]	0.69	3.3 [b]	4.8 [b]	66%
Bashair3	0.53	8.0 [a]	15.1 [b]	0.60	4.2 [a]	7.0 [a]	54%
Bashair4	0.54	7.5 [b]	13.8 [b]	0.71	3.4 [b]	4.8 [b]	65%
Bashair5	0.51	8.3 [a]	16.3 [a]	0.67	4.5 [a]	6.7 [a]	59%
Po262	0.53	7.0 [b]	13.2 [c]	0.68	3.1 [b]	4.6 [b]	65%
Po265	0.52	6.8 [b]	13.1 [c]	0.73	3.1 [b]	4.2 [b]	68%
LSD		0.50	0.72		0.81	0.83	
Average							63%

Means followed by the same letter (s) in the same column are not significant difference at P ≤ 0.05.





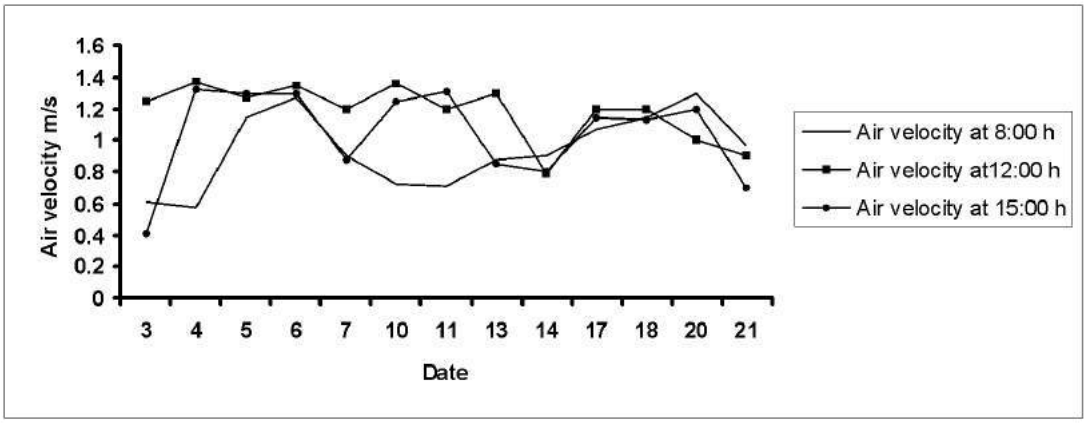
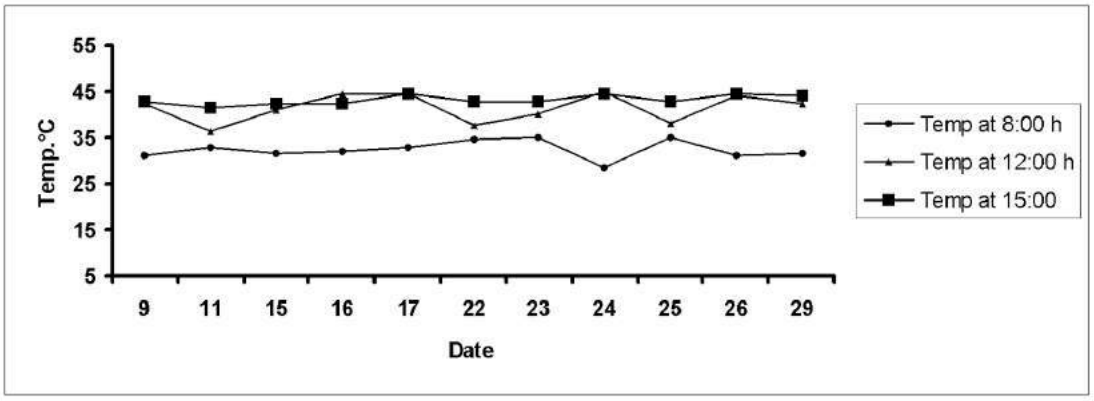
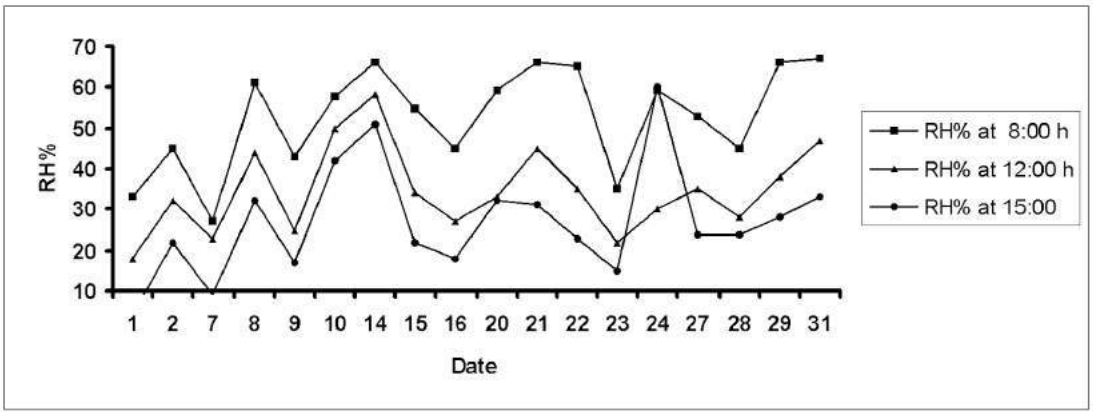


Fig. 1: Average temperature, relative humidity and air velocity inside the greenhouse during the first season (2009)





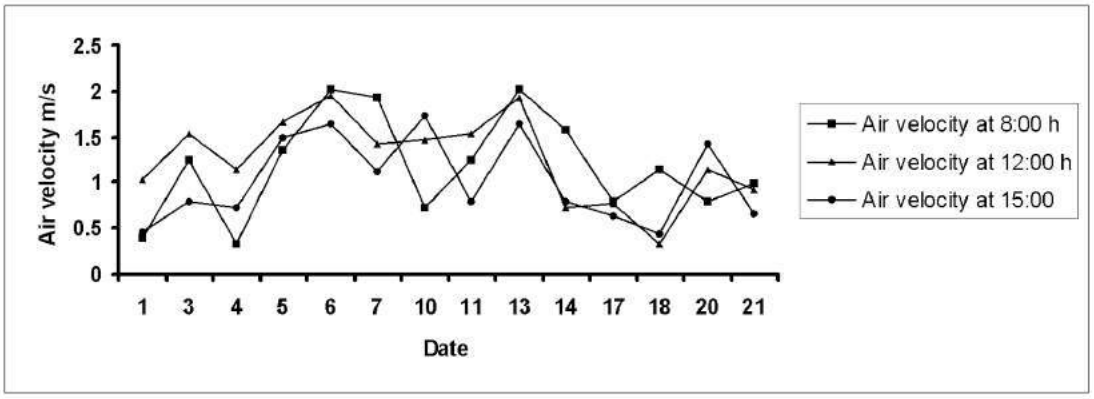


Fig. 2: Average temperature, relative humidity and air velocity outside the greenhouse during the firs[t] season (2009)

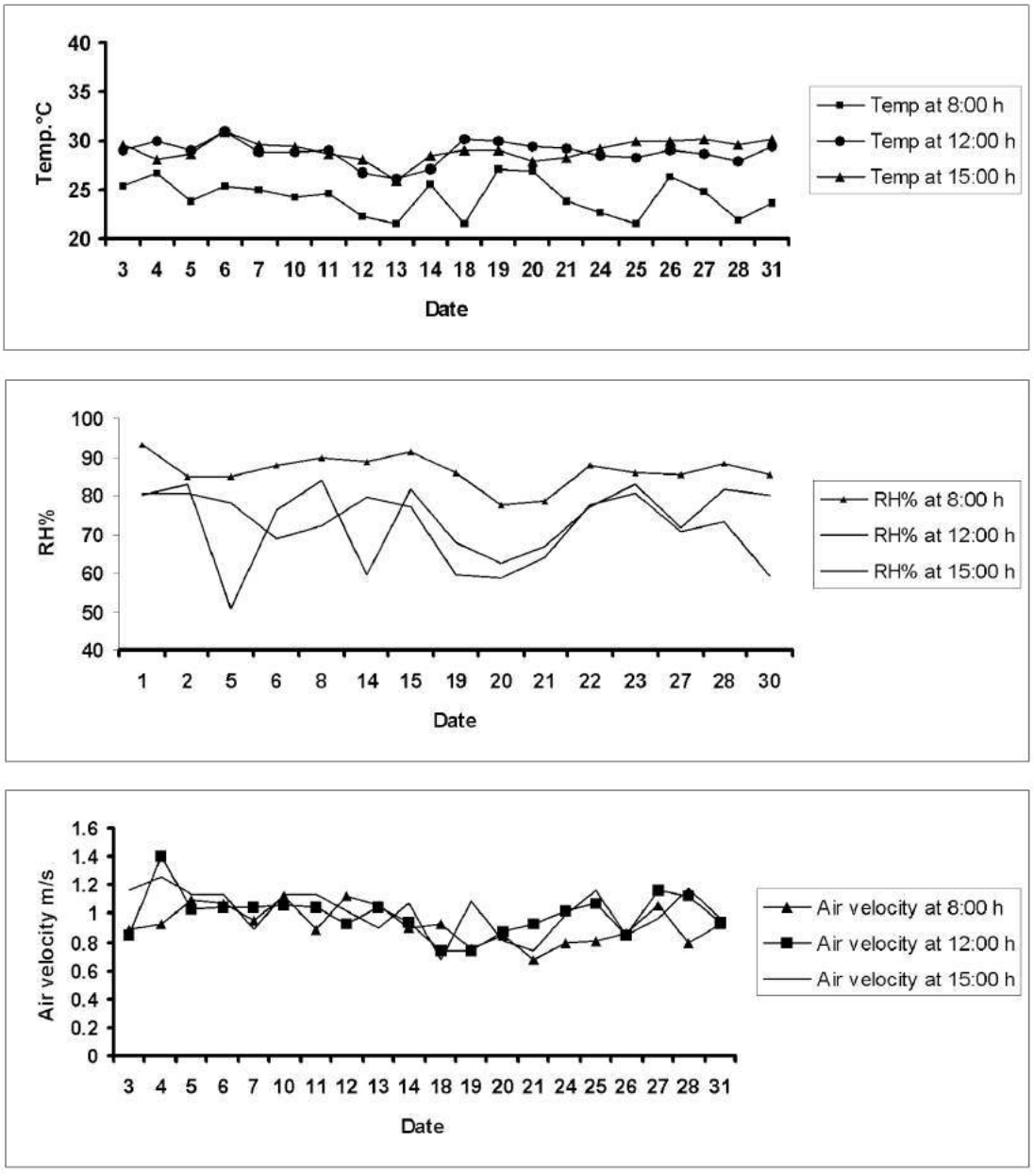


Fig. 3: Average temperature, relative humidity and air velocity inside the greenhouse during the first season (2010)

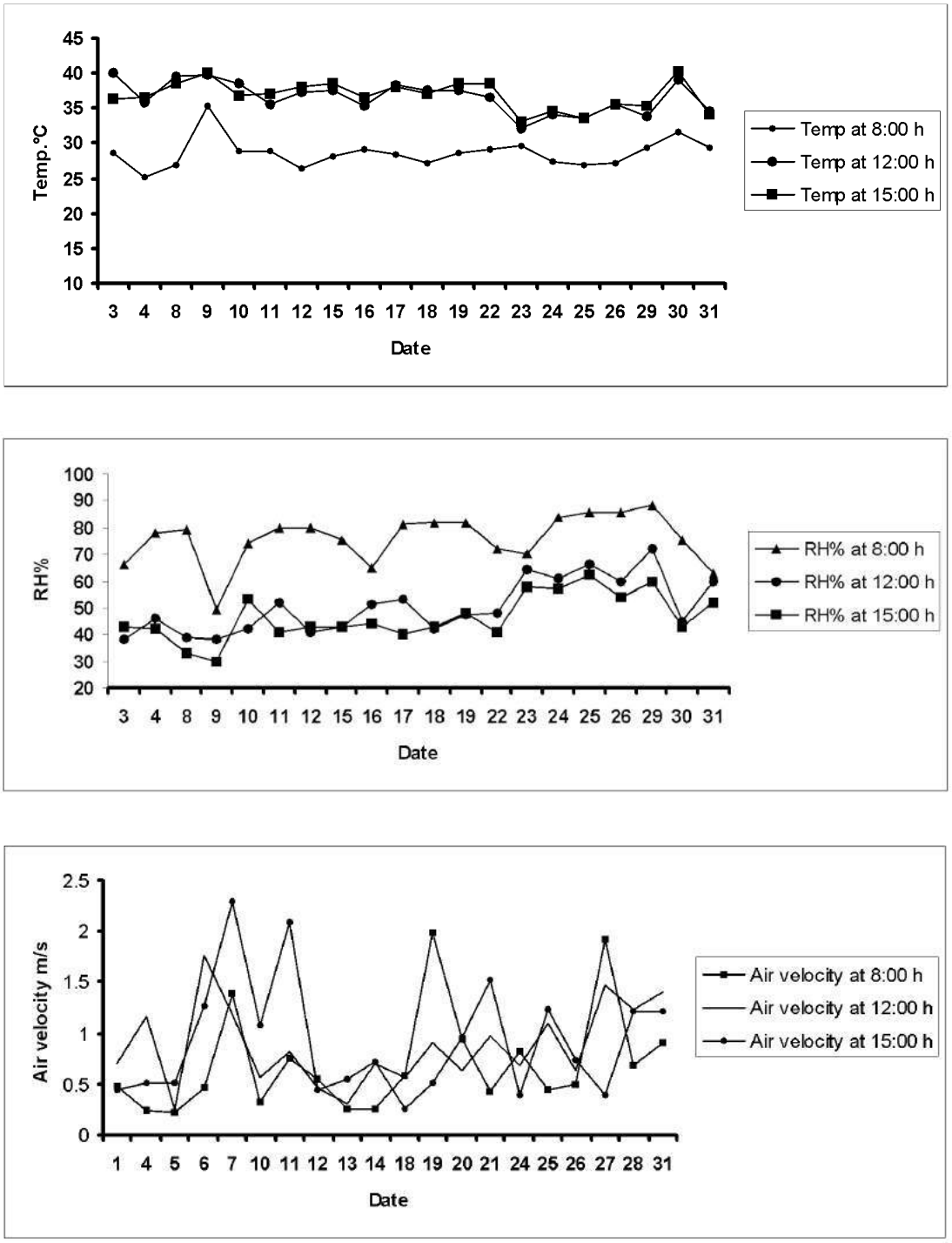


Fig. 4: Average temperature, relative humidity and air velocity outside the greenhouse during the first season (2010)

VII. CONCLUSION

Improving crop water productivity of tomato crop under the environmental control of greenhouses conditions is one of the main problems facing the crop production in the hot climate of Sudan. Therefore, good monitoring and adopting of greenhouses technology followed by good cooling efficiency could solve this problem which at the end reflected in increasing the crop water productivity compared to open field conditions.

REFERENCES

1. Abbouda, S. K.; El Mamoun, A. A.; Bush, A. A., Ahmed, S. G.,; Mourad, N. I. and Almahi, O. (2019). Effect of different greenhouse covers on evaporative cooling efficiency and crop yield of cucumber. *International Journal of Scientific* Research, 8(5), 26–28.
2. Abdalla, A.A. and Verkerk, K. (1968). Growth, flowering and fruit set of tomato at high temperature. *Netherlands Journal of Agricltural Science* 16:71- 76.
3. Adam, H.S. (2014). Agroclimatology, Crop Water Requirement and Water Management. Water Management and Irrigation Institute, University of Gezira Book. 2nd Edition. *University of Gezira Press*.
4. Ahmed, M.K.; Elnageeb, O.A.O.; Abedrao, E.R. and Yousif, T.H. (2005). Prospects of new technologies in vegetables production in Sudan: Case study of tomato and cucumbers. *Crop Husbandry Committee Meeting,* Wad Medani, Sudan.
5. Boulard, T. and Baille, A. (1993). A simple greenhouse climate control model incorporating effects of ventilation and evaporative cooling. *Agric. For. Meteorol.* 65, 145-157.
6. Bush AA.; Widaa A. and Hamid AM (2017). Effect of Management Practices on Water Use Efficiency of Gezira Irrigated Scheme, Sudan. *Intl. Res. J. Agric. Sci. and Soil Sci.* Vol 7(3). Pp 40 -45.
7. Bush, A.A.; Widaa, A., Saeed, A.B.; Abd Aldaim, A.M. and Elsheikh, T.M. (2016). Effect of Irrigation Systems and Watering Amount on Tomato (*Lycopersicon esculentum*) Production under Semi-arid Conditions. *International Journal of Scientific Engineering and Applied Science (IJSEAS)* – Vol3(2): 92-96.
8. Diyana, B.J. (2009). Effect of temperature and relative humidity on crop yield in tropical greenhouse with evaporative cooling system. *M. Sc Thesis, University of Putra*, Malaysia.
9. El Mamoun, A. A.; Bush, A. A.; Abbouda, S. K.; Ahmed, S. G.; Mourad, N. I. and Almahi, O. (2019). Water Productivity of Cucumber under Different Covers of Greenhouses Using Drip Irrigation System. *Indian Journal of Applied Research,* 9(5), 17–20.
10. Elhussien, G.M. (2008). Used of cooled fiber glass house for the production of summer Tomato. *Ph.D Thesis, Department of Horticulture,* Faculty of Agriculture, University of Khartoum.
11. FAO (1982). Crop Water Requirements "Irrigation and Drainage", Paper No. 24, Rome, Italy.
12. FAO, Stat. (2010). Food and Agriculture Organization of the United Nations. http://faostat.fao.org Furr, J.R. and C.L. Ream. 1968. Salinity effects on growth and salt uptake of seedlings of the date *Phoenix dactylifera* L. *Proc. Am. Soc. Hort. Sci.* 92:268-273.
13. Gad, N. and Hassan, N.M. (2013). Role of cobalt and organic fertilizers amendments on tomato production in the newly reclaimed soil. World App. Sci. J. 22:1527-1533.
14. Ganesan, M. (2002). Effect of poly greenhouse on plant microclimate and fruit yield of tomato. *Karnataka Journal of Agricultural Science*, 15(4).
15. Hamza, A. A. and Almasraf, S. A. (2016). Evaluation of the Yield and Water Use Efficiency of the Cucumber Inside Greenhouses. *Journal of Babylon University/Engineering Sciences*, 1(24), 95-106.
16. Luo, W.; Stanghellini, C.; Dai, J.; Wang, X.; de Zwart, H.F. and Bu, C. (2005). Simulation of greenhouse management in the subtropics, Part II: *Scenario study for the summer season*.
17. Mady, A. A. and Derees, A. H. (2007). Effect of water stress and application of compost on water use efficiency and productivity of cucumber in plastic house under trickle irrigation system, 24(1), 182-197.
18. Martínez-Ruiz, A., I. L; Ló pez-Cruz, A.; Ruiz-García and A. Ramírez-Arias. (2012). Calibration and validation of transpiration model for irrigation management in tomato (*Solanum lycopersicum* L.) under greenhouse. *Rev. Mex. Cienc. Agríc.* 4:757-766.

19. Mehdizadeh, M., E. I. Darbandi, H. Naseri-Rad and H. Tobeh. (2013). Growth and yield of tomato (*Lycopersicon esculentum* Mill.) as influenced by different organic fertilizers. *Int. J. Agron. Plant Prod.* 4:734-738.
20. Parameshwarareddy, R.; Angadi, S. S.; Biradar, M. S. and Patil, R. H. (2018). Water productivity of tomato as influenced by drip irrigation levels and substrates. *Journal of Pharmacognosy and Phytochemistry*, 7(2), 1343-1346.
21. Smith, M. G.; Allan, J. L, Monteith, A; Perrier, L. and Sergen, A. (1998). Report No 56 of the Expert Consultation on Procedures for Revision of FAO. *Guidelines for prediction of Crop Water Requirement* UN FAO, Rome, Italy.
22. Waister, P.O. and Hudson J.P. (1970). Effect of soil moisture regime on leaf water deficit, transpiration and yield of tomatoes. *Journal of Horticultural Science* .4:359-370.

Theory of Original Gravity

Amal Kumar Ghosh

ABSTRACT

This paper aims to present foundational concept of gravity based on my intuitive idea. I have assumed that every particle is subject to the influence of its own hyperbolic space surface (that I would like to say is a tiny universe of this respective particle). Here I have derived the wave function of hyperbolic surface of my space heuristically where hyperbolic surface has been treated as a hyperbolic surface particle in order to reach my goal. On the question of how I have calculated gravitational energy has been explained in 'Analytical Treatment' section. How this gravitational energy is expected to be valid ranging from planck's scale to macroscopic scale has been discussed in the conclusion section.

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Theory of Original Gravity

Amal Kumar Ghosh, PhD (Physics)

ABSTRACT

This paper aims to present foundational concept of gravity based on my intuitive idea. I have assumed that every particle is subject to the influence of its own hyperbolic space surface (that I would like to say is a tiny universe of this respective particle). Here I have derived the wave function of hyperbolic surface of my space heuristically where hyperbolic surface has been treated as a hyperbolic surface particle in order to reach my goal. On the question of how I have calculated gravitational energy has been explained in 'Analytical Treatment' section. How this gravitational energy is expected to be valid ranging from planck's scale to macroscopic scale has been discussed in the conclusion section.

I. INTRODUCTION

Out of many proposals the general theory of relativity has been regarded as the best theory of gravity which is a classical theory of space-time continuum being curved by matter. In Einstein's equation, geometry has been assumed as coarse matter. But matter is fundamentally quantum mechanical. So the ultimate question arises in the context of quantization due to approximation of continuum description of his geometric object. Again the discovery of the Bekenstein- Hawking entropy of black holes, the Hawking radiation, and information paradox puts an unanswered questions on the relation between quantum mechanics and the GR concepts of space-time. Even the most advanced quantum theories including super-symmetry, super-gravity, and super string have attempted to unify all fundamental forces but no attempt has succeeded.

This problem is therefore not only technical. This is again a non- renormalizable and low energy theory. As for GTR, major conceptual problem is how this theory has considered stress-energy tensor ($T\mu v$) as a significator of gravity which is actually a classical extension of Newton's stress-energy that has been poured into space-time continuum pot. Here matter is creating energy in the way of deforming space- time continuum. My opinion is that the stress-energy thus assumed by Einstein is not the true energy to understand gravity. This is purely incomplete theory. Both of GR and quantum theory are therefore problematic in the context of gravity. That is why they have broken down after travelling some path. Hence my motivation has hailed from the curiosity of how to solve this problem.

II. MY PROPOSAL AND ANALYTICAL TREATMENT

"Every particle is always subject to the tended energy of their respective elementary hyperbolic space surface, and this energy operates on the Schrodinger's particle wave function when placed in hyperbolic space to provide gravitational energy"

III. ANALYTICAL TREATMENT

Hyperbolic geometry occurs on surfaces that have negative curvature. Hyperbolic plane that exists within hyperbolic space is termed as hyperboloid model.

Suppose n-dimensional hyperbolic space sits inside $Rn+1$ as a hyperboloid, i.e $Hn = \{x \in Rn+1\}$: x∗ x = - 1} [Cannon 1997]. This definition is for general space Hn. Here for instance if I consider when n=4 and then this is as $H3,1$. This means that space and time have been treated classically i.e as an independent quantities.

Suppose H is a path metric space in Lorentz 3-space. It can be shown that the hyperbolic distance function dH is a metric on H [See details, Hayter 2008].

dH metric has not been discussed in detail in this paper because the detailed discussion is already in different existing text.

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This is important to note that hyperbolic space surface has been assumed as an elementary hyperbolic surface particle in my work. My heuristic derivation of wave function of hyperbolic surface particle is:

$$\Psi_A = \frac{1}{\Omega} e^{-id_H k^2 x} \quad (1)$$

where dH is a metric on H , $|\psi A| 2 = \psi A* \psi A =$ Probability of defining universe in hyperbolic space $H4 = H3,1 = (H3,t=dH=original\ time\ as\ accepted\ in\ this\ paper)$. Thus, space and original time has been taken independently. Here hyperbolic metric distance dH can be thought of as a real-time rather than our conventional time when the explanation calls for. Therefore, original time is some metric distance unlike our conventional time we deal with. This real time is associated with the equation of hyperbolic space surface (Eqn. 1). Our conventional time evolution is associated with the equation of wave function of particle (Eqn 5).

Dimension of $|\psi_A|^2 = [\frac{1}{H^4}] = [\frac{1}{H^{3,1}}] = [\frac{1}{H^3, d_H}]$
$= [\frac{1}{L^4}] = [L^{-4}]$

Dimension of amplitude ($\frac{1}{\Omega}$) of wave function = $[L^{-2}]$

Differentiating equation (1) w.r.t. x, we get

$$\frac{\partial \psi_A}{\partial x} = \frac{1}{\Omega} \frac{\partial}{\partial x} e^{-id_H k^2 x}$$

$$= -id_H k^2 \Psi_A$$

$$= -id_H \frac{p^2}{\hbar^2} \Psi_A \quad \text{where } p = \frac{h}{\lambda} = \frac{h}{2\pi} \frac{2\pi}{\lambda} = \hbar k$$

$$= -i\, d_H \frac{2m}{\hbar^2} \frac{p^2}{2m} \Psi_A$$

$$= -i \frac{2m\, d_H}{\hbar^2} E_A \Psi_A \quad \text{taken } E_A = \frac{p^2}{2m}$$

$$\frac{\partial}{\partial x} = -i \frac{2m\, d_H}{\hbar^2} \hat{E}_A \quad (2)$$

$$\hat{E}_A = i \frac{\hbar^2}{2m\, d_H} \frac{\partial}{\partial x}$$

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This is my energy operator.

Now, this energy operator acts on the wave function of Schrodinger's equation when placed in hyperbolic space of my interest. Schrodinger's wave function is given by

$$\Psi\,(\mathrm{x},\,\mathrm{t}) = \mathrm{A}\,e^{i\,(kx-wt)} \tag{4}$$

Now let me represent this wave function by hyperbolic coordinates which is the following:

$$\psi_h\,(\mathrm{x,t}) = \mathrm{A}\;e^{hi(kx-wt)}$$

= A [Coshi(kx-wt) + i Sinhi(kx-wt)]
= A [Cos(kx-wt) + i2 Sin(kx-wt)]
Given that Cosh(it) = Cost and Sinh(it) = iSint
= A [Cos(kx-wt) - Sin(kx-wt)]

$$= \frac{A}{2}\,[\,e^{i(kx-wt)} + e^{-i(kx-wt)}] - \frac{A}{2}[\,e^{i(kx-wt)} - e^{-i(kx-wt)}]$$

= A e−i(kx−wt) which is the hyperbolic version of Schrodinger's particle wave function. Eqn.(5)

Suppose x is a position vector of a particle found somewhere in a space of differential volume element d3x (d3x= dx1 ∧ dx2 ∧ dx3).

Now integrating over (Vol) where (Vol) is the space volume over which integration is to be carried out

$$<\hat{\mathrm{E}}_A\;> = \int_{(Vol)} \psi^*_h\,(x,\,t)\;\hat{\mathrm{E}}_A\,\psi_h\,(\mathrm{x,t})\;d^3\mathrm{x}$$

$$= \frac{\hbar 2\;A2\;k}{2m\;d_H}\;\int_{(Vol)} d^3\mathrm{x} = \frac{\hbar^2\;A^2K}{2d_H} \times \frac{1}{\rho_s}$$

= Gravitational Energy Eqn (6)

Where $\frac{\mathbf{1}}{\boldsymbol{\rho_s}} = \frac{\mathbf{1}}{\boldsymbol{m}}\int_{\boldsymbol{Vol}} \boldsymbol{d^3\,x}$ **and** $\boldsymbol{\rho_s}$ Space density

IV. CONCLUSION

1. If we analyse my energy operator carefully we can understand how technically the discreteness has arisen in my operator where hyperbolic surface geometry has been treated as hyperbolic surfaces particle. Here space time has been taken independently.
2. My energy is conceptually and technically different from Einstein's energy. In my case, surface energy operator provides gravitational energy in the way of acting on the particle wave function.
3. The presence of ħ term indicates that this energy is quantized and hence it is valid on planck's scale. Again this energy preserves the hyperbolic surface geometry term. It is therefore valid on larger scale. This energy is therefore expected to be valid ranging from smaller scale to macroscopic scale.
4. It is evident from equation (1) that the space of my interest is not aware of our conventional time (t) but the metric distance dH has been considered technically so as to it fulfills the criteria of metric distance and real time as well in accordance with the demand of explanation. Thus I have drawn a line of control between our conventional time and original time in brief. Time evolution operator can be obtained from Eqn.(5) since this equation is a hyperbolic version of Schrodinger's wave function.

5. Static or infinite d_H signifies zero energy and dynamic d_H is a real time whose dimension is the dimension of length.

REFERENCES

1. **[**Cannon 1997] James W. Cannon, William J Floyd, Richard Kenyon, and Walter R. Parry, Hyperbolic Geometry, Flavors of Geometry, MSRI Publications, vol. 31, pp 1-57, 1997.
2. [Iverson1992] B. Iversen, Hyperbolic Geometry, vol. 25 of London Mathematical Society Student Texts, Cambridge University Press, Cambridge, UK, 1992. View at Google Scholar · View at MathSciNet.
3. [Milnor 1982] J. Milnor, "Hyperbolic geometry: the first 150 years," American Mathematical Society, vol. 6, no. 1, pp. 9–24, 1982.View at MathSciNet.
4. [Renold 1992] W. F. Reynolds, `Hyperbolic Geometry on a Hyperboloid', Amer. Math. Monthly 100 (1992, 442 – 455).
5. [Hayter 2008] R. Hayter, The Hyperbolic Plane, "A Strange New Universe", pp 1-67, 2008.

Relevance of Vocametrics to Building Technology in Nigeria

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ABSTRACT

The relevance of vocametrics to building technology especially in construction industries in Nigeria has been x-rayed in this paper. The paper discusses the meaning of vocametrics and its components. Thus Vocametrics is seen as an instrument for data gathering, analysis and estimation of labour and materials needed in building industries. Various vocational trades in Nigeria are identified with full focus on building technology. The study adopted observational design.The population consisted of 22 bricklayers in Ekiti State, Nigeria that engaged in the erection of a bungalow in construction industries. The simple regression and forecasting power of vocametrics were used to analyse the data for the study. The paper further delineated some problems which could be solved using vocametrics. Findings revealed that there was no significant difference between the estimated parameters ($\hat{b}_o$ and $\hat{b}_1$) and true parameters (b_o and b_1) on the number of blocks laid by bricklayers in building industries. Findings also indicated that there was no significant difference between the value of forecast (Y_A) and confidence level ($\hat{Y}_F$) on the safety of workers in building construction industries. It was further recommended that vocametrics be accorded its rightful place in the field of building technology in particular and in Vocational and Technical Education in general. It was also recommended that building team such engineers, architects, contractors, builders and town planners should also endeavor to use the findings of this study to predict, identify and respond to project hazards that are likely to occur in future construction works.

Keywords: vocametrics, building technology, bricklayers, forecasting power.

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The relevance of vocametrics to building technology especially in construction industries in Nigeria has been x-rayed in this paper. The paper discusses the meaning of vocametrics and its components. Thus Vocametrics is seen as an instrument for data gathering, analysis and estimation of labour and materials needed in building industries. Various vocational trades in Nigeria are identified with full focus on building technology. The study adopted observational design.The population consisted of 22 bricklayers in Ekiti State, Nigeria that engaged in the erection of a bungalow in construction industries. The simple regression and forecasting power of vocametrics were used to analyse the data for the study. The paper further delineated some problems which could be solved using vocametrics. Findings revealed that there was no significant difference between the estimated parameters ($\hat{b}_0$ and $\hat{b}_1$) and true parameters (b_0 and b_1) on the number of blocks laid by bricklayers in building industries. Findings also indicated that there was no significant difference between the value of forecast (Y_A) and confidence level ($\hat{Y}_F$) on the safety of workers in building construction industries. It was further recommended that vocametrics be accorded its rightful place in the field of building technology in particular and in Vocational and Technical Education in general. It was also recommended that building team such engineers, architects, contractors, builders and town planners should also endeavor to use the findings of this study to predict, identify and respond to project hazards that are likely to occur in future construction works.

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I. INTRODUCTION

Vocametrics as defined by Olaitan and Ndomi (2000) refers to the integration of mathematics, statistical techniques and theories in vocations in explaining the relationship between variables, testing hypothesis and forecasting vocational phenomena. It is concerned with the theory and techniques of vocational measurement and thus deals with the measurement of skills and knowledge in any respective occupations such as Woodwork technology, Building technology, Automobile technology and Agricultural education technology (Olaoye, 2019).

Similarly, Vocametrics also refer to the use of vocational theory, statistics, mathematics and computer skills for the purpose of analyzing data in order to predict any vocational phenomena. The use of computer cannot be over emphasized in vocametrics because it stores and processes data into output for predicting vocational phenomena. Vocametrics involves two major types of research tasks. These include theoretical Vocametrics and applied vocametrics. It must be noted that those who practice vocametrics are called vocametricians. Vocametrics may use standard statistical models such as linear and multiple regressions to study vocametric problems, but most often they are with observational data, rather than in controlled experiments (Olaoye, 2019). From this definition, one can thus infer certain elements or components that make up vocametrics.These include mathematics, Statistical techniques,

Theories of vocations, testing of hypotheses and forecasting of vocational phenomena.

In addition, vocametrics entails values of attributes of variables in any particular vocation, analyzing them using mathematical and statistical methods so as to develop models for predicting future changes in the variables. This means that vocametrics is formed from two major words "vocation" and "metrics"While metrics deals with measurements, vocation deals with an occupation, employment, career, trade or profession that people enter and develop in it.

Vocation according to Egbule cited in Abo (2015) is a calling which is reserved for those who are committed to their work, have greater autonomy in performing it, derive feelings of importance from it and find it intrinsically rewarding with a lot of economic values attached to it. The Federal Government of Nigeria (2013) identified vocational areas to include but not limited to the following technical trades.

a. Mechanical Trades:

- Agricultural Implements and Equipment Mechanics work.
- Automobile Engineering Practice: Autobody Repair and Spray Painting.
- Automobile Engineering Practice: Auto Electrical Work.
- Automobile Engineering Practice: Autobody Mechanics Work.
- Automobile Engineering Practice: Autobody building.
- Auto Engineering Practice: Part Mechandising.
- Air-conditioning and Refrigeration: Mechanics' Work.
- Mechanical Engineering Craft Practice.
- Welding and Fabrication Engineering Craft Practice.
- Foundry Craft Practice.
- Instrument Mechanics' Work.
- Marine Engineering Craft.

b. Computer Craft Practice:

- Computer Maintenance Work.
- Data Processing.

c. Electrical Engineering Trades:

- Electrical Installation and Maintenance Work.
- Radio, Television and Electrical Work.
- Appliances repairs.

d. Building Trades:

- Block laying, Bricklaying and Concrete Work.
- Painting and Decorating.
- Plumbing and Pipe-fitting.

e. Wood Trades:

- Machine.
- Carpentry and Joinery.
- Furniture Making.
- Upholstery.

Students would engage in private establishment or work in industries after the completion of the stipulated vocational areas. At the completion of technical college programmes, building trades students' students would become bricklayers, plumbers, draftsmen, tillers, painters and decorators .A bricklayer constructs brick footings, piers, base or foundation walls, brick cavity walls ,brick veneer walls, fire places, chimneys, builds-in baths and shower recesses. .(Walton, 1979). In building industries, builders need to determine the quantity of blocks required to construct a house. The tillers need to determine the number of tiles required to lay the floors of a three bed-room flat. It is necessary to note that vocametrics is very useful or relevant in this regard in all vocational trades aforementioned. However, its relevance to building technology is emphasized in this study.

II. BUILDING TECHNOLOGY AND VOCAMETRICS

Building Technology is an aspect of technology that deals with provision of compartment for living. It has so many branches which include: bricklaying, and concreting; masonry work; painting; carpentry; plastering; architectural design; surveying; quantity surveying; plumbing; electrical installation; and fitting among others. All the areas mentioned above can be carried out with the application of vocametrics. Therefore, there is need to apply statistical techniques,

explain relationship between variables (for example, the relationship among water, cement, sand and concrete which are normally applied in proportional ratio).

Also, there may be additional need to carry out certain tests, apply some mathematical principles and test some hypotheses. Hence, vocametrics is very much relevant in Building Technology trades.The relevance as briefly discussed here, differ from one country to the other since the need for vocametrics in Building Technology field will depend on the level of development of a country. In the real sense, countries can be divided to two major groups. These are developing countries and technologically advanced countries. A developing country is that which is increasingly acquiring more and more artifacts of the type found in the western countries and which are created by the financial and industrial leaders of these foreign countries. The developing countries often consider the level of development of the western countries, learn from them and also aspire to grow like them. In addition, they maximize their natural gifts for the benefit of the people.

On the other hand, a technologically developed country is that which is advanced in the level of technical manpower, mechanization of agriculture executive capacity, use of electronics, use of computer, manufacturing of goods using expensive machines and production of various materials and skills development in manufacturing weapons and are now held forth as the key to national development. Hence, they maximize their gifts for the benefits of their people (Oke, 2009).

III. RELEVANCE OF VOCAMETRICS TO BUILDING TECHNOLOGY IN NIGERIA

Nigeria has the potentiality for development; hence it applies all available principles that would aid its development most especially in designs and construction. It is necessary to improve its level of design and construction. This is so because the future of design cannot be predicted since it will be greatly influenced by the development of new materials, new methods of construction and sociological changes.

This aspiration for development can be influenced as vocametrics could be applied in the following areas:

- Identification and measuring of relevant variables in the vocation – as earlier noted, changes in materials to be used take place as the desire for development in Nigeria takes place. The knowledge of vocametrics in this changing society will help in identifying such materials that are relevant with the present situation and that can be acquired through data collection. The data obtained can be subjected to vocametric analysis.
- Vocametrics helps in analyzing data on variables using appropriate techniques to provide meaningful explanations to the vocational phenomenon. That is, in a developing country like Nigeria, it may be necessary to find out the effects of a particular design on the people of a particular state of the country, usually before any project is embarked upon. It is necessary to note that the principle of vocametrics would first be used in analyzing data and bringing out result.
- Vocametrics can be used to estimate parameters for forecasting changes in variables and future event in Building Technology. The types of building to be constructed some years ahead could be predetermined through the theory of vocametrics.
- Vocametrics can be used for making inference and comparative analysis between the type of construction existing in the country and the developed countries like Japan, USA and Germany. This analysis can help to know the areas where necessary skill development is required in the developing country.
- Through vocametrics, a system of simultaneous equations to estimate structural and reduced form parameter of two-way interdependent variables can be generated. There are some variables that may interdependently affect the construction of roads. This may be the types of asphalt, stones and the period of construction with the condition of temperature prevailing at that period. There may also be another set of

variables which if gathered, may result in application of simultaneous equation.

- Vocametrics can be applied in the area of testing hypotheses. This can come up when research or test is being carried out on a particular building materials. The findings of the result will be analysed while necessary recommendations with reference to the test carried out will also be made available for the use of the nation.

Building practice entails the entire system that defines procedure and standards for all three phases of the building process; as well as spells out the responsibilities and interaction among the building industry professionals such as town planners, architects, builders, engineers, quantity surveyors and estate managers (Mbamali&Okotie, 2012)..In Nigeria today, the focus on infrastructural development by federal and state governments as well as the privatization and commercialization policy, are contributing to an unprecedented boom in the construction and property sectors (allafrica.com 2010). There is massive demand for buildings across all sectors of the economy. All these are attractions for global construction players. There is however shortage of skilled manual labour, relatively high cost of engaging managerial staff, shortage of building materials and escalating security challenges.

Nigeria is a developing country and her building practice is still grappling with a lot of inherent challenges, ranging from inadequate technical and managerial know-how to insufficient financial, material and equipment capital base (Oluwakiyesi 2011). The importance of building technology which is an integral part of technical and vocational education cannot be over emphasized since this field of study represents a core index of national development. A major distinction between an advanced country and a developing one is to a large measure the difference between their levels of scientific and technological development in various areas of technology education, building technology inclusive (Odu, 2010). Lack of technological capacity has made developing (Third World) nations to be relatively poor. Developing nations are poor because of their negligible investment in science and technological know-how and their people do not have the capacity to inform themselves in a competitive knowledge driven world. Increased competition in a global market place, adds to the need and urgency to get the right people, with the right skills, in the right place, at the right time (Odu, 2007). Thus, if vocametrics is accorded the right place in building technology, much benefit will be accrued from it in Nigeria.

IV. METHODOLOGY

The study adopted observational design. In observational research, an attempt is made to observe a phenomenon. Oluwatayo and Ibitayo in Olaoye(2019), described observational technique as a basic and one of the oldest research methods to gather data where the observer is not merely looking at what is happening but rather is watching with a trained eye for certain specific events. The population consisted of 22 bricklayers in Ekiti State, Nigeria that engaged in the erection of a bungalow in construction industries. The bricklayers laid the blocks as follows. On the first day, a bricklayer laid 280 blocks, two bricklayers laid 501 blocks on the second day, three bricklayers laid 752 blocks on the third day, four bricklayers laid 750 blocks on the fourth day, four bricklayers laid 750 blocks on the fifth day, five bricklayers laid 1152 blocks on the six day and four bricklayers laid 920 blocks on the seventh day. The criterion validity was used to ensure standard of the study. This validity was used because it was based on standard that is ability of the bricklayers to lay the blocks effectively.750 was made at the point X = 4 , which was the predicted value. There were seven observations and the value of four lied on the middle of the observations. The simple regression and forecasting power of vocametrics were used to analyse the data for the study. The dependent variable here refers to blocks laid by brick layers while the bricklayers that laid the blocks on the entire building refer to independent variables.

The explicit form of the model becomes:

$Y = b_o + b_1X + \ldots\ldots\ldots\ldots\ldots\ldots U$

Where

Y = Blocks laid by bricklayers

B_o and b_i = True parameters

X = Brick layers

U = Stochastic disturbance /Error term

X_F = 4 = Value of independent variable predicted for the forecast at 750 blocks

Hypotheses:

- There is no significant difference between the estimated parameters and true parameters on the number of blocks laid by bricklayers in building industries (True parameters are traditionally considered to be zero)
- There is no significant difference between the value of forecast (Y_A) and confidence level (^Y_F) on the safety of workers in building construction industries.

V. RESULTS

Hypothesis 1

There is no significant difference between the estimated parameters and true parameters on the number of blocks laid by bricklayers in building industries (True parameters are traditionally considered to be zero)

Table 1: Estimated Parameters and True Parameters on the Number of Blocks laid by Bricklayers in Building Construction Industries

Items	Parameters	Standard Errors	Df.	t-cal	t-tab	Decision
True Parameters	545.61	11.07	5	25.50	2..57	S
Estimated Parameters	165.84	78.28		2.12		

^b_o and $^b_1$ = Estimated parameters

b_o and b_1 = True parameters

S_{bo}= True Variance= Standard Error = 545.61

S_{bi} = True Variance = Standard Error= 165.84

N = Number of Observations= 7, DF = 5

The t- calculated value of t_o (25.90) was greater than t-table value of 2.57 .The hypothesis was rejected .This implies that there was significant difference between the estimated parameters (^b_o and $^b_1$). and true parameters(b_o and b_1) on the number of blocks laid by bricklayers in building industries (True parameters are traditionally considered to be zero). The calculated value of t_1(2.12) was less than table value of 2.57. The hypothesis was accepted. This implies that there was no significant difference between the estimated parameters (^b_o and $^b_1$) and true parameters(b_o and b_1) on the number of blocks laid by bricklayers in building industries.

Hypothesis 2

There is no significant difference between the value of forecast (Y_A) and confidence level (^Y_F) on the safety of workers in building construction industries.

Table 2: Value of Forecast and Confidence Level on the Relevance of Vocametrics to Building Construction Industries

Variable	Parameter	Forecast Error	Df	t-cal	t-table
The value of Forecast	750	1.9092	5	0.0762	2.57
Confidence Interval	1208.05				

Value of Forecast = Y_A Confidence Level = $Y_{FOmission}$

The table value of t at 95% confidence level and Df = 5 is 2.52. It was clear that $t_c < t_t$, therefore the null hypothesis was accepted; $Y_A = ^{Y_F}$. There was

no significant difference between Y_A and Y_F. The forecasting power of the model was good.

VI. DISCUSSION OF FINDINGS

The findings from table 1 indicated that there was significant difference between the estimated parameters ($\hat{b}_0$ and $\hat{b}_1$) and true parameters (b_0 and b_1) on the number of blocks laid by bricklayers in building industries (True parameters are traditionally considered to be zero). The findings are in support of Fagbenle, Adeyemi, & Adesanya, (2010) who stated that comparative analysis of sites with and without incentives showed that non- financial incentive schemes accounted for 6% to 26% of the variations in output between the two sets of sites on blocks laying and concreting activities measured. The bricklayers performed their duties based on standard. It was also revealed that there was no significant difference between the estimated parameters ($\hat{b}_0$ and $\hat{b}_1$) and true parameters (b_0 and b_1) on the number of blocks laid by bricklayers in building industries. The findings are in support of Luijsterburg, Bongers and Vroome (2005) who stated that the bricklayers were satisfied with the use of devices for raised bricklaying ,Accordingly, controlled intervention studies on ergonomic improvement in the construction industry may reduce physical load and the incidence of sickness. Workers need training to improve their performance in industries. This would enable the industries to retain workers.

Table 2 indicated that there was no significant difference between the value of forecast (Y_A) and confidence level ($\hat{Y}_F$) on the safety of workers in building construction industries. This is not in support with the finding of Carten (2006) who stated that majority of the construction accidents occur because of the inability to predict, identify and respond to project hazards. Also, Oke in Oke and Olaoye (2007) stated that safety refers to as state of working without any risk of injury, while safety precaution is the measure taken to prevent the occurrence of accidents in the industry. Safety of workers is very important in construction industries to protect them from accidents. Since this practice is the predominant means of obtaining work in many industries, it is difficult for contractors to determine their future workload, plan or invest for the future. (Theodore, 2001). This will surely affect the sub-contractors. It should be noted that where safety is not paramount to construction, it is extremely difficult for construction practitioners to ensure that they create workplaces for their workers.

VII. CONCLUSION AND RECOMMENDATION

The impact of vocametrics to building technology and allied in industries in Nigeria cannot be overemphasized. This is evident in the positions of scholars on the usefulness of vocametrics to building construction in particular and the application of its theory to both developing and technologically developed country in the contemporary world. Based on the findings, the following recommendations were made.

- It is of paramount importance that vocametrics be accorded its rightful place in the field of building technology in particular and in Vocational and Technical Education in general.
- Building team such engineers, architects, contractors ,builders and town planers should also endeavor to use the findings of this study to predict, identify and respond to project hazards that are likely to occur in future construction works.
- Contractors should use the findings of this study to predict the future workload of any buildings. on construction site. This can be done by planning and investing on any project that can boost the internally generated revenue of the construction industries.

REFERENCES

1. Abo, R.O. (2015). *Vocational guidance*. National Open University of Nigeria.
2. Allaffrica.com (2010). Construction Players Reap Rewards of Strong Demand [online]. Available from http:/allafrica.com/stories/

3. Carten G. (2006). *Industrial accidents prevention*. NewYork: McGraw Hill Book Company.
4. Fagbenle, O.I; Adeyemi, A.Y. & Adesanya, D.A (2010). The impact of non –financial incentives on bricklayers' productivity in Nigeria. *https://doi.org/10.1080/01446190420000241262*
5. Federal Government of Nigeria (2013). *National policy on Education* (revised). Lagos: NERDC.
6. Luijsterburg, P.A; Bongers, P & Vroome, E.D. (2005). A new bricklayer's method for use in the construction industry. Scandinavian Journal of Work, Environment and Health. 31(5), 394-400.
7. Mbamali, & Okotie, A.J. (2012).An assessment of the threats and opportunities of globalization on building practice in Nigeria. *American International Journal of Contemporary Research* 2(4), 143 – 150.
8. Odu, K.O. (2007). Poverty Alleviation Through Technical Education and Globalization. *Nigerian Journal of Research and Production* 11(3) 84-92
9. Odu, K.O.(2010). *Reappraising the work skill requirements for building technology education in senior secondary school for optimum performance in Nigeria*. Proceedings of the 1st International Technology, Education and Environment Conference 473 – 481
10. *Oke, J.O. (2009) The peer support of the new technologies in teaching and learning vocational / technical courses in Nigeria tertiary institutions*. The Cambridge International Conference on Open Distance Learning *U.K. 323-329*.
11. *Oke. J.O. & Olaoye, A.O (2007). Nature and reduction of accidents in secondary school woodwork shops. Educational Focus (EDFOC), 1(1), 22-28.*
12. Olaitan, S.O. & Ndomi, B.M. (2000). *Vocametrics: A high-tech problem solving quantitative text with computer skills*. Onitsha: Cape Publishers International Limited.
13. Olaoye, A.O. (2019). Vocametric Analysis of the Efficiency of Workers in Sawmill Industries for Optimum Production. *University of education Winneba Journal* 2 (1), 109- 118.
14. Oluwakiyesi, T. (2011). Construction Industry Report: A Haven of Opportunities *Vitiva Research* [online]. Avalable from t. oluwakiyesi@vetiva.com
15. Theodore, C.H.(2001). The performance approach to construction worker safety and health.
16. Unpublished Ph.D Dissertation. Graduate School University of Florida.
17. Walton, J.A. (1979). *Woodwork in theory and practice*. London: Australasian Publishing Company.