ISSN 2250-3153

EFFECT OF ELECTRO-MAGNETIC FIELD ON THE GROWTH CHARACTERISTICSOF OKRA (*Abelmoschus Esculentus*), TOMATO (*Solanum Lycopersicum*) and EGGPLANT (*Solanum Melongena*)

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Abstract- The study aimed to determine the effect of electro-magnetic field on the growth characteristics of Okra, Tomato and Eggplants and set to establish baseline data for farmers on the possible utilization of Electro-Magnetic Field (EMF). It was conducted on November 2011 to June 2012 and primed with the use of an inductor that produces EMF, exposing on it the Okra, Eggplants and Tomato. Susceptibility of the plants to insects and pests was also looked into by the study. The experimental and descriptive methods were used. The study found out that Okra plants when exposed to EMF grew faster and have its height, weight, sizes and number of fruits per plant significantly bigger and heavier than the Okra not exposed to EMF. On the other hand, EMF brought negative effect to Tomato. Egg plants, both exposed and not exposed to EMF were found with no significant effects on its growth characteristics. Moreover, Okra, Tomato and Eggplant plants which were exposed to EMF were observed with less number of insects and pests compared to those not exposed to EMF.A follow up study on the positive effect of EMF to the growth characteristics of Okra considering other variables is recommended.

Index Terms-Electricity, electromagnetic field, electric field, inductor

I. INTRODUCTION

Electricity as a highly commercialized prime drivers of technology undoubtedly has served its influence in the creation of paths of development as its physical effects include many recognized phenomena such as light effect, sounds, electromagnetic induction, photo electric effect, heat, refrigeration and air conditioning. It is an energy which is brought about by mechanical induction, chemical reaction and solar inducement. This energy can be converted or can produce another form of energy in order to become more useful and functional.

Any electrical loads or devices when supplied with electricity create electric field. It is present even when the loads are switched off or disconnected from voltage source. Its strength is measured in volt per meter (V/m) and its strength decreases with respect to distance from source. On the other hand electro-magnetic field (EMF) arises due to current flowing along a conductor. Unlike electric field, EMFexistsonly when a load or device isswitched on or connected to the voltage source. Its strength decreases with distance from the source.

Electromagnetic as a physical field produced by a moving electrically charged object can be measuredeverywhere in the environment. The electric current along a coiled-wire or conductor formed into an inductor produces an electromagnetic field (EMF) that may affect the living organisms like plants, animals and human beings around it near to it. It exists when there is a current flowing along a conductor and its strength increases as soon a device like inductor or coiled-wire is switched on and current moves through it. Definitely, the magnetic field becomes stronger when there is greater electricity flow.

According to Somasekaran (2007,) one of the sources of producing electromagnetic field is the high power transmission lines. Electromagnetic fields from high power transmission lines may affect the growth of plants and human beings. However no reports are made essential/available on the effects of EMF from high voltage power transmission lines in crop plants.

Shawanroy (2012) presented that EMF can be viewed as the combination of an electric field and a magnetic field. Electric field is produced by stationary charges, and the magnetic field by moving charges (currents); these two are often described as the sources of the field. Electro-Magnetic Field strength is measured in Ampere per meter (A/m). Commonly, EMF researchers and investigators use a related measure, flux density (in microtesla (µT) or millitesla (mT) instead.

In this study however, the researchers utilized the inductive-resistive (RL) loads formula to determinethe inductance value of the coiled-formed inductors being used in this study as an electro-magnetic field producer.

This concept and application of electro-magnetic field needs to set foot in places like the Rizal province where this way of electricity utilization in plants growth is still unknown. This will set new culture of technology application and utilization so as to establishtrend that may lead to a positive development inrural areas and indigenous places of the province.

League of provinces of the Philippines, (revised 2009) reported thatRizal province is very affable for agricultural development in consideration of its climatic condition, soil fertility, proximity to markets and vast agricultural lands. There are 32,276 hectares devoted to agriculture where 6,019.58 hectares are planted with diversified or high value crops like vegetables, fruits and root crops. Among the High Value Crops that can be potentially produced in the province are vegetables like cucumber, cabbage, lettuce, ampalaya, beans, okra, tomatoes among others. For the fruits are mango, cashew, citruses, rambutan, avocado, santol, atis, jackfruit (nangka), and the likes. Among these, tomatoes, okra and eggplant are one of the major producers in the province which can produce an average of 35,000 metric tons per year supplying almost three fourth of the annual local market demand of the province. All these prove right that Rizal province is rich not just with talents, tourist destination, products and crop but also in agricultural lands which people could still improve.

Today, Rizal-Philippines is stepping up to the challenges that are inspired by the declared policy in Sec 2 of Republic Act 9168 otherwise known and cited as Philippine Plant Variety Protection Act of 2002, which states…

> The State recognizes that science and technology are essential for national development and promotes the adaptation of technology and knowledge from all sources for the national benefit. The State also recognizes the need to protect and secure the exclusive rights of scientists and other gifted citizens to their intellectual property and creations.

The said Republic Act inspired the researchers to conduct the present study and cling to the belief that technology adaptation will definitely assured of national development. In support to this R.A.,Rizal has started to take a leap with its dealings in hydroponics technology, organic farming and other innovative system and processes. And yet, none so far has employed electro-magnetic fields in the growing of plants. Thus, the study becomes imperative. Furthermore, the present study attempted to label, introduce and employ electrical technology application and utilization in the farming process. It is expected that the result of this study may set a new trend among farmers not only in the province but also within the country.

Common household devices under 60 Hz frequency/220 volts source such as electric blanket has approximately 1 to 10 gauss, vacuum cleaners-.001 to .010 gauss, fluorescent lamps-.001 to .01 gauss washers ,blenders dryers-1 to 2 gauss of electro-magnetic strength (Anonymous, 1985).

Men are not aware that magnetism and plant growth are related to each other. Louis Pasteur discovered that magnetism affects plant growth when he was experimenting on the fundamentals of fermentation. He found out that the earth's magnetism affects the growth of plants. This concept can be effectively utilized in agricultural areas. Plant growth can be stimulated by treating the seeds, water, soil and nutrients in the soil. Magnetism is a renewable source of energy that can enhance plant growth (Aarti, n.d.)

Many scientists had made an investigations and came up with hypothesis that if a magnet was placed below the plants, those containing iron lean towards the ground. However, experiments have proved them wrong. In fact, plants with magnets grew taller than those without magnets below them.

The positive effect of magnetism on plant, animal and human life has been studied since the discovery of magnetism in the 16th century. It wasn't until the 19th century, however, that Louis Pasteur observed the positive effect of the earth's magnetic field on plant growth. Today, seed distributors magnetically treat seeds to encourage optimal plant growth (O' Grady, n.d.).

The cited literatures have significant bearing to the present study since it considered application of electro-magnetic field in plant growth through EMF producing device. It study relates with the idea and adherence of Pasteur that electro-magnetic field influences growth performance of plants.

Somasekaran (2007) disclosed in his study the effects of electro-magnetic field to selected crops, detailed the concept that the flow of electricity along a wire / conductor establishing an electromagnetic field (EMF) around it influences the living organisms like plants, animals and human beings by the way of electromagnetic induction.

The present study has relationship with Somasekaran's concept since both studies adhered with the idea that the flow of electricity along a conductor establishes an electromagnetic field. (EMF). This follows the concept that any living things near EMF will be affected by it and so with okra, tomato and eggplants that were used and exposed to electro-magnetic field in the conduct of this study.

II. Setting of the Study

The study was conducted inMorong Rizal, Philippines. The experimental lot was located at the garden field of the "Gusaling Ugnayan" of the College of Industrial Technology-Morong Campus of University of Rizal System. It was once an agricultural land where farmers sow their crops and vegetable plants to earn a living. At present, the site has variety of plants grown inside and alongside of the fence of the campus. The soil is observed to be rich with aluminum ion and has contained organic matters which are needed by plants in order to grow better. The area is equipped with garden tools, equipment and water system intended for gardening and watering of plants. A 220 Volts AC-3 phase source is located near the area for electrification purposes.

Objectives

Generally, the study aimed to determine the effects of electro-magnetic field to growth characteristics of Okra, Tomato and Eggplants. The study established a baseline data which will serve as future reference for farmers in the planting and growing of these plants.

ISSN 2250-3153

Specifically, the study aimed to:

1. Determine the growth characteristics of Okra, Tomato and Eggplant which were exposed to and not exposed to electro-magnetic field with respect to:
   1.1 plant height;
   1.2 length of fruit;
   1.3 basal diameter of fruit;
   1.4 weight of fruit; and
   1.5 number of fruits per plant
2. Label the significant difference between the plants which were exposed to and not exposed to electro-magnetic field considering the above cited variables.
3. Describe the susceptibility to insects and pests of the plants which were exposed to and not exposed to electro-magnetic field.
4. Prepare detailed technical guidelines on how to develop a coiled-wire EMF producer.
5. Prepare and submit reports of the findings of the study to the provincial government.

III. Methodology

The experimental and descriptive methods of investigations were usedin this study to determine the effects of electro-magnetic field (EMF) in the growth characteristics of growing plants. Two groups of plants were used and subjected to the study. The first group of plants was exposed to EMF while the second group was not exposed to EMF. Okra, Tomato and Eggplant were utilized in this study. Six plants were sown in a garden plot. These plants were chosen because of their capability to grow in summer season and abilities to withstand changing temperature and weather condition. The researchers followed the farmer's conventional way and standard procedure of planting and growing of plants. Descriptive method of research was thenused to describe the susceptibility to insects of both groups of plants. The two groups of plants were observed and compared as to their susceptibility to insects and pests. The observations processes were done from the time the plants sprout leaves up to the day they are ready for harvest. Data were taken religiously and recorded for analysis and interpretation.

Two garden plots measuring 5 X 1.5 meter each were cleared from weeds, cultivated and treated with hot water to germinate the soil and manually prepared to remove unnecessary objects like stones and dirt. Two 16-feet X 2" X 2" EMF producer-Inductors coiled with magnetic wire were placed in between the two rows of the first group of plant. It was manually adjusted upward to coincide with the height development of the plants and to ensure that they are near to the EMF by 10 centimeters until such time the plants are matured and ready for data gathering. The two Inductors connected in parallel with indicator lamps were supplied with 220 Volts AC power sourceand have a computed total Impedance value of 252 Ohms and .87 Amperes.

Two cages measuring 2.5 meters high x 2 meter wide and 5 meters long were installed to protect the two groups of plants and the Inductors from external influences like animals and humans. Weekly and monthly observations and data gathering on susceptibility to insects and pests were conducted. Data gathering on growth characteristics for Tomato was done on the 80th day after it was planted while data for Okra and Eggplant was observed on the 70th day after they were planted to determine the height of the plants, length of fruit; basal diameter of fruit; weight of fruit and number of fruits per plant.It was during the harvest time that the data was best gathered because the plants are already matured. To observe plants sensitivity and to record insects and pests which were visible with the garden plot, the researchers had regularly visited, maintained, monitored and observed the site where the experimentation has been done.

IV. Results and Discussion

Growth Characteristics of Okra, Tomato and Eggplant as Exposed to and Not Exposed to Electro-Magnetic Field with Respect to Plant Height, Length of Fruit, Basal Diameter of Fruit, Weight of Fruit and Number of Fruit Per Plant

Table 1 presents the computed mean on the response of okra, tomato and eggplant as exposed to and not exposed to electro-magnetic field with respect to plant height.

Table 1
Computed Mean on the Response of Okra, Tomato and Eggplant
as Exposed to and Not Exposed to Electro-magnetic Field
with Respect to Plant Height (in cm)

Plant	**Exposed To Electro-magnetic field**		**Not Exposed To Electro-magnetic field**	
	Mean	SD	Mean	SD

Okra	89.08	2.86	80.23	7.98
Tomato	86.1	2.50	104.5	10.7
Eggplant	83.86	0.48	83.51	1.07

Legend: SD – Standard Deviation

It could be gleaned from the table that with regards to plant height, plants that were exposed to electro-magnetic field, okra had a mean of 89.08 and a standard deviation of 2.86; tomato acquired a mean of 86.1 and standard deviation of 2.50; eggplant obtained a mean of 83.86 and standard deviation of 0.48.

Moreover, plants not exposed to electro-magnetic field, height of okra acquired a mean of 80.23 and a standard deviation of 7.98; tomato obtained a mean of 104.5 and a standard deviation of 10.7; eggplant got a mean of 83.51 and a standard deviation of 1.07.

The results showed that at early vegetative growth stage, okra plants exposed to electro-magnetic field are significantly taller than the ones not exposed to electro-magnetic field.

A different effect happened between the tomato which were exposed to and not exposed to electro-magnetic field when the tomato in the first garden plot came to be shorter than those tomatoes in garden plot 2.

The table further shows that there was almost a similar plant height between the eggplant exposed and not exposed to electro-magnetic field. Thus, implying that electromagnetic field has no effect to eggplants with respect to plant height.

Table 2 presents the computed mean on the response of okra, tomato and eggplant as exposed to and not exposed to electro-magnetic field with respect to length of fruit.

Table 2
Computed Mean on the Response of Okra, Tomato and Eggplant
as Exposed to and Not Exposed to Electro-magnetic Field
with Respect to Length of Fruit (in cm)

Plant	**Exposed To Electro-magnetic field**		**Not Exposed To Electro-magnetic field**	
	Mean	SD	Mean	SD
Okra	15.67	0.28	12.7	0.87
Tomato	4.18	0.20	5.11	0.09
Eggplant	18.4	0.54	18.4	0.45

As revealed on the table, the length of fruits of the plants that were exposed to electro-magnetic field, okra garnered a mean of 15.67 and standard deviation of 0.28; tomato acquired a mean of 4.18 and standard deviation of 0.20; eggplant obtained a mean of 18.4 and standard deviation of 0.54.

Furthermore, the length of the plants that were not exposed to electro-magnetic field shows that okra acquired a mean of 12.7 and a standard deviation of 0.87; tomato obtained a mean of 5.11 and a standard deviationof 0.09; eggplant got a mean of 18.4 and a standard deviation of 0.45.

The result shows that the fruit length of okra exposed to electro-magnetic field is significantly longer than those which were not exposed to electro-magnetic field.

On the other hand, tomatoes exposed to electro-magnetic field have fruit length that are shorter than the fruit lengths of those which were not exposed to electro-magnetic field.

Just like in plant height, electro-magnetic field seemed not to influence length of fruits of plants exposed and not exposed to electro-magnetic field.

Table 3 shows the computed mean on the response of okra, tomato and eggplant as exposed to and not exposed to electro-magnetic field with respect to basal diameter of fruit.

Table 3
Computed Mean on the Response of Okra, Tomato and Eggplant
as Exposed to and Not Exposed to Electro-magnetic Field
with Respect to Basal Diameter of Fruit (in cm)

Plant	**Exposed To Electro-magnetic field**		**Not Exposed To Electro-magnetic field**	
	Mean	SD	Mean	SD
Okra	2.108	0.09	1.83	0.12
Tomato	2.4	0.25	2.96	0.14
Eggplant	2.78	0.15	2.77	0.11

As reflected from the table, the basal diameter of plants exposed to electromagnetic field, okra in particular, garnered a mean of 2.108 and standard deviation of 0.09; tomato acquired a mean of 2.4 and standard deviation of 0.25; eggplant obtained a mean of 2.78 and standard deviation of 0.15.

ISSN 2250-3153

In addition, the basal diameter of okra which was not exposed to electro-magnetic field acquired a mean of 1.83 and a standard deviation of 0.12; tomato which was not not also exposed to EMF obtained a mean of 2.96 and a standard deviation of 0.14 while eggplant unexposed to EMF got a mean of 2.77 and a standard deviation of 0.11.

The result shows that the basal diameter of the okra exposed to EMF is bigger in diameter compared to those that were not exposed to EMF.

Further, tomatoes which were not exposed to EMF have bigger basal diameter than those with exposure to EMF.The eggplants, both exposed and not exposed to EMF have almost same basal diameter.

Table 4 presents the computed mean on the response of okra, tomato and eggplant as exposed to and not exposed to electro-magnetic field with respect to weight of fruit.

Table 4
Computed Mean on the Response of Okra, Tomato and Eggplant
as Exposed to and Not Exposed to Electro-magnetic Field
with Respect to Weight of Fruit (in grams)

Plant	**Exposed To Electro-magnetic field**		**Not Exposed To Electro-magnetic field**	
	Mean	SD	Mean	SD
Okra	24.17	1.47	13.67	2.42
Tomato	34.5	3.67	50.17	1.47
Eggplant	59.83	1.94	60	1.41

As revealed on the table, with regards to weight of fruits of plants exposed to electromagnetic field, the fruit of okra garnered a mean of 24.17 and standard deviation of 1.47; tomato acquired a mean of 34.5 and standard deviation of 3.67; eggplant obtained a mean of 59.83 and standard deviation of 1.94.

Furthermore, in view of the weight of fruit of plants, okra which were not exposed to electro-magnetic field acquired a mean of 13.67 and a standard deviation of 2.42; tomato obtained a mean of 50.17 and a standard deviation of 1.47; eggplant got a mean of 60 and a standard deviation of 1.41.

As revealed by the result, the weight of fruit of okra plants is significantly heavierthan those which were not exposed to EMF.

On the other hand, the fruits of tomatoes and eggplants which were not exposed toEMF are quite heavier compared to the weight of those which were exposed to EMF.

Table 5 presents the computed mean on the response of okra, tomato and eggplant as exposed to and not exposed to electro-magnetic field with respect to number of fruit per plant.

As can be reflected from the table, plants exposed to EMF specifically okra andeggplants earned a mean of 4 and 4.5 respectively and a standard deviation of 0.89 and 0.84 accordingly. Tomato on the other hand, got a mean of 2.167 and a standard deviation of 0.75.

Table 5
Computed Mean on the Response of Okra, Tomato and Eggplant
as Exposed to and Not Exposed to Electro-magnetic Field
with Respect to Number of Fruit per Plant

Plant	**Exposed To Electro-magnetic field**		**Not Exposed To Electro-magnetic field**	
	Mean	SD	Mean	SD
Okra	4	0.89	2.167	0.75
Tomato	2.167	0.75	3.83	1.47
Eggplant	4.5	0.84	4.167	0.75

An analysis of this result shows that okra exposed to EMF among other plants hasbetter number of fruits while tomato not exposed to EMF has good number of fruitscompared to tomatoes with exposure to EMF.

<u>Significant Difference Between the Plants Exposed to and the Plants Not Exposed to Electro-magnetic Field with Respect to the Different Aspect</u>

Table 6 shows the computed t–test on the significant difference between the plants exposed to and not exposed to electro-magnetic field with respect to plant height.

It could be gleaned from the table that in terms of plant height, okra and tomato obtained p-values of 0.043 and 0.009 respectively which did not exceed at 0.05 level of significance, Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field in terms of plant height are rejected for okra and tomato. Therefore, the presence of EMF brought positive effect to okra while negative effect on tomatoes with respect to its height.

Table 6
Computed T–test on the Significant Difference Between the Plants
Exposed To and Not Exposed To Electro-magnetic Field
with Respect to Plant height

Plant		**Mean**	**sd**	**df**	**t-value**	**p-value**	**Ho**	**VI**
Okra	Exposed	89.08	2.86	6	2.55	0.043	R	S
	not exposed	80.23	7.98					
Tomato	Exposed	86.1	2.5	5	4.09	0.009	R	S
	not exposed	104.5	10.7					
Eggplant	Exposed	83.867	0.482	6	0.75	0.483	FR	NS
	not exposed	83.51	1.07					

On the other hand, eggplant obtained a p-value of 0.483 which exceeded the 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field with respect to plant height failed to reject. Therefore, the existence of EMF does not affect the length characteristics of the eggplant.

Table 7 presents the computed t–test on the significant difference between the plants exposed to and not exposed to electro-magnetic field with respect to length of fruit.

As reflected from the table, the length of fruits for okra and tomato obtained p-values of both 0.000 which did not exceed at 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field with respect to length of fruits are both rejected for okra and tomato. Therefore, the EMF has positive contribution to okra with respect to latter's length of fruit. On the other hand, EMF has brought negative contribution to tomato with respect to length of fruit.

Table 7
Computed T–test on the Significant Difference Between the Plants
Exposed To and Not Exposed To Electro-magnetic Field
with Respect to Length of Fruit

Plant		**Mean**	**Sd**	**df**	**t-value**	**p-value**	**Ho**	**VI**
Okra	Exposed	15.675	0.281	6	7.96	0.000	R	S
	not exposed	12.7	0.872					
Tomato	Exposed	4.183	0.199	7	10.29	0.000	R	S
	not exposed	5.1167	0.0983					
Eggplant	Exposed	18.4	0.535	9	0.00	1.000	FR	NS
	not exposed	18.4	0.447					

On the other hand, in terms of length of fruits, eggplant obtained a p-value of 1.000 which exceeds at 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field with respect to length of fruits failed to reject for eggplants.
This closely implies that the use of an inductor/ coil producing EMF in growing eggplants is not advisable.

Table 8 presents the computed t–test on the significant difference between the plants exposed to and not exposed to electro-magnetic field with respect to basal diameter of fruits.

The table shows that with respect to basal diameter of okra and tomato obtained p-values of 0.001 and 0.002 respectively, both of which did not exceed at 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field in terms of basal diameter is rejected for both okra and tomato. Indeed, the use of EMF to okra is advisable since the study found out its significant contribution in the increase of the basal size of the fruits. This implies that, EMF should not be used with tomatoes as it does not help increase the basal size of the fruit.

On the other hand, with respect to basal diameter, the eggplants obtained a p-value of 0.915 which exceeds at 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field in terms of basal diameter failed to reject for eggplant. Therefore, EMF should not be utilized in growing eggplants since it has no effect at all to the basal size of the eggplant.

Table 8
Computed T–test on the Significant Difference Between the Plants Exposed To and Not Exposed To Electro-magnetic Field with Respect to Basal Diameter of Fruits

Plant		**mean**	**Sd**	**df**	**t-value**	**p-value**	**Ho**	**VI**
Okra	Exposed	2.108	0.0861	9	4.64	0.001	R	S
	not exposed	1.833	0.117					
tomato	Exposed	2.4	0.247	7	4.89	0.002	R	S
	not exposed	2.967	0.14					
Eggplant	Exposed	2.783	0.151	9	0.11	0.915	FR	NS
	not exposed	2.775	0.108					

Table 9presents the computed t–test on the significant difference between the plants exposed to and not exposed to electro-magnetic field with respect to weight of fruits.

Table 9
Computed T–test on the Significant Difference Between the Plants Exposed To and Not Exposed To Electro-magnetic Field with Respect to Weight of Fruits

Plant		**mean**	**Sd**	**Df**	**t-value**	**p-value**	**Ho**	**VI**
Okra	exposed	24.17	1.47	8	9.07	0.000	R	S
	not exposed	13.67	2.42					
Tomato	exposed	34.5	3.67	6	9.07	0.000	R	S
	not exposed	50.17	1.47					
Eggplant	exposed	59.83	1.94	9	0.17	0.869	FR	NS
	not exposed	60	1.41					

The table shows that with respect to weight of fresh single fruit, the fruits of okra and tomato obtained p-values of 0.000 which did not exceed at 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field in terms of weight of fresh single fruit is rejected for both okra and tomato. As observed and tried, Okra exposed to EMF has produced fruits with better weight. It implies that the use of EMF in growing okra should be continually observed.

On the other hand, in terms of weight of fruit, eggplant obtained a p-value of 0.869 which exceeds at 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field in terms of weight of fresh single fruit failed to reject.

Since the use of EMF in growing eggplant did not show any significant change or effect in the physical growth characteristics of eggplants, there is no need to expose eggplants with EMF.

Table 10 presents the computed t–test on the significant difference between the plants exposed to and not exposed to electro-magnetic field with respect to number of fruits per plant.

The table shows that with respect to number of fruits per plant, okra and tomato plants obtained p-values of 0.004 and 0.043 respectively which did not exceed at 0.05level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field in terms of number of fruits per plant is rejected for both okra and tomato. It can be said therefore that the number of fruits for okra increases when it is exposed to EMF. On the other hand, the number of fruits of tomato decreases when exposed to EMF. This then implies that EMF be used in growing Okra.

On the other hand, eggplant obtained a p-value of 0.487 which exceeds at 0.05 level of significance. Thus, the null hypothesis that there is no significant difference between the plants exposed and the plants not exposed to electro-magnetic field in terms of the number of fruits per plant failed to reject for eggplant. Therefore, eggplant should not be exposed to EMF because it has not significant effect to its growth characteristics most particularly in terms of number of fruits.

Table 10
Computed T–test on the Significant Difference Between the Plants Exposed To and Not Exposed To Electro-magnetic Field with Respect to Number of Fruits Per Plant

Plant		mean	Sd	df	t-value	p-value	Ho	VI
Okra	exposed	4	0.894	9	3.84	0.004	R	S
	not exposed	2.167	0.753					
Tomato	exposed	2.167	0.753	7	2.47	0.043	R	S
	not exposed	3.83	1.47					
Eggplant	exposed	4.5	0.837	9	0.73	0.487	FR	NS
	not exposed	4.167	0.753					

Susceptibility of Plants to Insects and Pests

After more than three months of monitoring the plants, both exposed to and not exposed to electro-magnetic field, the researchers found a very minimal infiltration of insects and pests among the plants exposed to Electro-magnetic field while manifestation of the presence and existence of worms, leaf hoppers, whitefly and flea beetle were seen in the leaves and fruits of plants that were not exposed to electro-magnetic field. This proves that Electro-magnetic field thwarts insects and other pests dwelling species to come into contact with the plants being exposed to it.

V. Conclusions

1. Okra plants when exposed to electro-magnetic field (EMF) grow faster and have its height, length, basal diameter, weight and number of fruits per plant, significantly bigger and heavier and have more number of fruits than the plants not exposed to EMF
2. The EMF has positive effect to Okra plant, thus, EMF can be used in growing of Okra.
3. The EMFhas negative effect to Tomato plants on aspects relating to plantheight, length, basal diameter, weight and number of fruits per plant, hence it is not advisable for use in growing of tomato.
4. The study revealed that eggplants exposed not exposed to EMFhaveno significant differences on theirheight, length, basal diameter, weight and number of fruits.
5. The study proved that Okra, Tomato and Eggplant plants when exposed to EMF are less susceptible to insects and pests. Thus, occurrence of pest and insects lessen in plants that are exposed to EMF.

VI. Recommendations

Based on the findings of the study, the following recommendations are hereby stated.

1. The result of the study showed thatEMF has positive effect in the growth characteristic of Okra with respect to its height, length of fruit, basal diameter, weight of fruit and number of fruits per plant.The strength of electro-magnetic field being produced by the electric charge on the coil and the strength of the electric field are the two factors that affect the growth characteristics of Okra, hence, EMF is recommended for use by farmers in growing of Okra.
2. A wider land area shall be applied with electro-magnetic field to have a more reliable specific data on its effectsto Okra in terms of its growth.
3. EMF should not be used in growing Tomato and Eggplant since the present study proves its negative effect on their growth.
4. A parallel study shall be conducted which will involve other plants such as leafy vegetables, Root crops and Vine Crops.
5. Further study shall be conducted to establishmore specific data on the growth response and performance of Okra to electro-magnetic field.This may involve other variables like sizes of stem, sizes of leaves, root elongation, fruit taste and nutrients and plants sensitivity.
6. A variable Inductor shall be utilized instead of a fixed variable to determine how Okra, Tomato and Eggplant respond when applied with different amount of EMF
7. The EMF has good effect to growing Okra since there are no insects and pests thatoccurred in the plants during the process. This implies that Okra if expose to EMF will grow better, hence, using EMF to growing of Okra is recommended. On the other hand, EMF should not be used in growing of tomato and eggplants since the study proved its negative effects to the growth of the tomato and eggplant.

8. A manual or moduleshall be prepared to guide farmers on how to prepare Inductor-EMF generator. This manual shall include the findings of this study for better understanding of the effects of EMF to Okra, Tomato and Eggplant.

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