Radiation Effects in Green House Vegetation and Integrated R.F Protectors

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Abstract— This paper proposes a novel system for improving production of agricultural products without radiation effects. The test sample plants are fenugreek, lady's finger which are tested under open area site (OATS), radiation area test site (RATS) and radiation protection area test site (RPATS). The samples are analyzed in different environments to study the growth characteristics. The plant growth is tested with and without radiation from a microwave source operating in 8-12GHz. When the plant is grown with an exposed microwave power in the range of 5-20mW, it gets affected by 66.6% for fenugreek and 50% for lady'sfinger with radiation. The integrated radiation protection unit is designed to prevent the plantation from radiation effect and helps to improve the growth. The plants growth with radiation protectors get less affected and provided 100% growth similar to OATS for fenugreek and lady's finger. The environment of the plant is monitored for standard growth monitoring through Embedded and GSM technology.

Index Terms— Radiation effect, Test Sites, Plant growth, Embedded, GSM.

1 INTRODUCTION

THE concern with a lot of consumer needs and demand for the agriculture products has stimulated awareness among the farmer to increase their products in the market by implementing advanced technologies [1]. The products of interest are used with natural sources to increase the products growth. Green house farm is an important part in the agricultural development of any country. As they can be used to grow plants under controlled climatic conditions to provide optimum yield [2]. The modernization helps to alert the user about the environment with GSM SMS technology. The environment is exposed to microwaves and electromagnetic radiations as a result of wide spread use of wireless communication systems. This created massive increase in electromagnetic pollution [3]. The enormous increase in the use of Mobile tower throughout the world is a prime concern on possible adverse effects caused by radiation [4],[5]. This work mainly focus on the prevention of radiation in the green house plantation using integrated protectors that prevent the EM fields to penetrate the fields.

2 Proposed Work Descriptions

2.1 System Archiecture

The plant samples are tested in three test areas like Open Area Test Site (OATS), Radiation Area Test Site (RATS) And Radiation Protection Area Test Site (RPATS). The test sample plants considered for the analysis are fenugreek and lady's finger. The radiation is generated using microwave source klystron that generates a frequency range from 8-12 GHz with a minimal range of power 5-20mW radiated using horn antenna. The plant growth was tested and monitored with environment observations on humidity, temperature and soil water content using an embedded controller unit.

A. Test sample characteristics

The plant of fenugreek has an average growth upto a length of 4.01 - 4.19mm. It grows in low light with a moisture content of about 8.9 - 20.1%. Another test sample is lady's finger which has physical properties with a growing temperature level well below 40^0F and requires low light. The average growth length is 6-12 inch height and 3-4 inch width.

B.Test area characteristics

Red soil contains the mineral iron.It can form two distinct oxides upon reaction with oxygen: ferrous oxide (FeO, one atom of Fe, one of oxygen) and ferric oxide (2 atoms of Fe and 3 of oxygen). Red soil is rich in the purple reddish ferric (Fe_2O_3) oxide. Constant weathering, especially in humid climate, washes away the rest of the chemicals leaving behind only the ferric oxide, which is highly insoluble in water. The various elements which are present in the soil are potassium, and calcium.So,this type of soil is selected for our work as shown in Fig. 1.

Fig. 1. Red soil

2.2 System Functionality

2.2.1 Green House Plant Area

The sample plants for test are considered as fenugreek & lady's finger. The plants are grown in three different test areas considered they are,

(i) Open Area Test Site - (OATS)
(ii) Radiation Area Test Site - (RATS)

(iii) Radiation Protection AreaTest Site - (RPATS)

A. Open Area Test Site

In open area test, a natural real time environment with periodical watering and natural sunlight is applied to the plant. But artificial radiation is not given to the plant. It is exposed to natural radiation that exists from the mobile towers. In the test areas, red soil is used for the plantation without adding any artificial fertilizers to the soil. In this system the plant is tested inside a lab environment using two test area prepared with a plastic tray having a dimension of 23*17*5.5cms. The plantation for test is shown in the Fig. 2.

Fig. 2. Open Area Test

B. Radiation Under Test Site

In radiation under test water, sunlight and radiation is given to the plant. The artificial radiation is provided in the X-Band to prove that any RF signal with a specific strength is affecting the agriculture growth and production. The microwave radiation from the klystron power supply through horn antenna is given to the test plant. The distance between horn antenna and tray is separated by a distance of 14cm as shown in the Fig. 3.

Fig. 3. Radiation Under Test Area

C. Intelligent R.F Protection Test Site

In intelligent R.F protection test the radiation on the plant is protected with the help of using metallic wire mesh arrangement. The principle is, if any electromagnetic signal falling on to a metallic surface it gets reflected back in the direction normal to its arrival. Here the plantation area covered with the wire mesh act as reflector to the RF signals. However based on the signal power it can pass certain fields to pass through. Still the amount of signal penetrate is marginal and creates less effect on the plants growth. "It is a perfect conductor to reflect the EM signal. The radiation is not entered to the plant. Only it will reflect all the EM waves by using porous shield.The test areas shown in Fig. 4.

Fig. 4. Radiation protection test

3. Antenna Section

3.1 Horn Antenna

The major antenna that is used in the X band is the Horn Antenna. A horn antenna is regarded as a flared out (opened-out) waveguide. The function of the horn antenna is to produce a uniform phase front with a larger aperture than that of the wave-guide and hence greater directivity. Types of horn antenna are circular and rectangular. Rectangular wave-guide with a flare in one direction is said to be sectoral horn.

3.2 Horn Antenna Analysis Parameters

3.2.1 Gain

Gain of the antenna obtained is expressed as

$$G = \frac{(4\pi R)}{\lambda}\sqrt{\frac{\mathrm{Pr}}{Pt}} \quad (1)$$

Where Pr is Received power
Pt is Transmitted power
R is distance between two antennas
λ is wavelength

In horn antenna,
Pt=33.3mW, Pr=0.621mW, λ=3.018cm, R=32cm
Gain is given by,
G= 18.19 (2)
Gain of the antenna in dB is expressed as

$$G = 10\log\left(\frac{4\pi R}{\lambda}\right) + 5\log\left(\frac{p_r}{p_t}\right) \quad (3)$$

Gain is given by
G=12.47 dB (4)

3.2.2 Directivity

Directivity D_o of an antenna obtained is given by

$$D_o = \frac{4\pi A_e}{\lambda^2} \quad (5)$$

$$A_e = \varepsilon_{ap} A_p \quad (6)$$

Where A_e is the effective aperture in m^2
A_p is the physical aperture in m^2
ε_{ap} is the aperture efficiency
λ is the wavelength in meter

For rectangular horn

$$A_p = a_E a_H \quad (7)$$

For conical horn

$$A_p = \pi \times r^2 \quad (8)$$

Assume ε_{ap} =1, then (5) becomes

$$D_0 \approx \frac{12.5 A_p}{\lambda^2} \quad (9)$$

Here a_E=1.1cm, a_H=2.4cm, λ=3.108cm

$$D_0 \approx \frac{12.5 \times 1.1 \times 2.4}{3.108^2} \quad (10)$$

D_0=3.4344 (11)

3.3 Beamwidth

Beam width between half power points is given as

$$BW = \frac{56}{a_{E\lambda}} \quad (12)$$

Where BW is beam width in degree

$a_{E\lambda}$ is aperture in E-plane in free space

Wavelength

$$a_{E\lambda} = 0.3539 \quad (13)$$

From equation (14),

$$BW = 158.1^o \quad (14)$$

3.3.5 X Band Reflection

The signal gets reflected entirely by a conductor whereas a dielectric transmits only a part of energy and reflects the remaining part. In case of insulator, part of energy will be reflected and transmitted wave will be refracted.

4 Radiation System

The radiation system consists of microwave test bench consisting of the source Klystron to operate in the X-Band (8-12GHz) and C-band (4-6GHz). The system is terminated with the antenna used for radiation using proper couplers and terminators. The center frequency of radiation is 9.8GHz with a maximum power measured using the HP Power meter is 20mW. The radiation is activated for a period of 8 hours a day. A VCO source is also used in the radiation system which generate frequencies in the C band (4-6GHz), which is used to couple microstrip antenna for testing purposes. The center frequency used is 5GHz for the C-Band test setup.

5. Analysis of plant Growth

The three test area growth are monitored on time basis and compared. The minimum radiation generated by the radiation source is used with the specific power level for the sample test sites considered. The plant growth is observed for a short span of five days. It is found out that the plant is affected by radiation. Comparison picture of fenugreek and lady's finger growth schematic is given in the Fig. 5, Fig. 6 and Fig. 7.

Fig. 5. Growth of the plant in open area test

Fig. 6. Growth of the plant in radiation under test

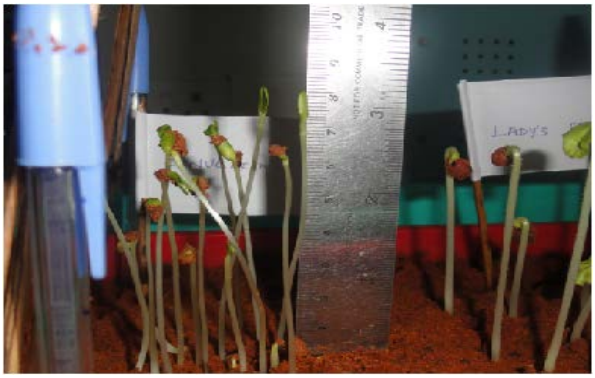

Fig. 7. Growth of the plant in radiation protection test

In the open area test observation and radiation protection test area observation, it is found out that Fenugreek plant has a growth of 7.8cm, whereas the area exposed to radiation for the same plant resulted with a growth of 6.8cm, which is 1cm lesser than OATS. It reveals the fact that the radiation has affected the fenugreek plant growth by 66.6%. Similarly, the lady's finger plant growth is observed under the same testing conditions considered for the fenugreek. It is observed that the growth without radiation in OATS area and RPASS is 8cms and the growth with radiation is 6.8cms which is 50% affected by radiation. The growth observations are given in the Fig. 8, Fig. 9 and Fig. 10.

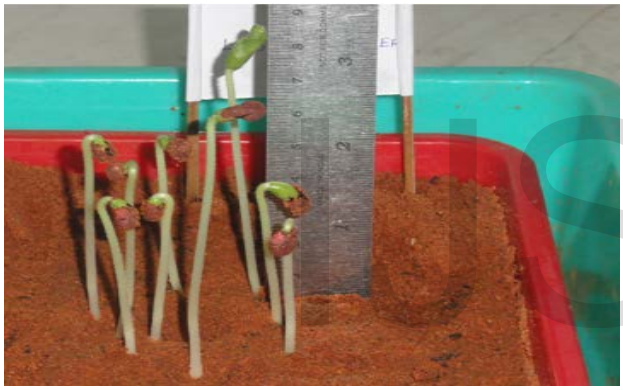

Fig. 8. Growth of the plant in open area test

Fig. 9. Growth of the plant in under radiation test

The plant growth is continuously monitored for five days and recorded periodically. The detailed observations are recorded and provided in the Table 2. The growth of the plant starting from the seeded date is maintained in similar conditions for the selected test areas. The open area and area with RF protectors had similar growth while the plant grown in the exposed RF area suffers from regular growthrate. The percentage of affected growth in percentage is calculated with the given formula,

$$\%\ \text{of the growth in RATS} = (\text{OAT growth})/(\text{RAT growth}) \times 100$$

Fig. 10. Growth of the plant in radiation protection test

In the growth analysis, the plant growth was not affected by radiation in the RPATS. So, the plant growth was 100% protected by using metalic mesh in the RPATS. Thus the radiation is completely reflected and protects the plant growth.

6. Embedded Unit

The PIC16f877a microcontroller interface with temperature and humidity sensor measures the respective values continuously and alerts abrupt variation through GSM technology. The Fig. 11 reperesents, pic16f877a microcontroller interface with temperature sensing module consisting of a thermistor. The temperature sensing module is kept in the sample test area and the analog input is given to PIC microcontroller. The analog input is converted to a digital form using the internal 10bit Analog to Digital converter. The corresponding digital data is used to display the sensed values in the LCD with the embedded programming.

S.no	Date	Day	Observation in FENUGREEK Growth										
			Open area test			Radiation under test				Radiation protection test			
			Growth(cm)			Growth(cm)			Radiation time	Growth(cm)			Radiation time
			9-12 AM	12-2 PM	2-4.50 PM	9-12 AM	12-2 PM	2-4.50 AM		9-12 AM	12-2 PM	2-4.50 AM	
1	4.2.13	I	**Planted Day**										
2	5.2.13	II	N	N	0.2	N	N	N	9am-4.50pm	N	N	N	9am-4.50pm
3	6.2.13	III	1.2	1.5	2	0.8	1	1.5	9am-4.50pm	1.2	1.5	2	9am-4.50pm
4	7.2.13	IV	3.5	4.2	5	2.5	3	3.5	9am-4.50pm	3.5	4.2	5	9am-4.50pm
5	8.2.13	V	7	7.5	7.8	5.5	6.2	6.5	9am-4.50pm	7	7.5	7.8	9am-4.50pm

Fig. 11. Temperature Measurement In the Plant.

S.no	Date	Day	Observation in LADY'S FINGER Growth										
			Open area test			Radiation under test				Radiation protection test			
			Growth(cm)			Growth(cm)			Radiation time	Growth(cm)			Radiation time
			9-12 AM	12-2 PM	2-4.50 PM	9-12 AM	12-2 PM	2-4.50 PM		9-12 AM	12-2 PM	2-4.50 AM	
1	4.2.13	I	**Planted Day**										
2	5.2.13	II	N	N	N	N	N	N	9am-4.50pm	N	N	N	9am-4.50pm
3	6.2.13	III	N	N	0.6	N	N	0.2	9am-4.50pm	N	N	0.6	9am-4.50pm
4	7.2.13	IV	2	2.5	3	1	1.5	2.1	9am-4.50pm	2	2.5	3	9am-4.50pm
5	8.2.13	V	5	6.5	8	4.5	6	6.8	9am-4.50pm	5	6.5	8	9am-4.50pm

TABLE 1
OBSERVATION OF THE PLANT IN FENUGREEK

TABLE 2
OBSERVATION OF THE PLANT IN LADY'S FINGER

7. Results and Discussion

The test sample of fenugreek and lady's finger is chosen. The

test was carried out for a period of five days, with the open area test (OATS), under radiation test (RATS) and radiation protection test (RPATS). The radiated power of 20mW was applied in the under radiation test and radiation protection test. The detailed observation on the growth of the fenugreek plant was tabulated as in Table 1. In the 1st day the fenugreek plant has no growth in open area test, under radiation test and radiation protection test. In the 2nd day evening, in open area test the plant growth is 0.2cm. But, under radiation test and radiation protection test it has no growth. In the 3rd day morning of open area test and radiation test, it has the same level of growth that is 1.2Cm. But, under radiation test its growth level is 0.8cm. Sixty six percentage (66.6%) of the growth is affected by applying a very small amount of radiation in fenugreek. The comparative growth in the fifth day, the growth of fenugreek plant resulted with a maximum height of 7.8cm in the open area test, 6.5cm in the under radiation test area and 7.8cm in the protected environment. The growth of the open area and protected environment nearly had the same growth of 7.8cm.

Similarly, the observation on the growth of the lady's finger plant was tabulated in Table 2. In the result of lady's finger plant, the first day and second day has no growth in open area test, under radiation test and radiation protection test. On third day evening, the plant growth in open area test and radiation protection test is 0.6cm. But, in under radiation test it has no growth. Fifty percentage (50%) of the growth is affected by a very small amount of radiation in lady's finger. The comparative growth of the lady's figure plant in the end of the week resulted with a maximum height of 8cm for open area test, 6.8cm in under radiation environment and 8cm in the protected environment. The growth of the plant in open area and protected environment nearly had the same growth of 8cm. This clearly shows that the exposed radiation suffers from growth rate that proves that radiation has affected the plant.

The embedded controller is programmed to be set for the specific environmental temperature (20^0C-30^0C). If abrupt change in temperature occurs, it will be recorded and transmitted through GSM module.

8. Conclusion

The natural growth of the plant is taken as reference in this growth study. The growth of plants is observed in the different environments to analyze the effect of growth on plant with and without radiation. The observation shows that the plant exposed to radiation is found to be affected when compared to the other areas. Test samples of fenugreek and lady's finger with radiation is affected with a growth rate of 66.6% and 50% respectively. If the growth of the plant gets affected it consequetively affects the production and becomes a carrier of radiation. The growth helps to understand the effect of radiation on plantation even at a minimum level of RF power exposure.

9. Acknowledgment

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10. References

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