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Research Article

Effect of Microwave Electromagnetic Radiation on Growth Measures and Photosynthetic Pigments of Green Gram (Vigna Radiate.) Seedling

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Abstract: A Laboratory test was conducted in completely randomize design, with three replications, in October 2018 at the Department of Botany, Jinnah University for women, Karachi to evaluate the *effect of microwave electromagnetic radiation* at *different* durations of *time* on seedling growth and photosynthetic pigments fractions (stress indicators) in Green Gram (*Vigna radiata* .L) Seedlings. The experiment was laid down at completely randomize design. Each set of treatment was replicated thrice for statistical analysis. The Seeds were irradiated with three different time periods of microwave radiation (5, 15 & 30 Seconds). Control seeds were not treated. Analysis of data showed that the differential exposure of microwave had significant effect on seedling growth & Pigments. The exposed electromagnetic radiation had a partially good effect on seedling growth significantly in 15 Sec exposures as compare to other treatment and control. The photosynthetic pigments also markedly responded with electromagnetic radiation and proved themselves a responsive stress indicator with differential radiation exposures. It can be noticed that the Photosynthetic pigments of green gram seedling were positively affected by microwave exposure. The highest results of chlorophyll content had been obtained when green gram seeds were treated with microwave radiation For 15 Sec of exposure.

Keywords: *Vigna radiate.L*; electromagnetic radiation; photosynthetic pigment; stress indicators.

INTRODUCTION:

Several researches showed that the chlorophyll quantity is interrelated with plant efficiency and physical condition (Dash and Curran, 2007).In plants, Phyto-chlorophyll work as an stress marker and give vital information about plant response to climate change. (Merzlyak and Gitelson, 1995; Penuelas and Filella, 1998). When a plant is under stress, chlorophyll content lowers down and this change is mainly obvious in initial stages. As much the stress intensified, chlorophyll content decreases faster than other pigments (Bannari *et al.*, 2007). This fluctuating quantity of chlorophyll indicates the stress to which the plant was subjected (Radu *et al.*, 1981). The adaptableness of organisms toward the intense conditions of environmental stress is an area of great current research. Now a day, the demanding use of mobile and other wireless devices generate an exponentially increased level of electromagnetic radiations. Thus, there is a new stress factor- electromagnetic field, especially microwave field greatly influence plant health (Vashisth and Nagarajan, 2008). To analyze this effect, many researchers worked on the effect of radio-frequencies (RF) on seeds through their experimentation (Chen and Wang, 2004). Thermal effect of microwave is evidently correlated with charged particles and polar molecules. Microwave field is basically a type of electromagnetic energy, and its interaction with charged particles and polar molecules leads to their agitation (heat). Biological material to be found under this radiation absorbs a selected quantity of energy, which depends on the dielectric characteristics of the material (Liang *et al.*, 2000).

In several published investigations regarding the exposure of microwave radiation consequence on plant growth has an encouraging effect in accelerating seed germination (Rao *et al.*, 1989; Hu *et al.*, 1996; and Chen *et al.*, 2004). However, there is still need a more research to know how pre-treatment of seeds with microwave causes a dramatic change in the inner energy of seeds, provoke activities of enzyme, leading

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to the enhancement of cell metabolism, and also improved the intensity of bio-photon emission, which is considered as the driven key of cell metabolism (Abeles, 1986; Higeg & Inaba, 1991).

It has been proven now that microwave short period exposure resulted in improved germination rate and percentage and also the vigor and vitality of the rising seedlings (Tran 1979; Nelson and Stetson 1985); however long exposure usually resulted in seed death (Ark and Parry 1940; Bebawi, *et al.* 2007; Brodie, *et al.* 2009). The fatal effect of microwave heating on seeds was first studied by (Davis *et al.*, 1971 & Davis *et al.*, 1973). They treated seeds in a microwave oven and observed that seed damage was mostly subjective by a combination of seed moisture content and the energy absorbed per seed. Therefore, in the present study is planned to evaluate the effect of a microwave (5 Sec, 15 Sec and 30 Sec exposures) on seed germination of Green Gram (*Vigna radiata*. L) And also to determine in biochemical changes related to this electro-magnetic radiation based stress factor.

MATERIAL AND METHODS

Experimental Design:

Three sets of green gram dry seeds were irradiated by Microwave radiation for 5, 15 & 30 Seconds. 10 healthy, irradiated, chemically sterilized seed of Green Gram (*Vigna radiata* .L) were kept in Petri dishes with one disc of filter paper under normal laboratory conditions with temperature ranging from 25-30^{o}C same set up replicate thrice for statistical analysis. Control was made with no exposure. Germinated seeds were counted and evaluated daily. Moisture of Petri dishes during the experiment was maintained at constant saturation. At the end of experiment, all the treated and non treated (control) seeds were subjected for the measurement of physical growth including seedling length, seedling biomass and Seedling Succulence = fresh weight /dry weight. After that the Photosynthetic pigments were extracted from experimental plants with 80% cold acetone and estimated according to Arnon's (1949). The data was analyzed by statistic software SPSS 16 (version 17). The differences were considered significant at $p<0.05$ when treatments' mean compared with control.

A. GROWTH PARAMETERS:

Morphological observations were comprised of root and shoot length (cm), fresh and dry weight (mg/seedling) and succulence (fresh wt /dry wt.) (Weatherley and Barrs 1962).

B. BIOCHEMICAL ANALYSIS :

- <u>Photosynthetic Pigment Content</u> (Chlorophyll a, b & Carotenoids) were determined in leaf samples (mg/g fresh weight) according to Arnon's Method[20],1949) by formula

1. Chlorophyll. a = 12.7 x $(OD)^{663nm}$ - 2.69 x $(OD)^{645nm}$ x V ÷ 1000 x W
2. Chlorophyll. b = 22.9 x $(OD)^{645nm}$ - 4.68 x $(OD)^{663nm}$ x V ÷ 1000 x W
3. Total chlorophyll = 20.2 x $(OD)^{645nm}$ + 8.02 x $(OD)^{663nm}$ x V ÷ 1000 x W
4. Carotenoid = 20 x $(OD)^{480nm}$ +2.28 x$(OD)^{663nm}$ - 12.76 x$(OD)^{645nm}$ x V ÷ 1000 x W

Where, OD= Optical density, V= total volume of chlorophyll Extract and 80% Acetone and W= Fresh Weight of plant sample

Inhibitory Percentage (I):

Inhibitory percentage of observed data in comparison to control was calculated by Surendra and Pota,1978[22] Formula.

I %= C-T/C x 100

Where, I is the % inhibition, T is treatment reading and C is control reading.

Statistical Analysis:

Calculated data was subjected to software program of SPSS version 17 for statistical analysis. Each tabulated value was the mean of at least three replicates. Data are displayed as mean ± standard deviation within three replications.

DATA RECORDED: Growth Parameters

Table-1 Effect of Microwave Radiation on Green Gram Seedling Growth

Treatment		Root Length (cm)	Shoot Length (cm)	Fresh Weight (gm)	Dry Weight (gm)
T0	0 - Sec Microwave Exposure	10.23 (0)	8.54 (0)	3.99 (0)	0.32 (0)
T1	5 – Sec Microwave Exposure	11.56 (+13.0)	9.69 (+13.46)	4.22 (+5.76)	0.47 (+46.87)
T2	15 – Sec Microwave Exposure	5.13* (-49.85)	11.36 (+33.02)	4.71 (+18.04)	0.49* (+53.12)
T3	30 – Sec Microwave Exposure	4.53* (-55.71)	7.76 (-9.13)	4.09 (+2.50)	0.29* (-9.37)

- Each tabulated value is the mean of 3 replicates.
- Values in parenthesis indicate percent increase (+) or decrease (-) over control reading.
- Values bearing * are significantly different with control at the level of Standard Deviation $p<0.05$ (LSD).

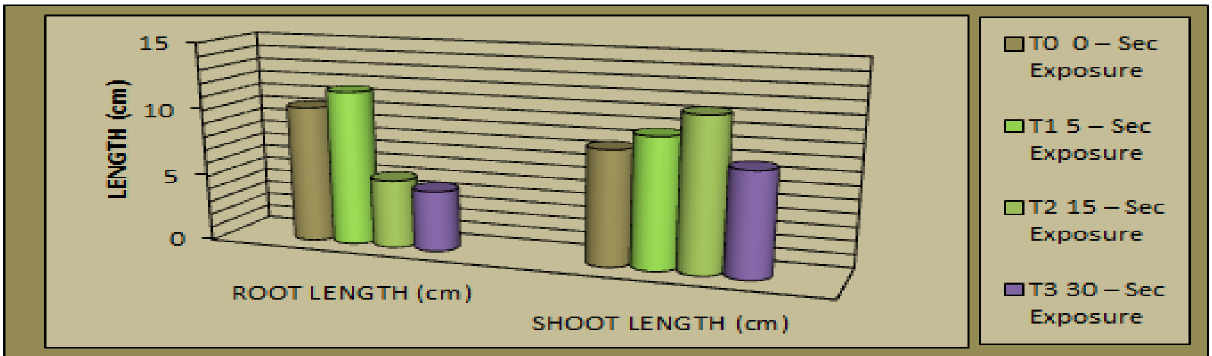


FIG:2a- EFFECT OF MICROWAVE RADIATION ON SEEDLING LENGTH
TREATMENT - Microwave Exposure (Seconds)

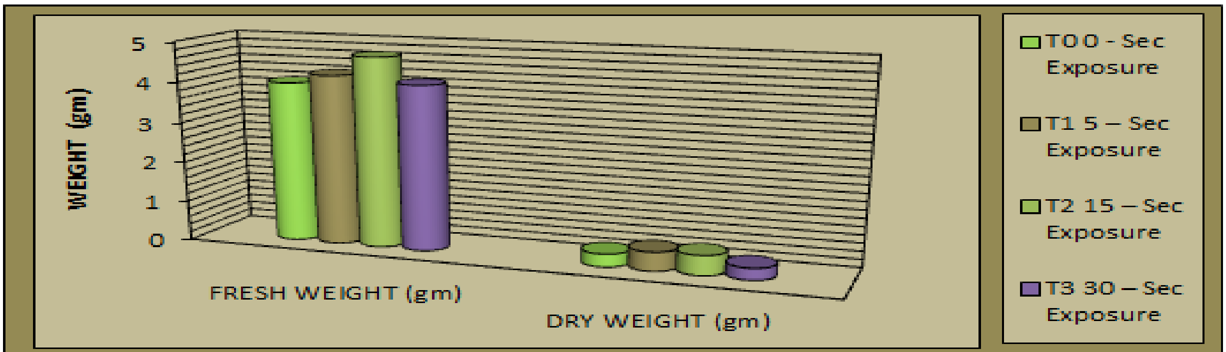


FIG:2b- EFFECT OF MICROWAVE RADIATION ON SEEDLING BIOMASS
TREATMENT - Microwave Exposure (Seconds)

Table-1-b Effect of Microwave Radiation on Seedling Succulence of Green Gram

Treatments		*Fresh Weight (gm)	*Dry Weight (gm)	* Seedling Succulence Fresh Mass / Dry Mass
T0	**0 - Sec Exposure**	3.99 (0)	0.32 (0)	3.99/0.32=12.46 (0) ± 0.012
T1	**5 – Sec Exposure**	4.22 (+5.76)	0.47 (+46.87)	4.22/0.47=8.97 (-28) ± 0.003
T2	**15 – Sec Exposure**	4.71 (+18.04)	0.49 (+53.13)	4.71/0.49=9.61 (-22.87) ± 0.015
T3	**30 – Sec Exposure**	4.09 (+2.50)	0.29 (-9.37)	4.09/0.29=14.1 (+13.16) ± 0.032

- **Each tabulated value is the mean of 3 replicates.**
- **Values in parenthesis indicate percent increase (+) or decrease (-) over control.**
- *** In Seedling Succulent data the Means followed by the Values that shows significant result at the level of Standard Deviation *p*<0.05 (LSD).**

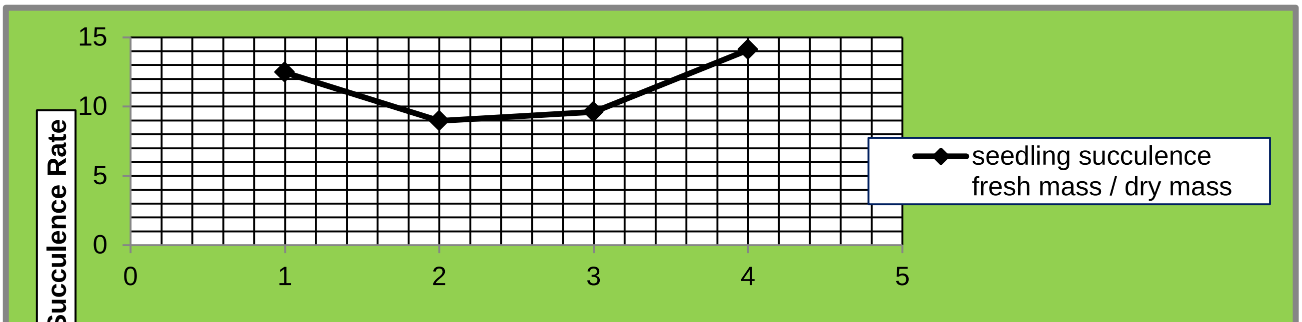


Fig: 2c- Effect Of Microwave Radiation On Seedling Succulence (Fr. Wt / Dry Wt.)

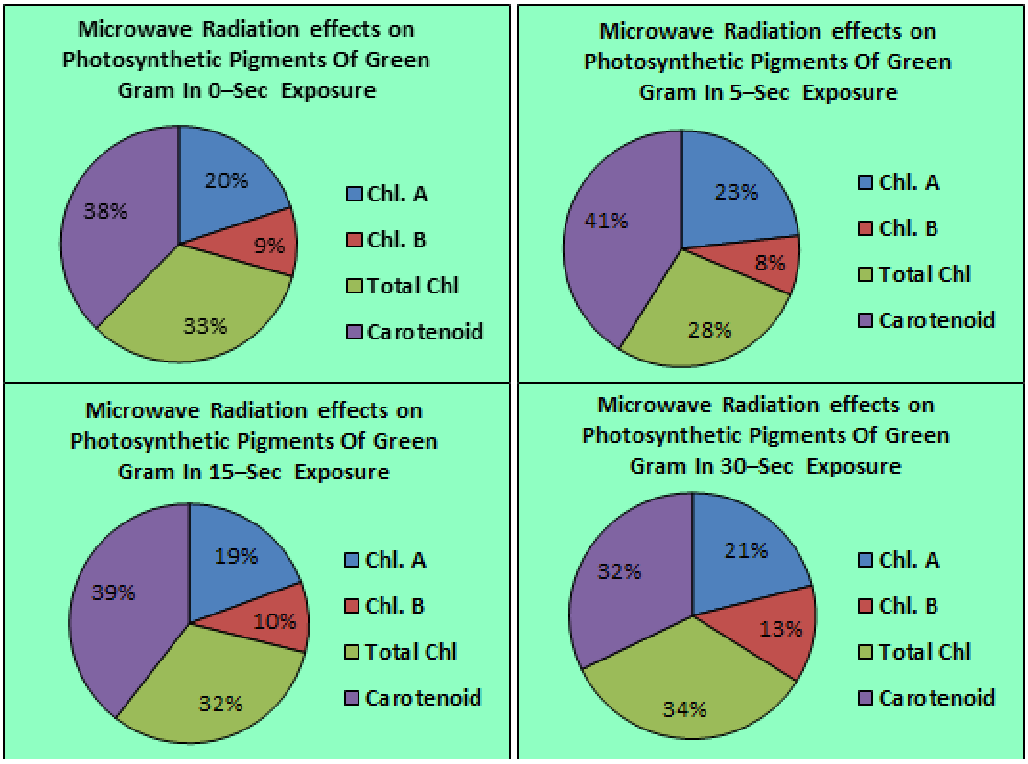
BIOCHEMICAL ANALYSIS:

Photosynthetic Pigment Content (Chlorophyll a, b and Carotenoids)

Table-2 Microwave Radiation effects on Photosynthetic Pigments of Green Gram

S. No.	Treatment	CHL. A (mg/gm)= 12.7 x (OD) ^{663nm} - 2.69 x (OD) ^{645nm} x V/1000 x W	CHL.B (mg/gm)= 22.9 x (OD) ^{645nm} - 4.68 x (OD) ^{663nm} x V/1000 x W	TOTAL CHL (mg/gm)= 20.2 x (OD) ^{645nm} + 8.02 x (OD) ^{663nm} x V/1000 x W	CAROTENOID (mg/gm) = 20 x(OD)^{480nm} + 2.28 x(OD)^{663nm} - 12.76 x(OD)^{645nm}
1	0 – Sec Exposure	0.09 (0)	0.043 (0)	0.149 (0)	0.17 (0)
2	5 – Sec Exposure	0.14 (+55.55)	0.049 (+13.95)	0.166 (+11.40)	0.248 (+45.88)
3	15 – Sec Exposure	0.172 (+91.11)	0.085 (+97.67)	0.281* (+88.59)	0.351* (+106.47)
4	30 – Sec Exposure	0.246 * (+173.33)	0.151* (+251.16)	0.397* (+166.44)	0.376* (+121.17)

- Each tabulated value is the mean of 3 replicates.
- Values in parenthesis indicate percent increase (+) or decrease (-) over control reading.
- Values bearing * are significantly different with control at the level of Standard Deviation $p<0.05$ (LSD).



RESULT AND DISCUSSION

- **<u>Effects of Microwave Radiation on Seedling Length (Root & Shoot Length):</u>**

The root length of 10 days old green gram seedling (Table-.2) showed significant increase only with microwave irradiance for 5 Sec, in comparison of control plant but the differences was not much considerable (i.e.13%). While the shoot length evidently proved the positive effect of short exposure of microwave radiation with 5 second (13.46%) and 15 seconds (33.02%) respectively. The data showed that 30 second exposure was harmful for root length and showed 55.71% decrease in root length as compare to control (Table -1).

- **<u>Effects of Microwave Radiation on Seedling Biomass (Fresh & Dry Weight):</u>**

The data of Table -1 declared that Microwave exposures had a significant effect on of 10 days old seedlings by improvement in fresh mass in all the exposed period (5, 15 sec and 30 Sec) and raise in Dry mass with 5 and 15 second exposure. But the dry mass did not significantly change and showed 9.37% inhibitions with 30 second exposure.

This Laboratory based growth experiment of plants subject to differential period of microwave magnetic field exposure demonstrated that the treated plants were taller and heavier than the non treated control plant and this observation was also in agreement with those of (Martínez *et al.*, 2003)

➢ **Effects of Microwave Radiation on Seedling Succulence (Fresh wt. / Dry Wt.):**

The seedling succulence shown improvement with 30 Sec exposure (+13.16), when compared with control plant succulence ($P<0.005$). The improvement of succulence and initial growth endorsed due to the decomposition of saccharides molecules in seeds by irradiation (Braginets, 1989, Dario and Salgado,1994) and thus cause mobilization of nutrients towards the growing embryo. This statement was also evident in the work of Ponomarev *et al.*, (1996) on oats and barley, Rao *et al.*, (1989) on mustard and Hu *et al.* (1994) and Kozai *et al.*, (1995) on rice However, this tendency of enhancement was also depended on duration of irradiation and type of the receiver plant.

➢ **Effect of Microwave Radiation on Photosynthetic Pigments**

The quantitative assay of green gram photosynthetic pigments was presented in table-2. The data clearly shown the increase of chlorophyll (Chl-a, Chl-b, Total chlorophyl) and Carotenoids Contents in 10 days old electro-magnetic irradiated seedlings with all the three exposed duration (5, 15 and 30 Sec), in comparison of control plant ($P< 0.005$) (Fig.-2). This observation also revealed that the low doses stimulated pigment contents production in seedlings state. Increase in photosynthetic pigment especially Carotenoid with microwave slight exposure due to heat treatment trigger the libration and the bioavailability of carotenoids as investigated by Rock *et al.*, (1998). These results were also in agreement with those of Creanga *et al.* (1996) and Cao *et al.*, (1998).

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