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"Studies in bio-physics: Effect of electromagnetic field and x-rays on certain road side legume plants at Saharanpur"

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Abstract: This work is done under Interdisciplinary Programme in Biophysics. Studies were carried on seeds of 4 socio-economically important Legumes growing on road side. The seeds of following four plants are selected:
Gram Cicer arietinum, Vigna Radiata Mung, Vigna moongo Urd, Vicia faba Bakhla
All four plants belong to botanical family. Leguminosae new named family (This family characterised by the presence of Legume fruit, diadelphons stamen condition and monocarpellary unilocular ovary with marginal placentation.

Keywords: Electromagnetic field, X-rays, growth and development of plants under high power line.

I. INTRODUCTION

We know that an electric charge at rest has electric field only. A moving charge produces both the electric and magnetic fields. If the charge is moving with a non-zero acceleration then both the magnetic and electric fields will change with time and space it then produces electromagnetic waves.
In an electromagnetic wave the sinusoidal variation in both electric and magnetic field vectors occurs simultaneously.
The electromagnetic field can be produced by electromagnets, electrical transmission lines, radiations are also electromagnetic waves.
The overhead power lines can generate electrical and magnetic fields. In Today's world, an increasing level of sensibility to health and ecological problems is seen. High voltage overhead power lines generate electric and magnetic fields in their neighbourhood.
For the general public, the limiting value of electric field is 10000 volt/m. The formula used to find electric field strength is

$$E = \frac{8K\lambda h^3}{\left(h^2 - 2hy + x^2 + y^2\right)\left(h^2 + 2hy + x^2 + y^2\right)}$$

Here = 2.5335×10^{-6} C/m
The formula used to find magnetic field is

$$B = \frac{\mu_0}{4\pi}\frac{2i}{r}$$

II. METHODOLOGY

Studies were carried out on four socio-economically important legume plants growing along road sides of district Saharanpur. Seeds of following four legume plants selected in the present study.

1. Cicer arietinum = Gram
2. Vigna radiata = Moong
3. Vigna moongo = Urd
4. Vicia faba = Bakhla

Growth Studies

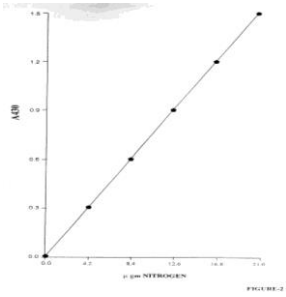
Germination and Seedling Growth

For seedling growth experiments were performed with above seeds soaked in water. For germination and seedling growth studies, seeds selected for uniformity (criteria being the size, weight and colour of the seeds) were surface sterilized with 0.1% mercuric chloride thoroughly washed and then seeds given various light & X-ray treatment. Thereafter seeds were washed with distilled water and transferred on moist filter paper in petri plates for germination and seedling growth in petri plates. Irrigation done when ever found necessary.
In order to obtain the effects of Red light, blue light and green light, the moistened seeds were exposed to these lights for 12 hr, at dark room temperature 24°C ± 2°C and then allowed to germinate in a dark room under normal temperature of their growth period. All the petri dishes containing seeds were kept in complete darkness after exposure to light. Side by side a control set also run in dark without any light treatments. Three petri dishes containing 20 seeds each were kept for further observation: at 3rd , 5th and 7th day of germination. Similarly 3 petri dishes containing 20 seeds each without any light treatment were also placed in dark as control set. The light source constituted one 60 W incandescent lamp which was kept 75 cm away from petri dishes.
In order to obtain result related to the effects of X-rays on seed germination and seedling growth, experiments were made on four legume seeds. The X-ray tube was operated at about 100,000 volts, 100 pk. Kilovolts and 5 milliamperes. The X-rays were filtered through 1 mm of aluminium screen and the soaked seeds were placed at a distance of 30 cm. from the target. At this setting the output of the machines was approx. 38 reontgens per minute. They were subjected to the radiations for various lengths of time in seconds such as 60 seconds, 90 seconds and 120 seconds.
This type of treatment gave doses of 38, 57 and 76 r units respectively (Wort, 2011). These treated seeds were then placed in petri plates consisting of moist filter paper, for germination and seedling growth. Side by side a control set without X-ray doses was also run, control set, simultaneously.
For seedling growth studies, samples were collected on 3rd, 5th and 7th day of germination. The seedling were dissected into root, shoot and cotyledon. Length, fresh weight dry weight of these seedling was recorded. In the case of residual cotyledon only the fresh weight and dry weight was measured. Here often root named as radicle and shoot named as Epicotyl in Cicer and Vicia sp. While in Vigna sp, it is named as hypocotyl.

The dry material of these selected seedling samples were used for quantitative estimation of total N, total P and total heavy metal content. Further to observe the effect electro magnetic field created by light and X-ray seeds were also used for chlorophyll development and studies on certain enzyme activity. **These plants were also collected from the field beneath high voltage wire (experimental)** and also away from high voltage wire (control) and total than in these samples total N, total P and total heavy metal were estimated.

Methods of Bio-Chemical Estimation: Total Nitrogen

For quantitative estimation of nitrogen in plant sample, the digestion was done according to Snell and Snell (1954) and later the nitrogen in the digest was estimated calorimetrically. 50 mg dry powder of plant sample or 500 mg air dried soil was digested with 5 ml of concentrated sulfuric acid (Conc. H_2SO_4) and 2 ml of 30 percent hydrogen peroxide (H_2O_2) for ca. 5 minutes on sand bath. After cooling the digest, 3 ml. more of hydrogen peroxide was added to it and the digestion was continued for about 30 minutes more, till the contents became clear. The cooled digest was diluted to a known volume (50 ml). The estimation of the digest was done with Nessler's reagent, 0.5 ml of digested solution was added, the volume was made pto 5 ml with distilled water and allowed to stand for 10 minutes to stabilize the colour. Absorbance was read at 430 nm and the nitrogen was estimated quantitatively with the help of calibration curve (Figure 2).

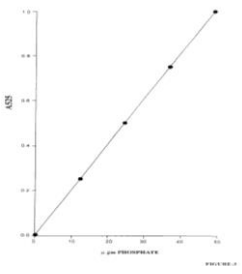


Side by side total Nitrogen is also determined by modified Kjeldahl method. For this digestion, 1 gm of air dry soil material/plant tissue material is put in 500 cc. Kjeldahl flask and pour into 25 cc of conc. H_2SO_4, 5 gm of fuses potassium and 1 piece of $CuSO_4$ of a size of mustard is also added. Now the content is heated slowly in the beginning and vigorously afterwards till the content in a flask becomes colourless and clear light blue. Content is cooled and volume made 250 cc with distilled water. Now the N2 was then distilled and driven off adding excess of NaOH and boiling in the distillation flask through routine method as suggested by Selwood (1959).

Total Phosphate

For the estimation of total phosphate, the digestion was done by 60 percent per chloric acid ($HClO_4$) and 30 percent hydrogen peroxide (H_2O_2). Later, the phosphate content was estimated calorimetrically using metol as reducing agent.

50 gm dry powder of plant sample of 1 gm air dried soil was digested with 10 ml of 60 percent percholoric acid and 3 ml of 30% hydrogen peroxide on a hot plate to dryness and the residue was dissolved in 10 ml distilled water. 1 ml of this digest was taken in a test tube along with 3 ml of copper acetate buffer (2.5 g $CuSO_4.5H_2O$) and 46 g of sodium acetate dissolved in 2N acetic acid and volume made to 1 litre); 0.5 ml 5 percent ammonium molybadate solution and 0.5 ml of metol reagent (2g metol dissolved in 100 ml of 10 percent sodium sulphite solution) and mixed thoroughly after each addition.

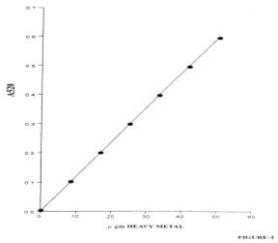


The intense blue colour developed was allowed to stand for 10 minutes. Absorbance was read at A 525 nm (Allen, 1940, Oser, 1965) and the amount of phosphate was then quantitatively determined by using a calibration curve (Figure 3).

Total Heavy Metal

For the estimation of total heavy metals, the digestion was done by concentrated nitric acid (Conc. HNO_3) and per chloric acid ($HClO_4$). Later, from the digest, the heavy metals were extracted in purified dithizone (Sandell, 1950) and estimated calorimetrically.

100 mg dry powder of plant sample was digested in a mixture of 2 ml 60% per chloric acid ($HClO_4$) and 2 ml concentrated nitric acid (Conc. HNO_3) by heating on a hot plate to dryness. The residue dissolved in 10 ml ammonium citrate buffer pH 8.5 (90 g ammonium citrate dissolved in 1 litre distilled water and made to pH 8.5 with ammonium hydroxide). Similarly 100 mg air dried soil was digested in 10 ml of 2N HNO_3 and 2 citrate buffer (pH 8.5) was added. For heavy metal extraction by complexing with dithizone, plant or soil digest was made to pH 8.5 with sodium hydroxide (NaOH) and extracted repeatedly with 5 ml of the purified dithizone solution (100 mg of dithuizone dissolved in minimum volume of chloroform ($CHCl_3$)), partitioning against dillute ammonia, collecting the aqueous dithizone containing layer, acidifying this fraction with few drops of NH_2SO_4, re-extracting the dithizone in chloroform and making up the volume of 1000 ml with chloroform to give a final concentration 0.01 percent dithizone in chloroform. The extracts were pooled, made to 20 ml with chloroform and the absorbance read at A520 nm. The quantities of total heavy metals were estimated with the help of standards and the calibration curve (Figure 4).



Chlorophylls

For chlorophyll contents fresh weight of tissue was homogenized with 80% acetone, later centrifuge at 3000 rpm, for 5 minutes, final volume was made to 10 ml with 80% acetone absorbance of the extracts was read at 645 nm and 665 nm. The chlorophyll content were estimated by the formulae of Arnon (1949) which is shown below:

Chl-a, mg/1 = 12.72 A_{665} – 2.58 A_{645}
Chl-b, mg/1 = 22.87 A_{645} – 4.67 A_{665}
Chl-a+b, mg/1 = 8.05 A_{665} – 20.29 A_{645}

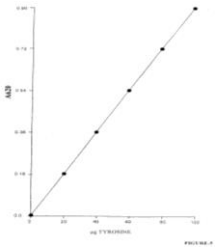
Estimation of Enzyme Activity

A common trismaleate solution hydroxide buffer (NaOH) pH 6.8 was used as the extraction cum assay buffer for assay of protease, alpha amylase, peroxidase and IAA oxidase (Vimla, 1983). The buffer was prepared with 50 ml of 0.2 M solution of tris maleate and (23.2 g of maleic acid and 45 ml of 0.2 MNaOH, both mixed and diluted to 200 ml) (Gupta et al. 2002)

Crude enzyme was extracted by homogenizing ca. 1 g tissue in ca. 10 ml of the above buffer. The resultant homogenate was centrifuged to get a clear supernatant and made to a definite volume of buffer. This preparation constituted the crude enzyme extract. Further each enzyme was assayed as per the method given here under.

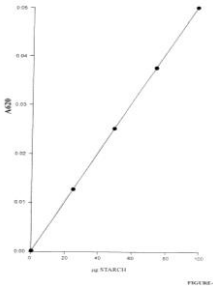
(A) Protease

1 ml enzyme was incubated with 1 ml substance (4g casein) per ml extraction buffer incubated for one hour at ca 400 C. The reaction was quenched by addition of 2 ml of 20% TCA and chilling for three hours. The supernatant was collected by centrifugation and then made slightly alkaline by the addition of 1 ml 1.5 N NaOH and the final volume made to 5 ml (A). 1 ml of (A) was mixed with 5 ml of copper sulphate reagent (50 ml of 20% Na_2CO_3 in 0.1 N NaOH was mixed with 1 ml of 0.5% $CuSO_4$ in 10% solution tertarate before use). After 10 minutes, 1 ml of Folin Phenol reagent (Lowry et al., 1951) was added to the reaction mixture kept for 0 minutes and it's absorbance was read against blank A_{620} mm (Yamono and Varner, 1973). The amount of Amino acid released in terms of Tyrosine was calculated with the help of calibration curve (Figure 5). Total protease activity has been express as mg. Tyrosine released per hour per gram fresh weight.



(B) Alpha-amylase

1 ml enzyme was incubated with 1 ml substrate (0.15% starch in 0.2 ml KH_2PO_4 for $CaCl_2$) for 10 minutes. The reaction was quenched by the addition of 3 ml iodine reagent (1 ml of 0.6% iodine in 5% to 6% potassium iodine in water : 1 ml of this stock solution made to 50 ml with 0.05 N HCl) and the amount starch degraded determined through A_{625} nm (Filner and Verner, 1967). Amount of starch degraded was determined with the help of a calibration curve (Figure 6) total enzyme activity is shown as mg starch degraded per minute per gram fresh weight.

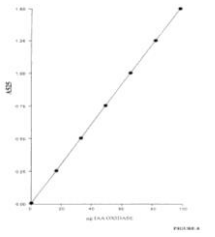


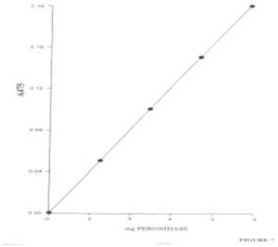
(C) Peroxidase

The reaction mixture for anzyme determination contained 0.8 ml extraction buffer and 2 ml 1% benzidine solution (0.5 benzidine was added to 4.33 m, of Glacial acetic acid at 50°C later kept in boiling water for ca 8-10 minutes to this a solution of 0.42 g Anhydrous sodium acetate in water was added and the volume made to 50 ml with extraction buffer), 2 ml hydrogen peroxide (30% H_2O_2 diluted in the proportion of H_2O_2 : H_2O (1:4) and 1 ml enzyme extract. The blank was prepared by mixing the reaction mixture as above, except that H_2O_2 was not added. The blue colour developed in reaction mixture by the enzyme activity, was measured by recording. A_{475} adding the enzyme exactly after 1 minute after. The enzyme activities expressed as A475 per minute fresh gram fresh weight with the help of calibration curve. (Figure 7)

(D) IAA Oxidase

2 ml of the enzyme was incubated with 0.5 ml IAA solution (200 □g/ml) and ml buffer at ca 25°C for 50 minute. After incubation 2 ml of the reaction mixture was mixed with 4 ml Salkowski Reagent (2% v/v 0.5 m ferric chloride in 35% perchloric acid). And its O.D. at A_{425} nm was read after 30 minutes against blank. The mg IAA degraded was calculated with the help of standard curve (Figure 8). Total IAA oxidase activIty has been expressed as □g IAA degraded minute per gram fresh weight.





III. PROPOSED WORK

On the basis of available literature and previous work done by some workers the present work was done to observe effect of various colour of light and x-ray on the following lines.

1. Seeds germination and seedling growth as affected by different colour of light doses in above plants.
2. Effect of X-ray doses on seed germination and seedling growth.
3. Total Nitrogen, estimation in the dry samples of seedling of above 4 plants.
4. Total phosphorus estimation in the dry samples of seedling of above 4 plants.
5. Total heavy metal estimation in the above dry samples of seedling of above 4 plants.
6. Side by side above 4 plants were also collected from the field growing beneath the high voltage wire and also away from these wire and then subjected to total N, total P and other heavy metal estimation.
7. Certain biochemical change such as enzymatic activity and chlorophyll development in above 4 plants.

Effects of Different Colour of Lights on Seed Germination and Seedling Growth

Studies were carried out on the effects of different colour of light such as Red, Blue and Green light on seed germination and subsequent seedling growth in dark in four Legume plants (1) Gram = Cicer arietinum (2) Mung = Vigna radiata (3) Urd = Vigna moongo and (4) Bakhla = Vicia faba. To carry out the study, surface sterilized seeds were used. There after the sterilized seeds were given light doses for 12 hrs, at room temperature and then growth in dark. Similarly, seeds soaked in distilled water serves as control. Likewise, the effect of different doses of X-ray were also studies in these plants. X-ray doses were given for 60 seconds, 90 seconds and 120 seconds.

Results of these observations are given in table 5 to 12 and figure 9 to 16.

Cicer Arietinum

Table 5 and 6 and also figure 9 to 10 show the effects of different colour of light pretreatment for 12 hours on germination and subsequent seedling growth of Cicer arietinum growth in dark.

Germination:

Table 5 indicates that Red light increases germination percentage, whereas, blue and green light results inhibition of germination percentage in this plant. However, the extent of inhibition is more is green light pre-treated sets. Thus, germination percentage in Red light is 107.1% of the control light.

Table 5

Effect of Different colour of light on germination percentage of Cicer arietinum seedling grown in dark

Treatment	Colour of Light			
	Control	Red	Blue	Green
12 hours	84.00	90.00	70.00	60.00

TABLE- 6

EFFECT OF 12 HOURS PRETREATMENT OF SEEDS WITH DIFFERENT COLOUR OF LIGHT ON THE GROWTH OF CICER ARIETINUM (GRAM)

SEEDLING PART	COLOUR OF LIGHT											
	CONTROL			RED			BLUE			GREEN		
	DAYS AFTER RADICLE EMERGENCE											
	3	5	7	3	5	7	3	5	7	3	5	7
	LENGTH, cm ± SD											
ROOT	3.46 ± 0.20	4.88 ± 0.20	6.68 ± 0.30	3.60 ± 0.26	5.80 ± 0.40	8.60 ± 0.36	3.00 ± 0.08	3.80 ± 0.80	4.80 ± 0.48	2.60 ± 0.20	2.68 ±0.24	3.40 ±0.80
SHOOT	5.40 ± 0.10	6.80 ± 0.30	7.80 ± 0.30	6.40 ± 0.20	8.00 ± 0.46	9.60 ± 0.98	4.00 ± 0.08	5.60 ± 0.36	6.90 ± 0.30	2.80 ±0.10	3.60 ±0.28	4.68 ±0.30
	FRESH WEIGHT, mg ± SD											
ROOT	40.10 ± 4.30	48.60 ± 3.78	60.20 ± 6.60	46.20 ± 3.40	60.30 ± 6.10	71.50 ± 5.00	20.40 ± 1.80	38.20 ± 2.43	50.30 ± 6.00	20.10 ±1.26	25.40 ±2.10	38.00 ±5.00
SHOOT	48.40 ± 1.80	60.00 ± 3.40	70.80 ± 5.60	54.00 ± 1.90	71.50 ± 4.16	88.40 ± 6.56	40.00 ± 3.10	50.10 ± 5.30	67.50 ± 6.20	24.60 ±2.85	38.60 ±3.25	49.60 ±3.60
COTYLEDON	198.00 ± 11.40	170.45 ± 15.20	159.40 ± 16.50	188.40 ± 5.00	130.30 ± 13.30	75.80 ± 5.30	218.10 ± 19.50	200.00 ± 15.10	150.10 ± 16.50	208.40 ±21.40	176.10 ±18.40	160.50 ±15.50
	DRY WEIGHT, mg ± SD											
ROOT	3.88 ± 0.30	6.00 ± 0.34	8.80 ± 0.38	40.70 ± 0.21	7.50 ± 0.20	10.40 ± 0.28	3.40 ± 0.21	4.40 ± 0.38	6.40 ± 0.41	2.50 ±0.40	3.35 ±0.45	4.40 ±0.32
SHOOT	5.80 ± 0.10	7.60 ± 0.28	10.50 ± 0.18	6.40 ± 0.19	8.96 ± 0.21	11.48 ± 0.38	4.96 ± 0.90	5.40 ± 0.45	6.88 ± 0.60	3.68 ±0.22	4.75 ±0.15	5.00 ±0.10
COTYLEDON	108.10 ± 8.30	100.00 ± 9.80	92.80 ± 8.30	104.10 ± 9.00	96.50 ± 6.40	85.40 ± 8.80	109.80 ± 9.60	102.50 ± 9.10	96.50 ± 1.90	109.50 ±10.50	106.00 ±10.10	100.50 ±9.10

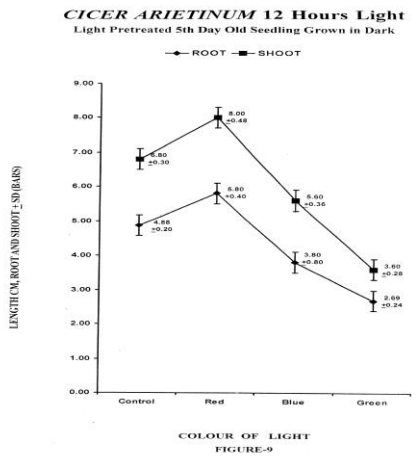


FIGURE-9

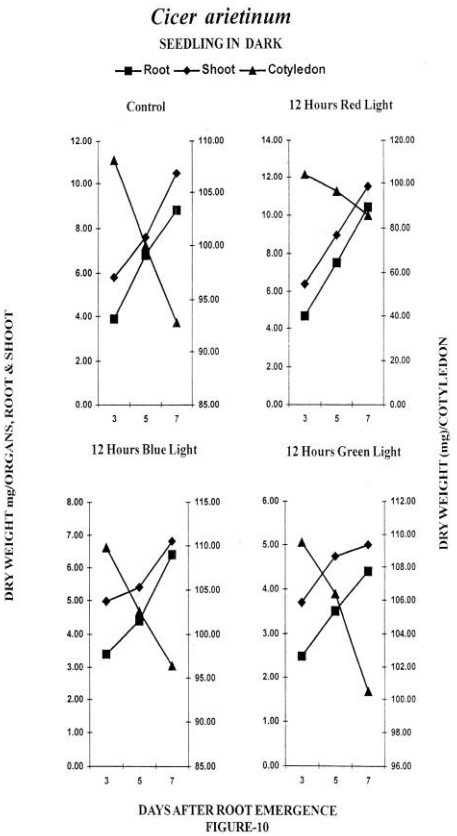


FIGURE-10

Seedling Growth:

Table 6 and figure 9 and 10 show that like germination seedling growth is also promoted in Red light pretreated sets and inhibited in blue and green colour light treated sets. Thus, in Red Light treated sets on 5th day root and shoot lengths are promoted as compared to control respectively. Likewise, fresh weight in the same Red light concentration are also promoted as compared to control at the same day. Results, further show that inhibition is more in green light pretreated sets as compared to other Light treated sets and control set. Thus, root length are inhibited by ca. 25%, 44% and 50% at 3rd , 5th and 7th day respectively in green light. Similar pattern of inhibition in fresh weight was also observed with root and shoot in Blue and Green light treated sets. Thus, on 5th day in Blue light root and shoot fresh weight inhibited by ca. 21% and 17% respectively on 5th day while fresh weight wise these inhibition in green light are more in the same organ.

Table 6 also shows that increase in dry matter of root and shoot are paralleled by decrease in the cotyledon dry weight. However, the pattern of dry matter transfer from cotyledon and distribution in the seedling part is nearly similar to that of control. Thus, in general there is more retention of dry matter in presence of green light in the cotyledon as compared to Blue and Red light pretreatment of seeds.

Effects of different X-ray doses on seed germination and seedling growth

Vigna Radiata (Mung)

Table 15 and 16 and figure 19 and 20 show the effects of pretreatment of seeds with different doses of X-ray on germination and subsequent seedling growth of Vigna radiata (L); Wilezek = Phaseolus aureus, Roxb.

Germination

Table 15 shows that there is an increase in percent germination at 60 seconds X-rays treated sets and gradual decline in germination percentage at all other higher concentrations used. However, the decrease in percent germination is more with the increase in X-ray doses. Thus, in this cultivar of Vigna radiata at 60 seconds X-ray doses, the increase in percent germination is 3.2% over the control. Although, there is a gradual inhibition in percent germination beginning from 90 seconds concentrations, however, decline in germination percentage significance at 120 seconds X-ray doses.

Table 15

Effect of different doses of X-rays on seed germination percentage of Vigna Radiata

Treatment	Doses of X-ray (Seconds)			
	0	60	90	120
X-rays	92.0	95.0	88.0	83.0

TABLE 16

EFFECT OF DIFFERENT DOSES OF X-RAYS ON SEEDLING GROWTH OF VIGNA RADIATA

SEEDLING PART	X-RAYS DOSES (SECONDS)											
	0			60			90			120		
	DAYS AFTER RADICLE EMERGENCE											
	3	5	7	3	5	7	3	5	7	3	5	7
	LENGTH, cm ± SD											
ROOT	2.80 ± 0.10	3.46 ± 0.24	5.80 ± 0.10	3.60 ± 0.24	4.86 ± 0.20	6.60 ± 0.10	2.20 ± 0.10	2.88 ± 0.18	4.60 ± 0.10	2.00 ± 0.60	2.40 ± 0.10	3.80 ± 0.16
SHOOT	3.60 ± 0.18	5.00 ± 0.36	7.10 ± 0.40	4.80 ± 0.16	6.00 ± 0.34	8.40 ± 0.46	2.80 ± 0.14	3.60 ± 0.18	5.00 ± 0.10	2.60 ± 0.10	3.20 ± 0.25	4.60 ± 0.24
	FRESH WEIGHT, mg ± SD											
ROOT	30.40 ± 3.00	40.80 ± 4.00	60.00 ± 6.10	36.40 ± 3.10	50.00 ± 3.30	70.00 ± 4.40	26.00 ± 2.50	38.60 ± 4.30	50.00 ± 4.30	24.00 ± 2.00	36.40 ± 2.10	46.00 ± 4.24
SHOOT	40.00 ± 2.08	60.40 ± 4.18	80.00 ± 2.08	48.45 ± 1.80	69.50 ± 2.20	84.20 ± 1.70	28.80 ± 0.90	45.40 ± 1.50	58.40 ± 3.00	26.00 ± 0.94	36.50 ± 1.63	42.40 ± 2.40
COTYLEDON	193.40 ± 13.80	180.45 ± 12.80	165.75 ± 13.10	186.50 ± 13.80	174.60 ± 13.40	160.48 ± 14.00	195.36 ± 12.00	180.61 ± 11.30	171.43 ± 11.60	197.58 ±12.70	186.45 ± 11.80	170.90 ± 12.70
	DRY WEIGHT, mg ± SD											
ROOT	4.20 ± 0.70	4.80 ± 0.80	8.40 ± 1.24	6.00 ± 0.80	8.10 ± 0.90	10.80 ± 1.20	3.60 ± 0.80	5.60 ± 0.70	7.80 ± 0.80	3.10 ± 0.30	4.60 ± 0.60	6.20 ± 0.30
SHOOT	6.00 ± 0.50	10.80 ± 0.40	12.60 ± 0.70	8.80 ± 0.48	12.60 ± 0.46	17.60 ± 0.60	5.20 ± 0.30	7.80 ± 0.30	10.00 ± 0.10	4.30 ± 0.40	6.00 ± 0.40	7.80 ± 0.20
COTYLEDON	100.80 ± 10.10	90.10 ± 8.40	80.40 ± 7.80	86.80 ± 8.30	76.00 ± 6.10	66.00 ± 6.80	102.40 ± 10.40	95.10 ± 9.10	80.40 ± 8.48	106.80 ± 9.40	100.00 ± 9.40	90.50 ± 8.60

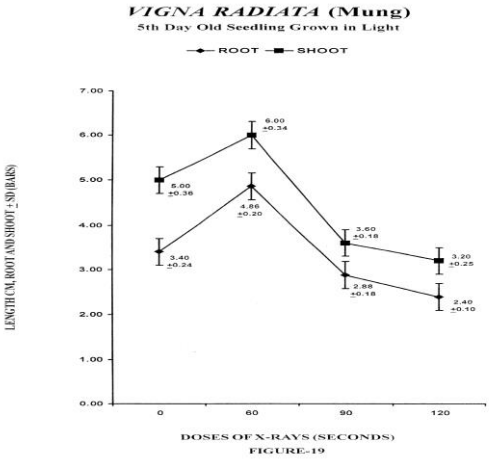


FIGURE-19

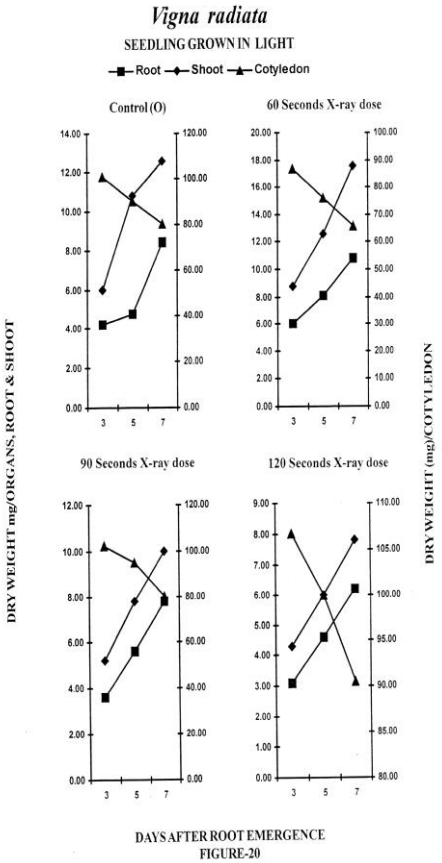


FIGURE-20

Effect of Different colour lights and X-rays on total Nitrogen during seedling growth

Vigna Moongo (Urd)

Table 23 and figure 27 show the pattern of total nitrogen (Total N) uptake and transfer from cotyledons and distribution in various seedling parts as affected by pretreatment with 12 hours. Red, blue and green lights in Vigna moongo (urd) grown in dark. Total N transfer is promoted in Red light treated sets and inhibited in blue and green light treated sets matches with growth promotion and inhibition in the same lights. Comparison of the data also indicates that transfer of N to root and shoot part is more in Red light treated sets than blue and green light treated sets. Further, results also show that the retention of total N is more in shoot as compared to roots in this Legume. Thus, in red light treated sets total N content in root is 138.8%, 119.9% and 119.9% of control respectively on 3rd , 5th and 7th day of germination. While these values of shoot are 139.8%, 126.2% and 116.6% of control respectively a the same days in same treatment. Further, in blue and green light treated sets total N level is inhibited in both root and shoot. Thus, total N level in root on 3rd , 5th and 7th day are 59.8%, 53.4% and 65.0% of control respectively in green light treated sets, whereas, these values are 62.8%, 52.7% and 62.5% of control respectively on the same day in shoot. Table also shows that the loss/transfer from cotyledon is more in presence of Red light than two other light treated sets in this legume.

TABLE – 23

EFFECTS OF 12 HOURS PRETREATMENT TO SEEDS WITH DIFFERENT COLOR OF LIGHT ON TOTAL NITROGEN (µg/organ) TRANSFER FROM COTYLEDON TO SEEDLING PARTS IN DARK GROWN SEEDLING OF VIGNA MOONGO (URD)

Treatment Color of Light	Seedling Part	Days after Radicle Emergence		
		3	5	7
0	Root	14.50	30.15	40.19
	Shoot	20.11	38.15	48.23
	Cotyledon	180.70	146.60	120.52
Red	Root	20.14	36.17	48.22
	Shoot	28.12	48.18	56.24
	Cotyledon	168.71	120.61	100.40
Blue	Root	10.84	20.12	30.17
	Shoot	16.68	28.13	40.21
	Cotyledon	190.75	162.68	138.56
Green	Root	8.68	16.11	26.16
	Shoot	12.60	20.14	30.18
	Cotyledon	196.88	180.00	156.58

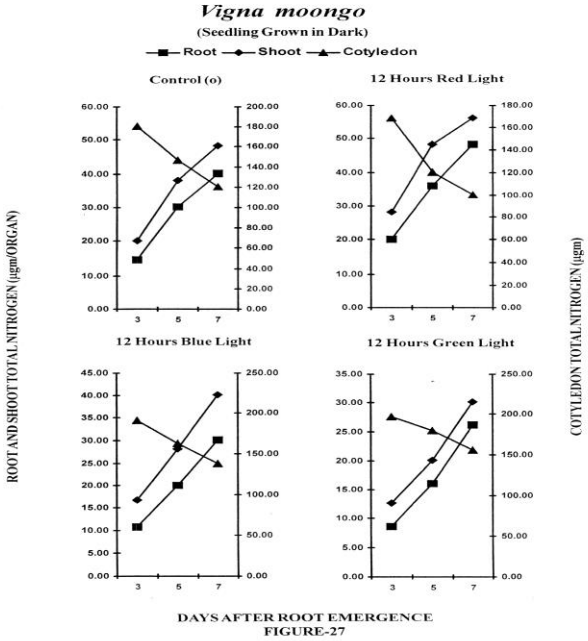


FIGURE-27

Effect of Different colour of lights and X-rays on Total Phosphate transfer during seedling growth

Vicia Faba (Bakhla)

Table 32 and figure 36 shows that pattern of total phosphate uptake and transfer from cotyledons and distribution in the seedling parts as affected by Red, Blu4e and green light pretreatment to seed grown in dark. Result shows that there is promotion in total P transfer in Red light treated sets as compared to total P level in seedling of blue and green light treated sets. Thus, in Red light sets total P level in root are 139.7%, 134.5% and 124.8% of the control and in shoot 134.0%, 118.1% and 131.7% of the control on 3rd , 5th and 7th day of germination, respectively. Similarly, in blue light sets total P levels in root are 67.2%, 76.1% and 80.0% of control on 3rd , 5th and 7th day of germination, whereas, in shoot in blue light treated sets on same days these values are 68.0%, 82.0% and 80.6% of the control, respectively. Further in green light treated sets total P levels on 3rd , 5th and 7th day are 59.1%, 72.3% and 70.7% of the control in root and 60.6%, 75.9% and 64.1% of the control of shoot respectively. Comparison of the data indicates that transfer of total P is more in Red light than in blue and green light treated sets.

TABLE – 32

EFFECTS OF 12 HOURS PRETREATMENT TO SEEDS WITH DIFFERENT COLOR OF LIGHTS ON TOTAL PHOSPHATE (µ gm/organ) TRANSFER FROM COTYLEDON TO SEEDLING PARTS IN DARK GROWN SEEDLINGS OF VICIA FABA (BAKHLA)

Treatment Color of Light	Seedling Part	Days after Radicle Emergence		
		3	5	7
0	Radicle	1.86	7.88	12.58
	Hypocotyl	10.00	22.00	31.50
	Cotyledon	104.00	86.70	70.10
Red	Radicle	2.60	10.60	15.70
	Hypocotyl	13.40	26.00	41.50
	Cotyledon	100.20	77.50	54.30
Blue	Radicle	1.25	6.00	10.10
	Hypocotyl	6.80	18.10	25.40
	Cotyledon	107.00	86.60	72.30
Green	Radicle	1.10	5.70	8.90
	Hypocotyl	6.00	16.70	20.20
	Cotyledon	110.00	94.10	82.50

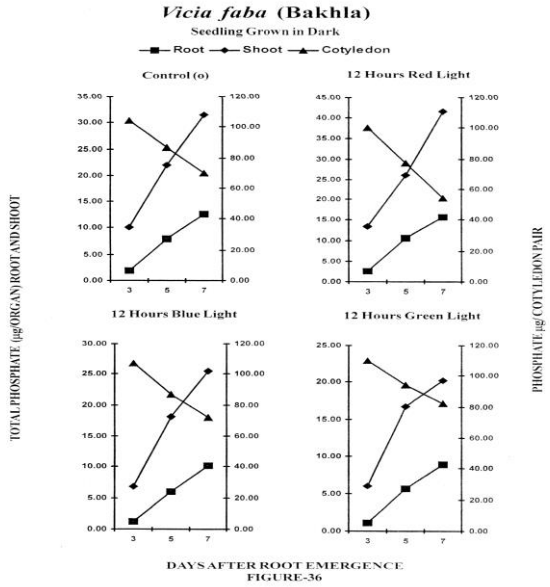


FIGURE-36

Effect of Different colour of lights and X-rays on total heavy metal transfer during seedling growth

Cicer Arietinum (Gram)

Table 37 and figure 41 shows the pattern of total heavy metal and transfer from cotyledon in seedling parts as affected by Red, blue and green light to pretreated seeds in Cicer arietinum. Results shows that the total heavy metal transfer is promoted in Red light treated sets as compared to control and other lights treated sets. Thus, in Red light treated sets total heavy metal levels in root are 116.6%, 122.7% and 128.5% of the control and in shoot these values are 120.0%, 115.3% and 111.1% of the control on 3rd , 5th and 7th day of germination, respectively. Similarly in Blue light treated sets total heavy metal levels on 3rd , 5th and 7th day of germination are 88.8%, 90.0% and 96.4% of the control in root respectively. However, total heavy metals in root of green light pretreated sets are 77.7%, 77.2% and 78.5% of the control on 3rd , 5th and 7th day of germination respectively.

TABLE – 37

EFFECTS OF 12 HOURS PRETREATMENT TO SEEDS WITH DIFFERENT COLOR OF LIGHTS ON TOTAL HEAVY METAL ($\mu g/organ^{-1}$) TRANSFER FROM COTYLEDON TO SEEDLING PARTS IN DARK GROWN SEEDLINGS OF CICER ARIETINUM (GRAM)

Treatment Color of Light	Seedling Part	Days after Radicle Emergence		
		3	5	7
0	Root	0.18	0.22	0.28
	Shoot	0.20	0.26	0.36
	Cotyledon	0.140	0130	0.114
Red	Root	0.21	0.27	0.36
	Shoot	0.24	0.30	0.40
	Cotyledon	0.132	0.120	0.100
Blue	Root	0.16	0.20	0.27
	Shoot	0.19	0.24	0.30
	Cotyledon	0.141	0.132	0.119
Green	Root	0.14	0.17	0.22
	Shoot	0.18	0.22	0.28
	Root	0.146	0.138	0.125

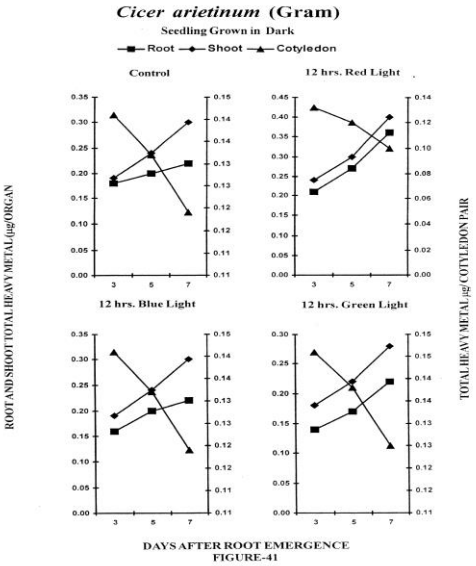


FIGURE-41

Biochemical Analysis of total N, P and heavy metals of soil and edible parts of four legume plants grown beneath high voltage electric wire (Experimental) and 200 mt. distance away (Control) from electric wire

Vigna Radiata (Mung)

Table 46 shows certain comparative biochemical characteristics total N total P and total heavy metal in and plant parts of Vigna radiata at 60th day frown on field beneath high voltage wire (experimental) and also 200 mt away from wire (control).

Analysis of total N, total P and total heavy metal done in collected samples of soil, root, shoot, pod and seed of Vigna radiata grown on both control and experimental fields. Results shows that uptake of total N, total P and total heavy metal decreases in mung plant growing beneath high voltage wire. Thus, total N, total P and total heavy metal values in soil of experimental fields are 85.0%, 76.9% and 93.4% of control field soil respectively. However, these values in root tissue are 79.8%, 73.1% and 69.2% of control respectively. Similarly these parameters in shoot are 88.0%, 84.9% and 76.9% of control samples respectively. These investigation were also done with the edible part of plant. Thus total N, total P and total heavy metal in pod are 80.2%, 78.0% and 85.9% of control respectively nearly similar results found in seed tissue.

TABLE-46

BIOCHEMICAL CHARACTERISTICS OF SOIL, AND CROP PARTS OF MUNG (VIGNA RADIATA) AT 60TH DAY UNDER FIELD CONDITIONS OF FARM 200 MT DISTANCE (CONTROL) AND BENEATH HIGH VOLTAGE WIRE (EXPERIMENTAL).

STUDY SITE	FARM SOIL	ROOT	SHOOT	POD COVER	SEED
	mg/gm DRY WEIGHT				
	TOTAL NITROGEN				
Control	0.40	26.30	35.00	8.60	27.14
Experimental	0.34	21.00	30.80	6.90	23.40
	TOTAL PHOSPHATE				
Control	0.26	4.10	10.60	5.00	10.10
Experimental	0.20	3.00	9.00	3.90	8.09
	TOTAL HEAVY METAL				
Control	0.860	0.26	0.235	0.235	0.229
Experimental	0.804	0.18	0.202	0.202	0.200

Effect of light and X-rays on Chlorophyll development and Enzymatic activity in some legume plants

Vicia Faba (Bakhla)

Table 52 shows that different colour of light have twin effect of promotion and inhibition in chlorophyll development of Bakhla plant. Thus, Red and Blue light promotes chlorophyll development whereas, green light inhibits chlorophyll development. Thus, total chlorophyll content on mg per gram fresh weight basis in Red light and blue light treated sets are 143.0% and 127.5% of control respectively in this plant. However, these value in green light are 79.3% of the control.

TABLE-52

EFFECT OF DIFFERENT COLOUR OF LIGHT ON CHLOROPHYLL DEVELOPMENT IN SHOOT OF 7 DAY OLD SEEDLING OF VICIA FABA

Treatment Color of Light	Shoot Disc. Fresh Weight mg, $Shoot^{-1}$	Chlorophyll Content mg gfw^{-1}			
		Chl a	Chl b	Chl a+b	chl a/b
Control	20.10	0.17	0.12	0.29	1.41
Red	20.35	0.23	0.18	0.41	0.17
Blue	20.25	0.21	0.16	0.37	1.31
Green	20.40	0.13	0.10	0.23	1.30

RESULTS AND DISCUSSION

1. Pretreatment of soaked seeds with different colour of light shows that there is general inhibition (in blue and green light) and promotion (in red light) of germination and seedling growth of 4 legumes in response to 12 hours pretreatment with red, blue and green light at room temperature, grown in dark. At both blue and green light treatment the dry weight increase in seedling parts are suppressed with simultaneous decrease in day matter loss/transfer from the cotyledons of legumes. Further, in red light pretreated seeds the dry weight increase in various seedling parts are induced with simultaneous increase in dry matter loss/transfer from cotyledons. Observation also shows that different colour of light have differential effect on seed germination and seedling growth in four legume plants.

2. Similarly pretreatment of soaked seeds with different doses of x-rays (60 seconds, 90 second and 120 seconds). It was observed that there is general inhibition (at higher time lengths i.e. 90 and 120 seconds pretreatment of x-ray) and promotion (at lower time lengths of 60 seconds pretreatment of x-ray) of seed germination and seedling growth f four legumes. At both inhibitory doses the dry weight increase in seedling parts, are decreased with simultaneous decrease in dry matter loss/transfer from the cotyledons of four legumes. Further the dry weight increases in various seedling parts are induced with simultaneous increase in dry matter loss/transfer from cotyledons. Result further shows that x-ray treatment for different time length have differential effect on seed germination and seedling growth in above four plants.
3. Observation made with total Nitrogen (Total N) uptake and distribution in seedling part is nearly similar to dry weight changes in four legume plants. Further, the total N level on per organ basis are inhibited in presence of blue and green light as compared to red light and control. Similarly total N level also decreases in different doses of x-ray pretreated sets. Observation shows that 60 seconds x-ray dose promotes total N transfer from cotyledons to seedling parts, however, beyond this there is suppression in total N mobilization.
4. Observation made with total phosphate (total P) uptake and distribution in seedling part is nearly similar to total N mobilization. Likewise, total P levels on per organ basis increases in red light pretreated sets as well as in 60 seconds x-ray pretreatment. However, total P mobilization decreases in blue and green light treated sets as well as in 90 and 120 seconds x-ray doses. Thus, these observation shows that the decreased total N and P levels of seedling parts as shown by data on per gram basis, is consequence of decreased growth in seedlings.
5. In general, total heavy metal uptake and distribution rates are enhanced in the presence of red light pretreatment as well as in 60 seconds x-ray doses. However, total heavy metal mobilzation is inhibited in blue and green light as well as in the presence of higher x-ray doses.
6. In the same manner observation were under actual field conditions to note the effect of high voltage electric wire on our four experimental legume plants. Result indicates that total N, total P and total heavy metal in general found to decrease in plant parts present beneath high voltage wire.
7. Likewise, observations with chlorophyll development have also shown that light has dual effect of promotion and inhibition on total chlorophyll development in all these plants. There is considerable promotion of chlorophyll development in Red and blue light and inhibition in green light. Similarly, observation shows that chlorophyll development is promoted in 60 seconds x-ray pretreated sets as compared to 90 and 120 seconds x-ray pretreatment to seeds.

REFERENCES

Alad. Jadjiyan, A. (2002): Study of the influence of magnetic field on some biological characteristics of Zea mays. Journal of Control European Agriculture 3 (2): 89-94.

Bhatt N. & B. Bhatt (2004): Effect of □□□□ radiation on net primary productivity of Lycopersicon esculantum J.I.B.S. 83 (1-4) 61-64.

Binhi V.N. and A.V. Savin (2003): Effects of weak magnetic field on biological system. Physical aspects. Journ Physics Uspekhi, 46 : 259-291.

Cantor M., I. Pop and S. Korosfoy (2010): The effect of gamma radiation and magnetic field on Gladiolus. Journ of Central European Agriculture 3 (4): 277-284.

Charan R.V.K. (2009): Effect of stimulating magnetic field on plants. Free Online Articles Directory. Pages 1 to 4.

Chen Ching Jen (2001): Effect of magnetic field on biological cells and application. NASA ADS Physics Electronic online article page 1 & 2.

Das, R. and R. Bhattarchrya (2009): Impact of electromagnetic field on seed germination. Paper presented in National Conference. Univ. of Kalyani, Kalyani, Calcutta.

Dodd, A.N., J. Love, A.R. Webb (2005): The plant clock shows its metal. Circadian regulation of cytosolic free Ca^{++}. Trends Plant Sci. 10 : 15-21.

Giebler M. J. (2005): The effect of electromagnetic radiation on plant growth and development. Magnetism & Seeds, 12 : 18-19.

Huang, H.H. & S.R. Wang (2008): The effects of inverter magnetic fields on early seed germination of mung beans. Bioelectromagnetic Early View. 29 : 510-516.

Jha C.V. & B.K. Jain (2003): Effects of the lights on different spectral composition on in vitro pollen germination and tube growth in Zea mays, Linn. Adv. Plant Sci. 16 (1) : 237-242.

Kumar, V; K.K. Sharma and A.K. Bhargava (2009): Effect of magnetism on seedling growth of Hordeum Vulgare. Paper presented in UGC sponsored National Seminar at M.S. College Sharanpur (U.P.) India.

Lynikiene, S. And A. Pozeliene and G. Rutkauskas (2006): Influence of Corona discharge field on seed viability and dynamics of germination. Int. Agro Physics, 20: 195-200.

Martinez, E. M.V. Carbonell, M. Florez and R. Maquedo (2008): Effect of seed treatment by stationary magnetic field on the germination rate of Pea (Pisum sativum, L.) Electromagnetic Biology and Medicine, 27 (1): 61-63.

Razur A. and V. Rassadina (2009): Transient effect of weak electro magnetic fields on calcium ion concentration in Arabdiopsis thaliana. B M C Plant Biol 9 : 47-64.

Peter, K. (2005): Effect of electro magnetic radiation on plants and mammals. Magnetizer 06 : 23-58.

Rao P.K. & C. Suvartha (2006): Effect of Gamma rays on in Viva & in Vitro seed germination, seedling height & survival percentage of Lycopersicon esculantum cv. Pusa Ruby Adv. Plant Sci 19 (11) : 335-339.

Teotia Seema (2006): Bio Physics and Medical Electronics. R. Lall Book Depot, Meerut (U.P.) India.

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