Electromagnetic Frequency Induced Stress Responses in *Vernonia Cinerea*

Geeta, Puja Kumari Singh

Abstract: - The Electromagnetic frequency (EMF) pollution around the living world has gripped it to such an extreme that it has potentially become unavoidable to live without it. As the development of mankind has become a slave of technology , it has to bear the brunt also. The stress created by the exposure of electromagnetic pollution on plants is a completely novice field. The stress expression in plants may be displayed by their developmental and biochemical responses. Since chlorophyll is one of the strong antioxidants known , variation in its amount has been taken up as an established symptoms of oxidative stress. The initiation of stress responses on Vernonia cinerea at different distances from cell towers having ascending number of antennae has been evaluated and found to be positively correlated with the cumulative intensities of Electromagnetic frequencies. In all the cases perceived it was decreasing significantly with increasing distances.

Keywords: antioxidants, antennae, chlorophyll, EMF, Pollution.

I. INTRODUCTION

The increased exposure to Radiofrequency Electromagnetic fields (EMF) has raised serious concerns about the biological and health related effects of RF radiations. Most of the studies on such effects have been documented on animals while very few investigations have been dedicated to plants. Plants are continuously exposed to various environmental stresses. A wide spectrum of developmental and biochemical responses are displayed by plants for adaption to stress. Being biological samples plants must perceive and respond to electromagnetic fields and therefore may provide certain physio-biochemical dues to these responses. In many investigations of plant life growing near high voltage transmission lines the EMF field was reported to cause slight influence on plant growth (Hart and Marinor, 1977) [1]. The physiological responses of plants can be evoked by various kinds of external stimuli of which EMF from antennae of mobile towers is one. The Plant Pigment chlorophyll is one of the strong antioxidant substances known. Therefore variation in chlorophyll content has been taken as a established symptom of oxidative stress that could be the result of chlorophyll degradation. The stress caused by EMF on widely growing vegetation of *Vernonia cinerea* has been discussed primarily in this paper. Significant changes in the amount of total chlorophyll and carotene was obtained in plants growing at five distances from two neighbouring cell phone towers. The data were compared with those at control after statistical analysis.

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II. MATERIAL AND METHODS

With the conceptual idea of plants getting stimulus or stress from the emitting frequencies from the antennae of cellular mast, this project has been undertaken. The experimental design was centralized around cell phone mast with varying number of antennae so as to get the cumulative effect of frequencies from the neighbouring mast also. Accordingly locations were selected as Jamshedpur where varying number of masts and antennae were located very close to each other to get the desired results , the area were arranged in Table-1(a) according to total number of antennae on tower in ascending order.

Table 1 (a):- Selected locations for cell phone towers at Jamshedpur

Sl. No.	No. of Cell Phone Tower With Multiple Antennae	Location
1.	2 cell phone tower with 8 Antennae	Near Co-operative college, Circuit house, Jamshedpur.
2.	1 cell phone tower with 15 Antennae	Near Bagicha , Bagmati road , Sakchi, Jamshedpur.
3.	4 cell phone tower with 18 Antennae	Near Barodha Ghat, Bagbera , Jamshedpur.

Table 1(b) – Radial Distances from Cell Phone Tower

Sl. No	Distances	Parameter
1	CONTROL	No tower at a place upto 500m
2	D1	50 m distances from cell tower
3	D2	100m distances from cell tower
4	D3	150m distances from cell tower
5	D4	200m distances from cell tower
6	D5	250m distances from cell tower

Keeping the towers at central place, five radial distances were taken around the peripheral points from where the naturally growing plants of *Vernonia cinerea* were collected Table 1(b). The leaves collected in different polythene bags (Previously labelled) were taken to lab, washed and processed for the biochemical analysis of chlorophyll-a , chlorophyll-b and carotene. The estimation of chlorophyll and carotene was done by spectrophotometry by DMSO method of Hiscox and Isrealstam 1979[2]. The chlorophyll

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contents estimated in 250 mg of crushed fresh weighed leaves in 5ml of DMSO (Dimethyl sulphoxide) and incubated at 60-65℃ for 20 minutes in a water bath. The absorbance for chlorophyll-a, chlorophyll-b and carotenoids from supernatant liquid at 645,663 and 480 nm against a blank DMSO cuvette was taken by Spectrophotometer and estimated by Arnon's equation (1949) [3] and Krik and Allen (1965) [4].

Chl a mg/g = $[(12.7 \times A_{663}) - (2.6 \times A_{645})] \times V/W$

Chl b mg/g = $[(22.9 \times A_{645}) - (4.68 \times A_{663})] \times V/W$

Total Chl = Chl a + Chl b

Carotene = $A_{480} + (0.114 \times A_{663} - 0.638 \times A_{645})$

Where

A_{663} = Absorbance at 663

A_{645} = Absorbance at 645

A_{480} = Absorbance at 480

V = Total volume of extract

W = Weight of leaf tissue in mg

For every distance five plant samples were taken to minimize any error. The average values were calculated for each data. Data were analyzed statistically.

III. OBSERVATION

Plants collected from the planned distances under the influence of cell towers with no. of antennae were put under physiological procedures for the analysis of chlorophyll-a, b and carotenes. The amount of pigments evaluated spectrophotometrically. The no. of antennae in the cell phone mast were eight, fifteen and eighteen.

The data tabulated could be viewed bidirectional (Table-2):-

1. The amount of chlorophyll and carotene in plants with respect to the no. of antennae in ascending order at one or multiple towers erected nearby but at same distance and
2. The amount of chlorophylls and carotenes in plants around mast with fixed no of antennae at various distances as planned compared with the control zone.

3. Table – 2 :- Showing Amount of Pigments at Various Distances with Multiple Antennae

Distance/ Location	50m		100m		150m		200m		250m	
	Tot Chl.	Caro.	Tot Chl.	Caro.	Tot Chl.	Caro.	Tot Chl.	Caro.	Tot Chl.	Caro.
Control	0.6927 ±0.21	1.8005 ±0.26	0.6927 ±0.21	1.8005 ±0.26	0.6927 ±0.21	1.8005 ±0.26	0.6927 ±0.21	1.8005 ±0.26	0.6927 ±0.21	1.8005 ±0.26
2T/8	0.4151 ±0.06	1.5512 ±0.17	0.0918 ±0.00	0.2390 ±0.04	0.1853 ±0.04	0.6282 ±0.21	0.2097 ±0.04	0.5745 ±0.14	0.2604 ±0.03	0.6918 ±0.09
1T/15	0.4756 ±0.10	1.3000 ±0.38	0.2066 ±0.15	0.6632 ±0.41	0.3036 ±0.06	1.0984 ±0.20	0.3622 ±0.13	1.3749 ±0.32	0.3135 ±0.05	1.1433 ±0.21
4T/18	0.2116 ±0.05	1.0453 ±0.20	0.1463 ±0.02	0.7800 ±0.09	0.1625 ±0.01	0.7609 ±0.06	0.3035 ±0.12	1.1144 ±0.43	0.2150 ±0.05	0.7506 ±0.16

Tot. Chl.=Total chlorophyll,
Caro.= Carotene

Table- 3: Showing Carotene/Chlorophyll Ratio

Distance/Location	50 m	100m	150m	200m	250m
Control	2.60	2.60	2.60	2.60	2.60
2 T / 8	3.74	2.60	3.39	2.74	2.66
1 T /15	4.94	5.33	4.68	3.67	3.49
4 T /18	2.73	3.21	3.62	3.80	3.65

2T/8 = 2 cell tower with 8 antennae
1T/15=1 cell tower with 15 antennae
4T/18=4 cell tower with 18 antennae

Graphs were plotted for –

1. The amount of pigments against distances (fig no 1-5) and
2. The amount of pigments against no. of cell towers having multiple no. of antennae. (Fig-6-8)

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Fig 1- Pigments (µg/g) in *Vernonia cinerea* against distances

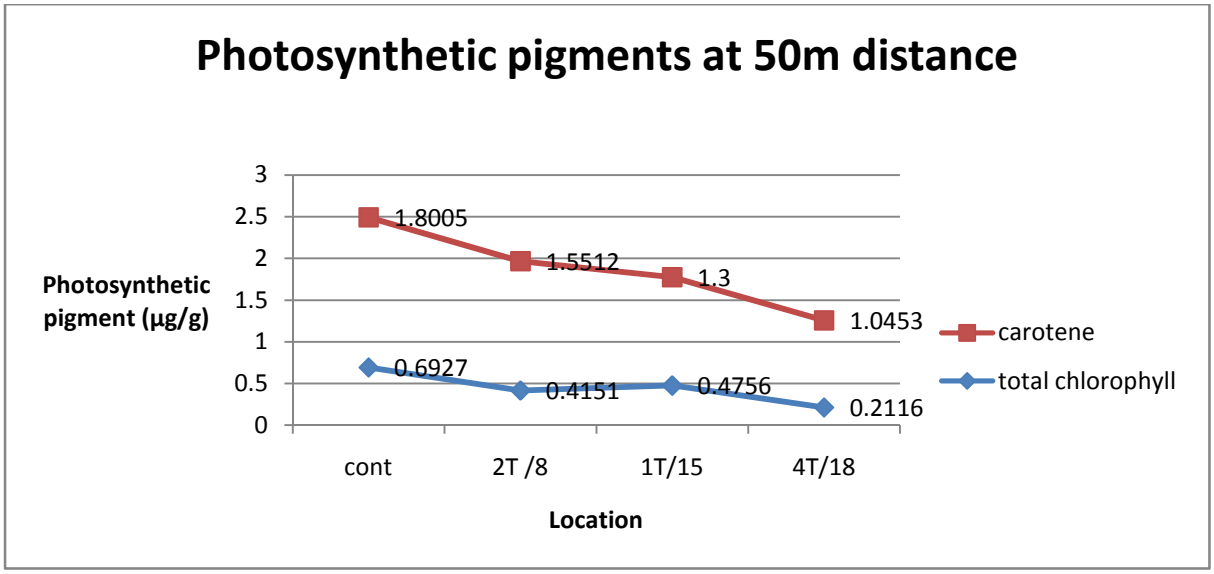

Fig 2- Pigments (µg/g) in Vernonia cinerea against distances

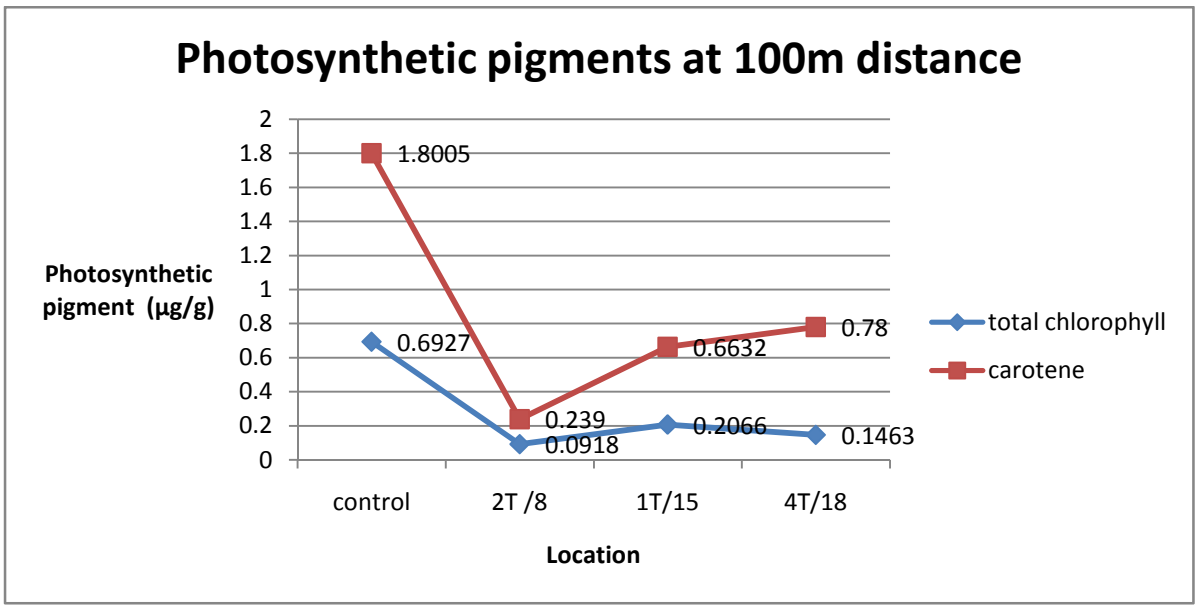

Fig 3- Pigments (µg/g) in Vernonia cinerea against distances

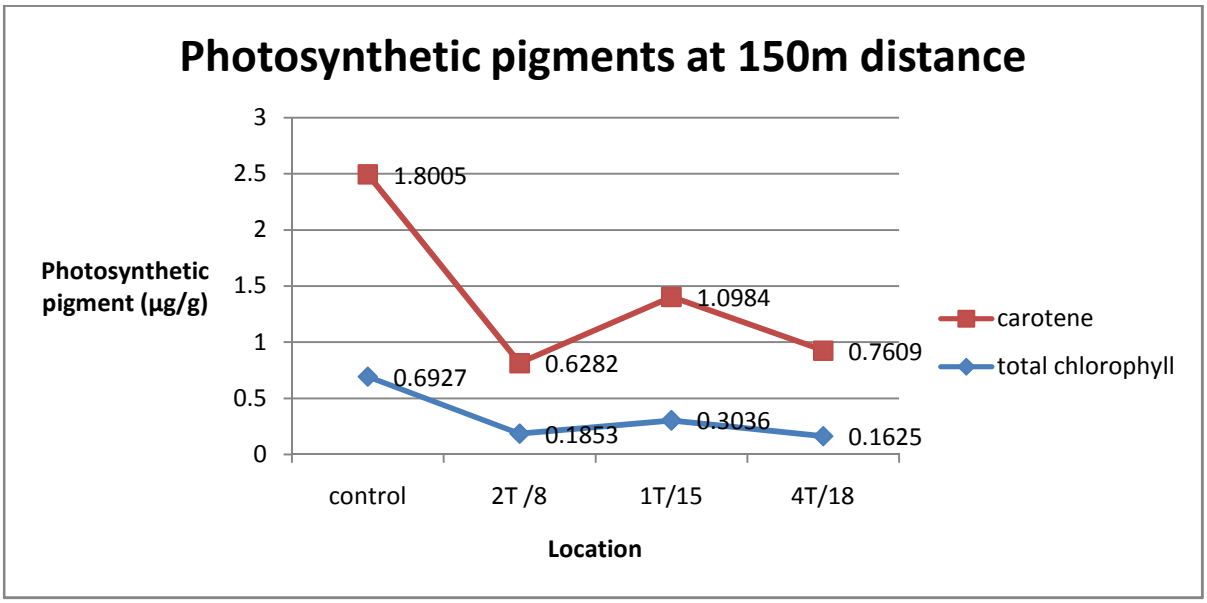

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Fig 4- Pigments (µg/g) in Vernonia cinerea against distances

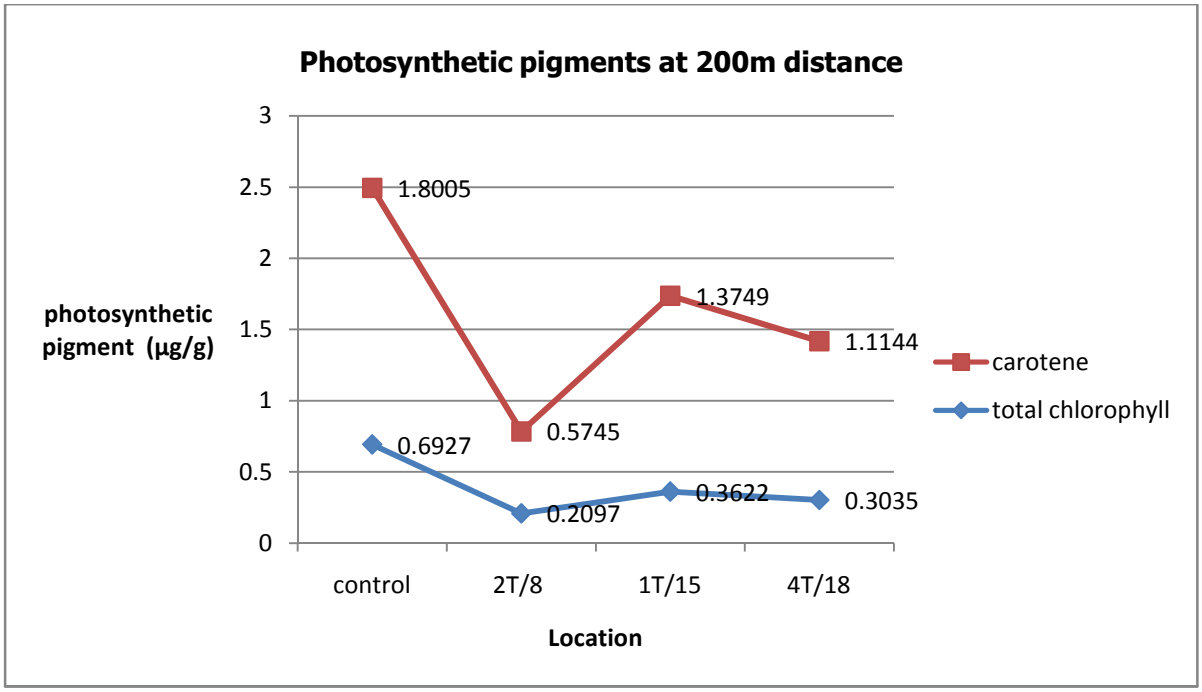

Fig 5- Pigments (µg/g) in Vernonia cinerea against distances

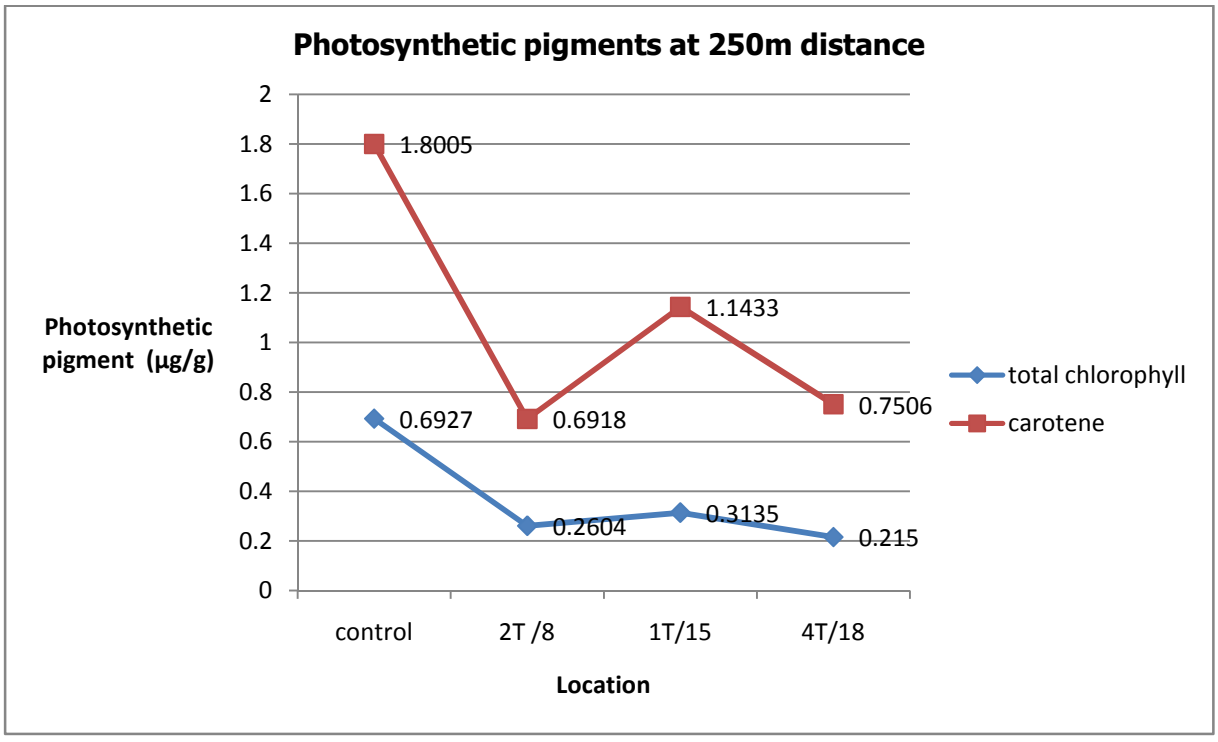

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Fig 6- Pigments (µg/g) in Vernonia cinerea against location

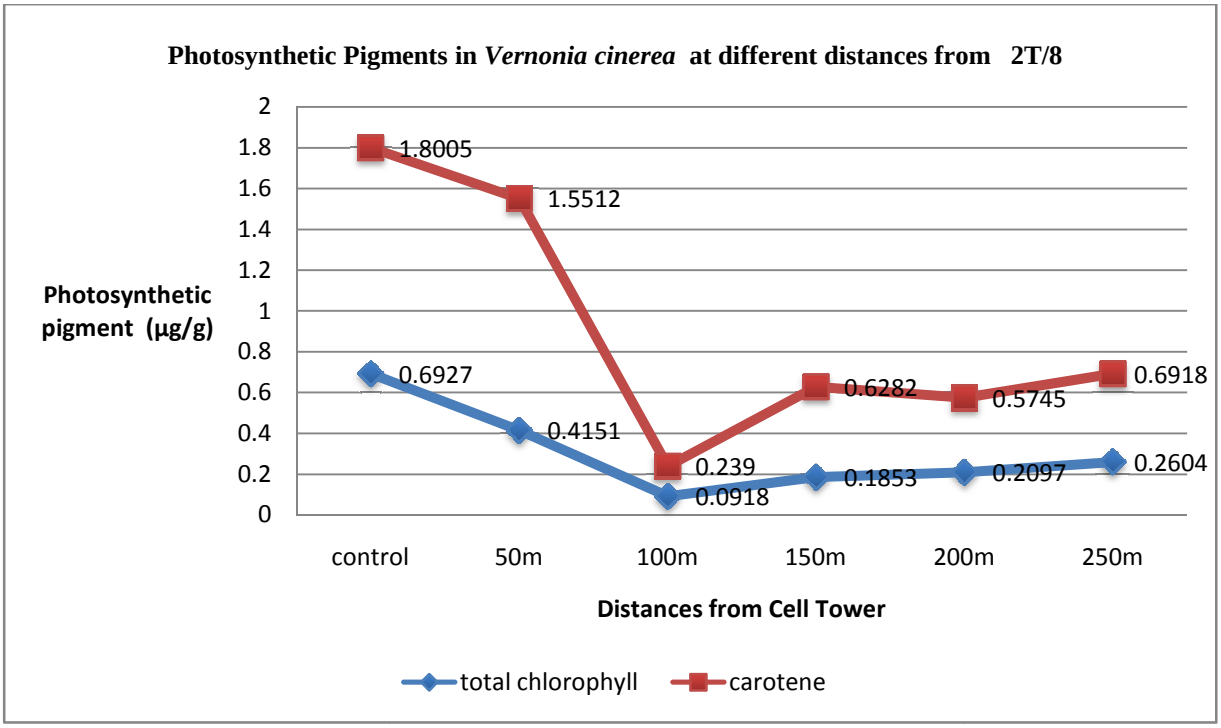

Fig 7- Pigments (µg/g) in Vernonia cinerea against location

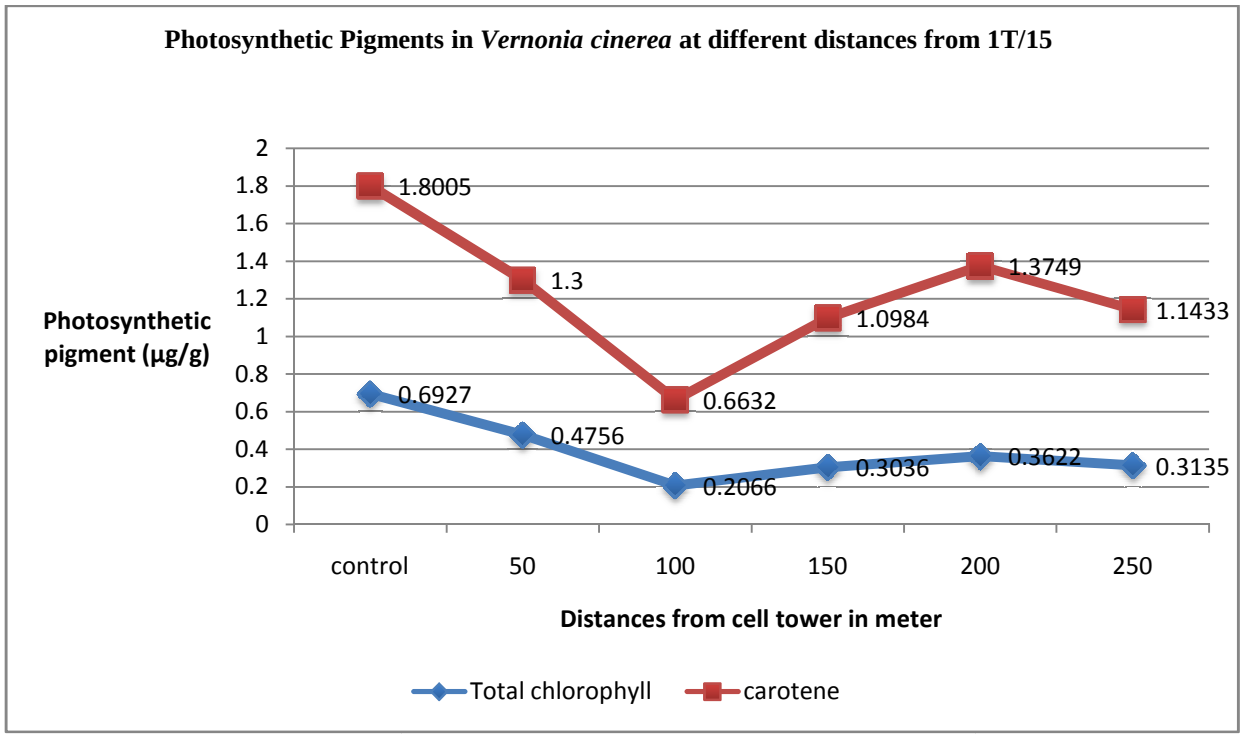

Fig 8- Pigments (µg/g) in Vernonia cinerea against location

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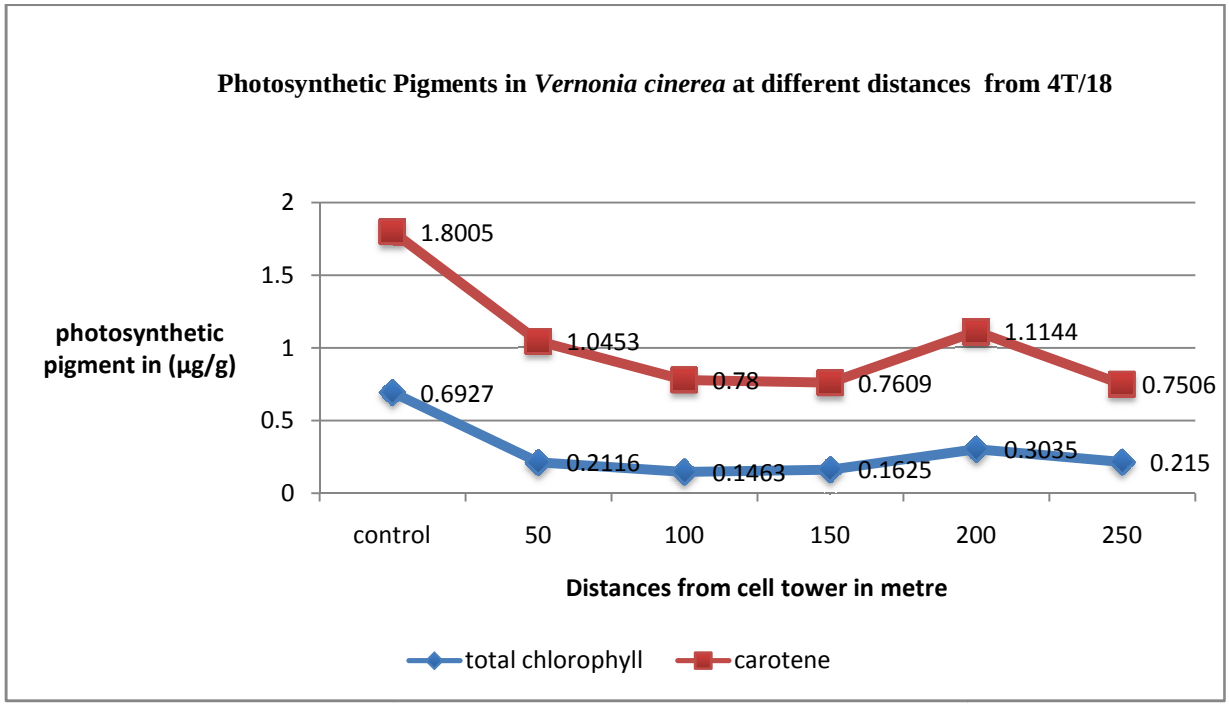

The tabulated observations (Table-2) led towards the indication that there was significant drop in the amount of chlorophylls and carotenes at around 100m distance from cell tower. After that farther away the amount increased somewhat but still it could not go beyond the normal values as in control which came to be 0.6927 ±0.21 for total chlorophylls and 1.8005 ± 0.26 for carotenes.

As far as no. of antenna is concerned, at increased number of antennae the pigments evaluated were far below the level of that at control for every distance. The highest no of antennae being 18 showing least amount of chlorophyll (0.1463µg/gm of leaf) at 100 m distance from tower. Similarly in 8 and 15 antennae , the reduced amounts of pigments were observed at 100m . Although there is a bit elevated amount obtained in case of 15 antennae but that might be due to the tower location in rural area (Baroda ghat) of Jamshedpur where there is no other tower in neighborhood within a radius of 2 kms. Twin towers with 8 antennae and quadruple towers with 18 antennae affected the leaves the most as they are located in densely populated zone which might have been affected plants on the theory of cumulative effect. These data are also supported by carotene/ chlorophyll ratio for every distance which is 2.6 in control while escalated in all most all the plants growing under the influence of electromagnetic frequencies. This effect signifies for Photoprotection by carotenes.

IV. DISCUSSION

The chlorophyll biosynthetic pathway consists of highly co-ordinated and regulated steps. This regulation is essentially very precise because free chlorophyll and many of the biosynthetic intermediates are damaging to cellular contents. The damage results largely because the molecules are highly coloured and therefore absorb light efficiently but don't have efficient pathways for disposing off the energy with the result that toxic singlet oxygen is formed.

The evaluated amounts of chlorophylls show a decreasing trend as we move from 50m to 100m but farther upto 250m the loss tend towards increase but not beyond the level of control value. This increment has always remained to be lesser than that in control. The abrupt loss in chlorophyll at 100m is probably due to photoinhibition [5] which results in reduced photosynthesis activity when plants get exposed to high and chronic radiations .It might be due to non-dissipation of the excess energy obtained from electromagnetic radiations unused for photochemistry. It might also lead to high irradiation induced damage of the thylakoid. This may also trigger conformational changes in D_1 protein or its proteolytic degradation. Carotenes in this severe situation ensures that most of the energy should be passed on to the energy reaction centre without damaging the thylakoid. Thus carotene increases its amount and protect against too much radiations i.e. Photoinhibition [6]. The lower the amount of chlorophyll per unit leaf, the higher the radiation level expected resulting in higher carotene/chlorophyll ratio as exhibited in Table -3.It justifies the elevated carotene levels in each range of distance[7]. The role of carotene is thus well established . They are primarily the accessory pigments and protect the chlorophylls. Variation in pigment contents in *Dunaliella salina* , a carotene non- accumulating species by a large variety of environmental agents has been correlated woth the integral irradiance received by cell tower antennae on leaves of plants . Recent studies have revealed that carotenoides stabilizes and Photoprotect the lipid phase of Thylakoid membranes. The data on chlorophyll and carotenes obtained at various distances are in sincere co-ordination with this revealation. These results are interpreted as indicating a protective effect of carotene against injury of chloroplast by high irradiance under conditions of impairement in chlorophyll. Carotene thus got an obligatory role in the assembly and stability of Photosystem-II and protein complex.[8,9]. Cell phone tower antennae emits radio frequencies having power density as the no of particles per second from the source. Both duration and distance translate into the realm of exposure . Cell tower antennae usually operate at power levels of about 10 watts for each

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antennae on the tower. But cumulative effect when multiple antennae are activated on the same mast.

Dr. Peter French, Principal Scientific officer at the Centre for Immunology Research at St. Wincent Hospital, Sydeny, referred that Mobile Phone frequencies well below current safety levels could stress cells and make them with increased susceptibility . It might be one of the reasons why carotene level increases in response to stress which induces damage to chlorophyll and elevation of carotene . this susceptibility gradually exhibited retardness with increasing distances from cell phone tower as the influence of radiofrequencies decrease with increasing distances.

V. CONCLUSION

Hundred meter distance has been found to be critical for *Vernonia cineria* showing significant reduces level of carotenes and chlorophylls. These results certainly exhibit the stress induction on plants growing near cell tower due to Electromagnetic environmental pollution.

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REFERENCES

1. Hart F.X. and Marino A.A. (1977), Energy flux along high voltage transmission lines. IEEE Trans. Biomed. Eng. 24, 493-495.
2. Hiscox, J.D., Israelstam, G.F., a method for the extraction of chlorophyll from leaf tissue without maceration , Canadian journal of botany;57:1332-1334,(1979).
3. Arnon, D.I., copper enzymes in isolated chloroplasts, polyphenoxidase in beta vulgeris. Plantphysiology 24;1-15,(1949).
4. Krick ,J.T.O; and R.L. Allen,1965.Dependence of chloroplast pigments synthesis on protein synthetic effects on actidione. Biochemical , Biophysical Research communication.21:523-530.
5. Choudhary, N.K., P. K. Behra, 2001."Photoinhibition of Photosynthesis : Role of carotenoids in Photoprotection of chloroplast constituents." Journal of Photosynthetica 39 (4):481-488.
6. Thrash, R.J., H.L.B. Fang and G.E. Leroi, 1979. "On the role of forbidden low-intensity excited states of light – harvesting carotenoids in energy transfer in Photosynthesis." Photochemistry and Photobiology 29 (5) :1049-1050.
7. Ami Ben- Amotz and Mordhay Avron,1983." On the factors which determine massive β-carotene accumulation in the halotolerant alga Dunaliella bardawil",Plant Physol.72,593-597.
8. Frank, H.A. , and Cogdell, R. J. , 1996, Photochem . photobiology,63 ,257-264.
9. Young, A. and Britton ,G ,1993. Carotenoids in photosynthesis , Champen and Hall ,Londen .

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