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Some Metabolic Activities of *Calotropis procera* Habitated under High Voltage-Power Lines

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ABSTRACT: The effect of electromagnetic field (EMF) induced by high voltage-power lines on some metabolic activities of *Calotropis procera* habitated under these circumstances was studied. Four towers installed at different years (1981, 1991, 2008 and 2013) were selected at North of Jeddah city for this study. The leaves samples were collected randomly from the shrubs habitated at three distances apart from each tower (0 m, 50 m and 100 m) beside the control plants.The metabolic parameters studied were total protein, amino acids,proline, chlorophylland total carbohydrates contents.Magnetic field intensity was found to be inversely related to the distances studied.With the increasing the sampling distance from tower, the magnetic field intensity was smoothly decreased. The tower's construction date and distances apart from towers differed in both intensities of magnetic field and light. The highest magnetic field intensity was recorded just beneath the tower built at 2008, while the minimum value was found at 100 m apart from the towers build at 2008 and 2013. The intensity of EMF was found to be directly related to each of protein and amino acids contents and inversely related to carbohydrates content. Each of protein, amino acids and carbohydrates contents were higher for the EMF-stressed leaves comparing to the control ones and vice versa for the proline content.

KEYWORDS:Metabolic activities; High voltage-power lines; Protein; Proline; Carbohydrates.

I. INTRODUCTION

Electric field is one kind of stress, which can affect directly or indirectly the plant exposed to it. Plant species vary in their sensitivity and response to environmental stresses because they have various capabilities for stress perception, signaling and response (Bohnert*et al.*, 1995).

The high power-electrical transmission lines are one of the sources of producing electromagnetic field. Most of the areas in Saudi Arabia are desert, but some are agricultural, through which high power transmission lines pass. These electromagnetic fields from high power transmission lines are assumed to affect the growth of plants growing nearby.

There is a shortage in available knowledge concerning to the effect of high voltage transmission lines on the natural vegetation. The scarce number of published studies addressing the risk of EMF to terrestrial ecosystems shows little or no evidence of a significant environmental impact, except for some effects near very strong sources. However, in Kingdom of Saudi Arabia, many wild plants are observed under the high transmission lines (Alaish, 2015).

Previous studies have evidence that low frequency electromagnetic radiation caused abiotic stress on the growth parameters and activity of defense mechanisms of some plants. Consequently, high voltage of electromagnetic field is expected to have some effects on plant growth.

The effect of electromagnetic field on organisms has become very important among scientists. The results of numerous researches deal with the sensitivity of organisms to the electromagnetic field effect. These effects may be useful and harmful for human life depending on the intensity and frequency of the field, the period of exposure and the organism itself (Alaish, 2015).

Increasing the population of Saudi Arabia and fast growing economy resulting in the expansion of towns and many buildings are constructed near high voltage overhead power transmission lines, accordingly the increase of power demand has increased and the need for transmitting huge amounts of power over long distances is urgently required. Large transmission line configurations with high voltage levels (380Kv, 110Kv) and current levels generate large values of electric and magnetic fields stresses which will affect humans, animals and plants (anonymous, 2014).

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Many wild plant species was found to be habited at arid landssuch as*Calotropis procera* (milkweed or apple of sodom) that is known as medicinal plant. The milkweed plant is a species of flowering plant (Family: apocynaceae).

The green globes are hollow but the flesh contains a toxic milky sap that is extremely bitter and turns into a gluey coating resistant to soap. (Upadhyay, 2014 and Alaish, 2015). In addition, wood and seed floss taken from milkweed can be used in composite lignocellulosic materials and fibrous products, respectively (Hindi, 2013[a,b]). The distribution of *Calotropis procera* is covering most of the desert and semi desert areas, including underneath of the power transmission lines. Themilkweed shrubs that grow in electromagnetic field areas might be different than other shrubs that grow in their natural environment (Alaish, 2015). Different parts of the plant have been reported to possess a number of biological activities such as proteolytic, antimicrobial, larvicidal, nematocidal, anticancer, anti-inflammatory properties (Basu and Chaudhury, 1991 and Kumar and Arya, 2006). Its flowers possess digestive and tonic properties.

Revealing the relationships between magnetic field and plant responses is becoming more and more important as new evidences clarify the ability of plants to perceive and respond quickly to varying magnetic field by altering their gene expression and phenotype. The recent implications of magnetic field reversal with plant evolution open new horizons not only in plant science but also to the whole biosphere, from the simplest organisms to human beings (Maffei, 2014). Plant morphological and physiological traits responded variably to electromagnetic effect. Leaf area, chlorophyll content, plant height, number of branches, photosynthesis rate, intercellular CO_2concentration, stomata conductance and perimeter showed inconsistent results at different tower ages and different distances (Alaish and A1-Zahrani, 2014). These results may be due to interactions of other environmental factors such as temperature, light intensity, soil variability and plant age (Rochalska, 2005 and Yano *et al*, 2004). Pulsed electromagnetic field was used for 0, 5, 10, 15 minutes as pre-sowing treatment of tomato seeds in field experiments for two years. Magnetic field applied for 10, and 15 days favour tomato growth and yield significantly (Duarte Diaz et al., 1997). In another study on garden peas treated with magnetism responded negatively as compared to tomato (Maffei, 2014). In this study, direct exposure at (0) distance to EMF enhanced an announced increase in leaf area, chlorophyll content, transpiration rate and stomatal conductance. Similar results in cotton crop magnetism enhanced transpiration rate, photosynthetic rate, stomatal conductance, root length, shoot growth and nitrogen, phosphorus, potassium, calcium and magnesium percentage over control (De Souza *et al.,* 2010). This enhancement may be attributed to better availability and absorption of nutrients. Carbonell*et al., (*2000) reported that vigorous germination and seedling growth was also attained in corn crop under magnetic field stress. Duration of exposure plays vital role in the efficiency of these treatments (Moon and Chung, 2000).

It was noticed that at slight exposure to EMF at (50 and 100 m), increased number of branches, plant perimeter. In consistent with these results, larger and more elongated vegetative meristems in treated samples compared to control may be a symptoms of more active divisions in the area affected by electromagnetic waves (RamezaniVishki*et al*., 2013). Increasing each of number of stem trichome, frequency and diameter xylem elements and collenchyma cell row with thick cellulose walls in electromagnetically-stresse cells compared to controls which can increase plant resistance against stress (Aladjadjiyan, 2007; Chatzy*et al*., 2010).

Exposure of rice field to static magnetic field was found accountable for improved leaf growth, meristematic tissues in stems and roots. Sunflower under magnetic field exposure for 90 minutes at intensity of 2000 Gauss produced positive mutation in term of germination, plant height, days to flowering, days to maturity, yield, oil content and oil quality of seeds over control (Carbonell*et al.,* 2000). The amylase is responsible for degradation of seed during germination. Enhanced exposure of seeds to electromagnetic field decreased a-amylose activity at 100 mT for 2 hours while reducing sugars were higher for wheat crop. Increase in activity of dehydrogenase enzyme is also associated with electromagnetic treatment (Mahmood*et al*., 2013). Exposure of electromagnetic field reacts like priming with almost similar improvements. Protease activity in germinating seeds significantly increased when treated with electromagnetic field (Kucera*et al*, 2005).

The thermal effects produced by absorption of electromagnetic energy are the direct result of water molecules acted upon by the oscillating electric field, rubbing against each other to produce electric heal creating thermal effect (Kasevich, 2000). Scientists are attributing this effect as also causing global warming and more emphatically on radio frequency radiation (Chatterjee and Kar, 2014). Regarding biochemical changes in *Calotropis procera* affected by EMF, the effect of EMF on carbohydrates was observed to be more related to towers ages than distances, nonetheless only slight difference between treatments. It was found byHanafy*et al.,* (2006) that carbohydrate content of exposed wheat is lower than the control plants.

Results of the effects of EMF on plant nutrients content clarified so many things. The external electric and magnetic fields influence activation of ions in living cells (Johnson and Guy,1972 and Moon and Chung, 2000).

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Although a number of studies have been conducted on the effects of electromagnetic filed on plants growth, very little is known about the specific physiological, biochemical and molecular changes that take place (Nuccitelli, 1988; Karcz and Burdach, 1995; Liang *et al.,* 2009). Maziah*et al.*, (2012) studied the effects of electromagnetic fields (EMF) from 275 kV high voltage transmission line on physiological and biochemical system changes in palm oil leaves under field conditions, their results showed that power line EMFs negatively and significantly influenced the soluble protein content in oil palm leaves. The palm planted nearer to power lines (0, 8.8, and 7.6 m) showed lower protein content than did those further away (26.4, 44.0, 52.8 and 61.6 m). The least protein content was reached for the palms grown beneath the 275 KV power line for seven years comparing to six month exposure, the main reason for least protein was attributed to the long-term exposure to the high electromagnetic field which might have broken the peptide bonds between peptides and polypeptides, thus reducing the formation of globular or functional protein and releasing more free amino acid or nitrogen containing compounds.

Similarly, Shalaby and Al-Wakeel (1995) suggested that amino acids accumulation found in stress treated plants are possibly due to the increase in protein breakdown. It has been reported that the general characteristics of plants subjected to stress is the increased level of free amino acids and reduced rates of protein synthesis which leads to decreased protein levels (Nemec and Meredith, 1981). A study conducted by (Hanafy*et al.*, 2006) found that, the total protein content of wheat grains was decreased for the exposed grains as compared with unexposed as a result of decreasing of nitrogen element (Pakhmova, 1992). This result is in agreement with Walter *et al.,* (1997), MacGinitic (1994), and Laberge (1998) who reported that the electric field inhibit the biological properties of the membrane protein.

Revealing the relationships between magnetic field and plant responses is becoming more and more important as new evidences clarify the ability of plants to perceive and respond quickly to varying magnetic field by altering their gene expression and phenotype. The recent implications of magnetic field reversal with plant evolution open new horizons not only in plant science but also to the whole biosphere, from the simplest organisms to human beings (Maffei, 2014). It can be suggested that through the results of this study and previous findings that most of the plant morphological and physiological attributes presented improvement through different levels. Major variation was achieved in physiological attributes. Electromagnetic field exposure may be helpful for seed improvement of these traits under biotic and abiotic stress.

While it is difficult to avoid all EMF radiation, certain precautions can be taken to avoid EMF radiation. An EMF meter is one of the most import EMF protection devices available. A meter assesses the level of emission from individual electrical devices as well as the room as a whole. Determining and avoiding the highest emitting items is crucial for overall health. Additional steps that can be taken to avoid radiation include purchasing and running an aquarium in the home to absorb microwave energy, limiting mobile phone use and using a wired internet connection. An additional option includes surrounding the home with several crystals of Himalayan rock salt or eolithic limestone to ground the waves.

The general objective of the study was to observe the changes on plant as a result of exposure to electromagnetic of high voltage transmission lines. Whereas the specific objectives were to evaluate the following metabolic changes such as protein, amino acids, carbohydrates and proline contents.

II. MATERIALS AND METHODS

This research was conducted in two parts, the first part was field study which involved field study to determine the coordinates of the sampling sites and measure the electromagnetic field, light intensity and collect the samples of the plants and soil, In addition, the second part was conducted in a laboratory to detect the contents metabolic parameters in plant leaves.

The study area

The study area, Jeddah province, lies within the coastal desert plain at Tehama region west of Saudi Arabia, at the Red Sea coast (21°25′0″N 39°49′0″E), the elevation of this city began from zero at the west to more than 277 m above sea level.

Towers selection

Four towers installed at different years (1981, 1991, 2008 and 2013) that located at North of Jeddah city were selected for this study. These towers are a part of the high voltage transmission lines transport electricity extended from Ashoaebah Area (south coast of Jeddah) to different parts of Saudi Arabia.. The research focused on numerous variables like, gradation of high voltage power lines, equal number of transmission lines, height from the ground,

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locality and plant species. The power of magnetic field was measured by the Trifield Range Broad Band from the bottom of the tower until the power measured weak (Figure 1) for each of the four towers as well as at three different distances apart from each tower by 0 m, 50 m and 100 m beside the control site far away from the effect of electromagnetic field.

Raw Materials

Five plants were selected randomly from each of the three distances apart from each of the four towers beside the control place (Figure 1). Five fresh leaves of *Calotropis procera* were collected randomly from each shrub. The collected leaves were thoroughly washed and rinsed with distilled water. The samples were then dried in oven at 75° C for 48 hours until a constant weight. The dried samples were then ground into fine powder and were used for the determination of protein, proline and carbohydrates contents.

Figure 1.The *Calotropis procera*: a) a shrub habitated at a high voltage-power linearea and b) measuring the electromagnetic field using tri-field range broadband device.

Determination of the Metabolic Parameters

Total Protein

Oven-dry leaf samples (5 random leaves) were digested in H_2SO_4 (30ml) in the presence of 1 g catalyst of $CuSO_4$ and 10 gm K_2SO_4. After digestion, sodium hydroxide (NaOH, 33%) was added followed by steam distillation. The distillate was collected in 20 ml boric acid (4%). Then, nitrogen content was determined by using titration with HCl (0.01 N). A factor of 6.25 was used to calculate the total protein (Alaish, 2015).

Amino Acids Content

Free amino acids were extracted from the dry leaves (5 random leaves) of *Calotropis procera*, according to the method proposed by Shad *et al.* (2002). Two grams of each sample were socked separately in 75% ethanol (100 ml). After 24 hr. the sample was ground and filtered. The residue was washed with a few ml's of 75% ethanol and the volume was completed up to 100 ml. several amino acids were examined using a HPLC system (HP1050) with a UV detector at 254 nm. The separation was accomplished with a ODS, C18 (5µm.4 x 250mm) column. The mobile phase consists of 32% (acetonitril/tetrahydrofuran, 90/10 v/v); and 64 % (tetrahydrofuran/water, 5/95 v/v) with 0.3 ml acetic acid and pH adjusted 5.15 with NaOH (1M). The flow rate was adjusted at 1.5 ml/min and the temperature of column was adjusted to 60 ºC, while the injection volume was 10 µl according to the method of Gertz, (1990).

Proline Content

The determination of prolinecontent in leaves was performed according to the method of Bates *et al.* (1973). Oven-dry leaf samples (1g) were extracted with 3% sulphosalicylic acid. The extract(2ml) was put for 30 minutes in water bath after adding 2ml ninhydrin and 2ml glacial acetic acid, after which cold toluene (4ml) was added. Proline content was measured by a spectrophotometer (Shimadzu UV 1601) at 520nm and calculated as mg/g/dry weight against standard proline using three replicates.

Chlorophyll content:

The content of chlorophyll for five random leaves of *Calotropis procera* was determined using a CL-01 Chlorophyll Content Meter, Hansatech chlorophyll content Meter, England. The field-portable, hand-held device determines relative chlorophyll content using dual wavelength optical absorbance (620 and 940nm wavelength) measurements from leaf samples. Relative chlorophyll content was displayed in the range of 0 – 2000 units.

Total Carbohydrates:

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The total carbohydrates was estimated according to the phenol-sulfuric acid method described by Dey (1990). The oven dried leaves powder (0.25mg) was suspended in 20ml of 90% ethanol in 50mL test tube that were sealed and was incubated in hot water bath at 60^0C for one hour. The extract was decanted and collected in 25ml capacity volumetric flask and re-extracted with another 10ml volume of 90% ethanol. The extract was collected and final volume was made to 25ml with the 90% ethanol. About 1ml of phenol (5%) was added to about 0.2ml of the leaves extract and mixed thoroughly. Then, 5 ml of concentrated sulfuric acid (analytical grade) was added and the mixture was cooled at room temperature in air.The absorbance was recorded at 485 nm and the soluble carbohydrates yield was determined using a standard glucose (0.1mg/ml) and expressed in g/100 g of dry leaves.

Statistical Design and Data Analysis

Factorial experiment applied as randomized complete block design (RCBD) was used in two factors and three replicates. The two factors studied were tower's construction date and distance apart from towers. The first factor examined had four levels, namely, 1981, 1991, 2008 and 2013 along the control one. The second factor was used in four levels, namely beneath tower (0 m), 50m-apart and 100 m-apart from the tower. Furthermore, each of the three replicates used in the present investigation. Accordingly, there are three sources of variation, namely replicates, tower 's construction date and distance apart from towers. To detect the differences between the treatments means, the analysis of variance was made for the metabolic parameters as well as the least significant difference at 95% level of confidence ($LSD_{0.05}$) method to compare the differences between (Cochran and Cox, 1957; Steel and Torrie, 1980).

III. RESULTS AND DISCUSSION

The measurements data of magnetic intensity and light intensity of the investigated sites (four towers constructed in 1981, 1991, 2008 and 2013 as well as control) and the distances apart from a tower (0, 50 and 100 m) are presented at Table 1.All the studied sites demonstrated significant difference for magnetic field intensity and light intensity.

It can be seen that magnetic field intensity is inversely related to the distance apart from electric tower (Table 1). Increasing the sampling distance from tower has decreased the magnetic field intensity smoothly. The highest magnetic field intensity (8.7milligauss) was recorded just beneath the tower build at 2008, while the minimum magnetic field intensity (0.90milligauss) was found at 100 m under the towers build at 2008 and 2013 (Table 1).

Table 1: Magnetic intensity and light intensity in the investigated sites

Tower Ages	Distance apart from tower (m)	Magnetic intensity (milligauss)	Light intensity (μ mol/m^2s^{-1})
1981	0	6.9	52
	50	1.9	90
	100	1.1	63
1991	0	8.2	89
	50	2.5	95
	100	1.5	107
2008	0	8.7	7
	50	2.1	14
	100	0.9	17
2013	0	8.2	14
	50	2.4	38
	100	0.9	63
Control		0	100

The Metabolic Parameters

The effects of electromagnetic field (EMF) intensity on the proteins, proline, amino acids, chlorophyll and carbohydrates contentsare presented at Table 2 and Figures 2-5.

For the protein content (PC) in leaves of *Calotropis procera*growing under the electromagnetic stress was higher than that for the control samples (Figure 2). In addition, the PC for the recent towers was higher than those for the older ones (Figure 2). Furthermore, the lowest PC value was recorded at 0-distance (7.56 mg/g plant) for the oldest tower (1981). It is clear from Table 3 that the PC was directly correlated to the intensity ofEMF (R^2= 0.951 in Equation 1).

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This means that the PC in leaves is increased with the increasing the EMF intensity. Accordingly, it may be stated that plants habitated under EMF-stress may enhance their self- production of the PC as a stress defence tool to the abnormal conditions.This finding may indicates that interactions of other environmental factors may be interfered with the studied factors revealing to formation of more proteins comparing to that for control.

However, this result contradicts with the concluded byMaziah*et al.,* (2012)and Shalaby and Al-Wakeel (1995) in which long exposure to EMF reduces protein content in plants as a result of breaking of the peptide bonds between peptide and polypeptides. In addition, other studies also contradicted with our results such as those done by MacGinitic (1994), Laberge (1998) and Hanafy*et al.,* (2006). They indicated that electric field inhibits the biological properties of the membrane protein in wheat causing the amount of total protein to decrease, rather than increase after seed had been exposed, as a result of a decrease in the amount of nitrogen present.

The results of amino acids content (AAC) in *Calotropis procera* leaves are presented in Tables 2 and 3 and Figure 3. The highest content of the amino acids of *Calotropis procera* leaves exposured to electromagnetic field was found near the oldest tower which established in 1981 (5.60 mg/g of leaves). Furthermore, proteins and amino acids recorded their high values at distances of 0 and 50m (10.2, 9.9, 3.52 and 3.30 mg/g DW plant, respectively).It was found thatthe AAC in leaves of *Calotropis procera* growing under the electromagnetic stress was higher than that for the control samples (Figure 3). In addition, the AAC values for the older towers were higher than those for the recent ones (Figure 3). It is clear from Table 3 that the AAC was directly correlated to the intensity of EMF (R^2= 0.904 in Equation 2). This means that the AAC in leaves is enhanceded with the increasing the EMF intensity. Accordingly, it may be stated that plants habitated under EMF-stress may enhance their self- production of the AAC as a stress defence tool to the abnormal conditions. This finding was agreed with that indicated by Shalaby and Al-Wakeel (1995) who suggested that the increase in amino acids under EMF is due to break of proteins although the protein amounts in stressed leaves were found to be higher than the control ones in our study.

As shown in Table 2 and Figure 4, the proline content of leaves was found to be lower for the four towers compared with that for the control leaves with a consistent increase beginning from the older towers up to the control samples. The recorded values of proline were found to be 0.127, 0.147, o.163 and 0.177 mg/g of plant at Towers 1981, 1991, 2008 and 2013, respectively (Table 2). The increased proline production for the stressed Calotropis procera leaves is adapted to that indicated byMittler, (2002) who reported that plant increase proline against oxidative stress caused by electromagnetic waves for improving the defense mechanisms. Furthermore, Hare *et al.,* 2003 reported that production and accumulation of proline is most important and adaptation in higher plants under stress. In addition, the present results agreed toMittler, (2004), Hare, 1999, Maggio, 2002; Szabados and Savoure(2009). Thus, during stress increases as a defensive or adaptive response and plays a role in osmotic pressure adjustment and is a good source of energy, carbon and nitrogen in the tissue repair (Saradhi, 1995; Kostal, 2011). It was also stated that increased proline under stress could be due to stimulate the production of proline from glutamic acid (Lakobashvil, and Lapidot, 1999). Proline effects on free radicals, osmoregulation, contribute to the sustain ability of the natural form of protein, and preserve the natural structure of the protein monomers and oligomeric proteins complex, preventing deformation of enzymatic compounds in stress, contributing to membrane stability and decrease the negative effects of stress on the cell membrane and on the other parts as a source of carbon and nitrogen caused increased plant tolerance and resistance to stress (Verbruggen and Hermans, 2008). EMF exposure causes significant increase in proline content. Accumulation of proline to high levels in plant cells under stress could greatly increase the ROS (reactive oxygen species) scavenging capacity of the cells and reduce the potential for oxidative damage (RamezaniVishki*et al.,* 2012[a,b]).

The chlorophyll content (ChC) results in leaves of *Calotropis procera* habitated under the four power lines and the control area are presented at Tables2. There were no notably difference in the ChC between the control samples and those collected from plants found just under beneath the power lines (0 m). The ChC values of the control was higher than those habitated apart from the towers built in 1991, 2008 and 2013 by 100 m. in addition, the ChC was lower than those found at 50 m and 100 m apart from the towers built in 1981 and 2008, respectively.

The carbohydrates content (CaC) datafor the leaves of *Calotropis procera* habitated under the four power lines and the control area are presented at Tables 2 and 3 and Figure 5.It is clear from Table 3 that the CaC was inversely related to the intensity of EMF (R^2= 0.984 in Equation 3). This means that the ChC in leaves is decreased with the increasing the EMF intensity.

It can be observed from Table 2 and Figure 3 that the (CaC) in leave samples was higher than those for the control ones.In addition, it is clear from In addition, no consistent trend of carbohydrates content could be observed when taking in consideration the effect of tower's construction date only. The highest carbohydrates content is observed in

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the samples habitated near the tower established in 2008 (22.25 mg/g DW plant). On the other hand, the lowest carbohydrates content was recorded in control plant (20.95 mg/g DW plant). The carbohydrate content of the exposed sampless is lower than the unexposed ones indicating that exposure to high voltage electric field stimulate the biological process and the nutrient metabolism (Rabold et al., 1999 and Hanafy*et al.*, 2006). This may be attributed to an increase in total chlorophyll which leads to increase in photosynthesis rate.

Regarding the effect of the EMF on carbohydrates content of leaves, only small variations were noticed when taking tower's construction date into account. However, the rethym followed the pattern 0<50<100m. Generally proline, protein and amino acids results showed slight differences among different towers. However, plants near newly established towers (2008 and 2013) has higher Protein and Proline than those near old established towers (1981 and 1991) shown in Table 1. This was not true in case of amino acids whereby its highest values were recorded for tower 1981 (5.60 mg/g of plant) and tower 1991 (3.2 mg/g of plant) compared to other plants including the control. For the interaction effect of the two factors (tower's construction date and distances) on different metabolic products of *Calotropis procera*, generally, carbohydrates and proteins are high at far distances (50,100 m) in all towers compared to the control, although there are no wide variations. However, there are controversial results regarding proline and amino acids when talking about the interaction effect of tower age and distances.

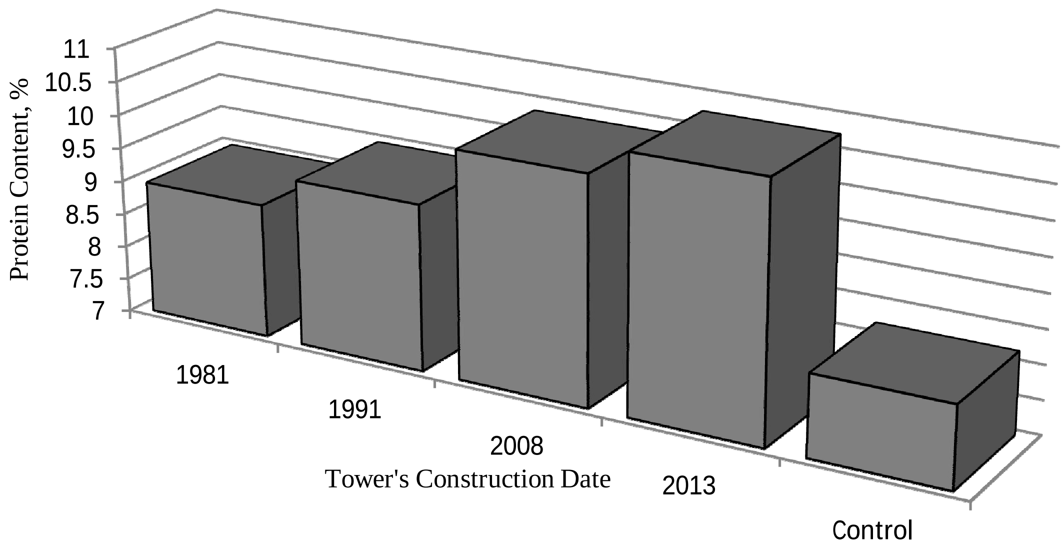

Figure 2. Protein content in leaves of *Calotropis procera* habitated under the four power lines and the control area.

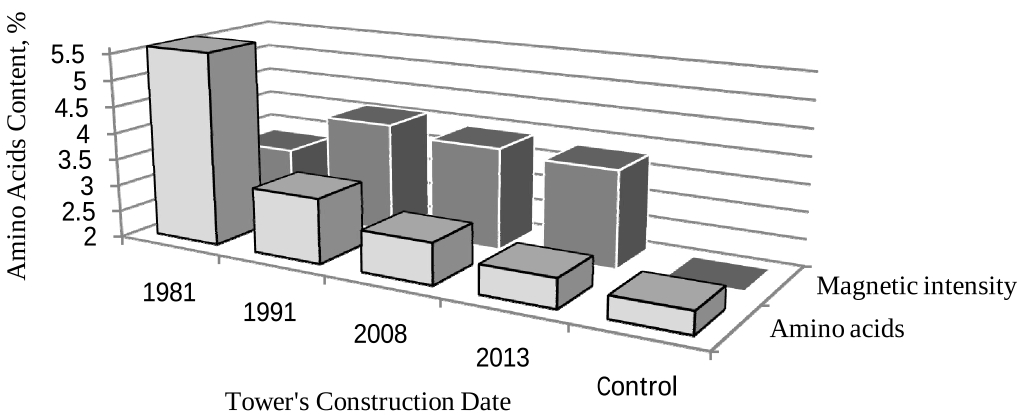

Figure 3.Amino acids content in leaves of *Calotropis procera* habitated under the four power lines and the control area.

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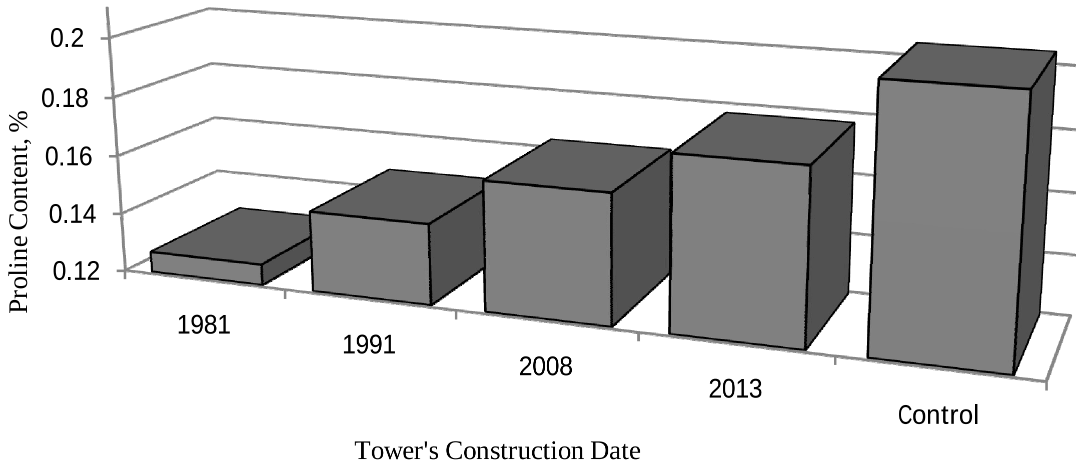

Figure 4. Proline content in leaves of *Calotropis procera* habitated under the four power lines and the control area.

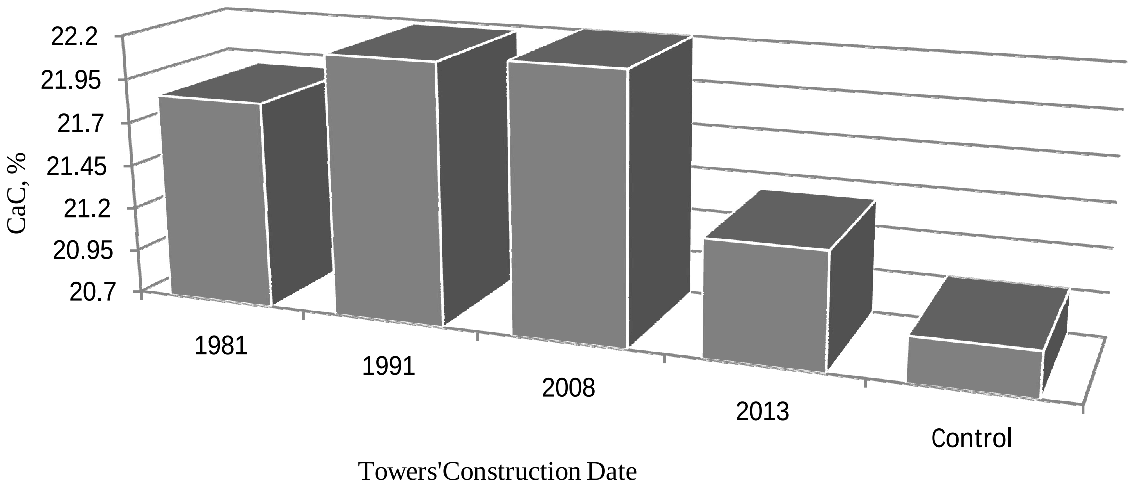

Figure 5. Carbohydrates content (CaC) in leaves of *Calotropis procera* habitated under the four power lines and the control area.

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Table 2: Mean values of protein, proline, amino acids and carbohydrate contents of *Calotropis procera* leaves habitated at the four tower at the three different distances apart from the towers.

Tower ages	Distance (m)	Protein (mg/g)	Proline (mg/g)	Amino acid (mg/g)	Chlorophyll (mg/g)	Carbohydrates (mg/g)
1981	0	7.56	0.13	4.10	15.77	21.62
	50	9.94	018	2.80	13.34	20.50
	100	9.44	0.07	2.70	21.59	23.5
1991	0	9.70	0.18	4.60	15.62	22.90
	50	8.74	0.11	5.60	9.68	20.40
	100	9.92	0.15	6.6	10.25	23.20
2008	0	8.83	0.21	3.30	11.03	19.78
	50	10.98	0.17	2.50	18.54	23.20
	100	11.19	0.11	2.50	6.07	23.77
2013	0	12.37	0.14	3.20	15.38	15.30
	50	9.92	0.20	2.10	15.24	26.45
	100	9.94	0.19	2.30	7.55	22.3
Control		8.0	0.22	2.40	15.27	15.27
LSD at 0.05		0.52	0.004	4.68	2.62	2.56

Table 3. Regression relationships[1] between electromagnetic field intensity (X) and each of amino acids, protein and carbohydrates contents of Calotropis procera leaves habitated at the study sites.

No.	Equation	SEE	R2
1	Protein Content=0.065X+9.69		0.951
2	Amino acids Content=0.056X+3.086		0.904
3	Carbohydrates Content= -0.332X+22.91		0.984

[1]Samples number=75.

IV. CONCLUSIONS

- Generally, the tower's construction date and distances apart from towers demonstrated notably difference for their magnetic field intensity and light intensity effects on the metabolic parameter studied.
- Magnetic field intensity is inversely related for distance studies from electric tower. Increasing the sampling distance from tower, a decreased smoothly the magnetic field intensity.
- The highest magnetic field intensity are was recorded just beneath the tower built at 2008, while the minimum value was found at 100 m apart from the towers build at 2008 and 2013.
- Protein content in plant growing nearthe tower built in 2013 is higher than that for the control samples. The lowest value of protein was recorded at 0-distance for the oldest tower (1981).
- Proline content was decreased in response to longer exposure to magnetic field significantly.
- The highest content of the amino acids of *Calotropis procera* leaves exposured to electromagnetic field was found near the oldest tower which established in 1981. In addition, no consistent trend of carbohydrates content could be observed when taking in consideration the effect of tower's construction date only.
- The carbohydrates content in leave samples of *Calotropis procera* was higher than that for the control.
- The highest carbohydrates content is observed in the samples habitated near the tower established in 2008 . On the other hand, the lowest carbohydrates content was recorded in control plant. the rethym followed the pattern 0<50<100m.
- Generally proline, protein and amino acids results showed slight differences among different towers.

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- Plants near newly established towers (2008 and 2013) has higher protein and proline than those near old established towers (1981 and 1991). This was not true in case of amino acids whereby its high values were recorded for tower 1981 and tower 1991 compared to other plants including the control.
- When distance was taken into consideration, the same pattern of amino acids was observed. Furthermore, proteins and amino acids recorded their high values at distances of 0 and 50m.
- For the interaction effect of the two factors (tower's construction date and distances) on different metabolic products of *Calotropis procera*, generally, carbohydrates and proteins are high at far distances (50 and 100 m) in all towers compared to the control, although there are no wide variations.

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