BIOLOGY EXTENDED ESSAY

THE EFFECTS OF ELECTROMAGNETIC FIELDS IN THE RESISTANCE OF A PLANT TO CHILING TEMPERATURES

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ABSTRACT

In this study, the effects of E.F. in 10 and 40 minutes periods every day, in midday and normal room conditions to the plant *Cactus suculent* was investigated. The E.F. was applied by two plates that are charged by negative and positive charges. After the E.F. application, the plants are carried into chilling colds (-17 ºC, 15/21 light/dark), other plants carried to normal conditions . Both plant groups are marked with numbers. All plant groups were exposed to cold 40 minutes after E.F. application. All trials(ten times) are repeated and their results are analysed statistically.

This experiment is carried in June-July-August-September months for 105 days in 2009.

10 minutes of E.F. has no differences with the control group in normal conditions but it was observed that they have more lifetime. However, it was observed that 40 minutes of E.F. has inhibitory effects.

Keywords: Electrical field, cactus suculent, , cold acclimation, chilling resistance

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Troya Çağıl KÖYLÜ

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CONTENS

SYMBOLIZES AND STRINGS ATTACHED INDEX

ºC : Celsius derecesi

min : Minute

g : Gram

cm : Cantimetre

ml : Millimetre

sec : Second

List of Abbreviations

E.F. : Electromagnetic Field

A : General Control

A1 : 10dk E.F. application + cold

A2 : 40dk E.F. application + cold

B : General Control

B1 : no application of e.f. + cold

B2 : no application of e.f.+ cold

AC : Alternative Current

DC : Direct Current

ELC. APL. Electric Application

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INTRODUCTION

All plants in the world are in the effect of the world's magnetic and electrical fields because the world features as a large bar magnet (Nelson and Walker, 1961; Takahashi, 1986; Watanabe and Yamashita, 1987; Maeda, 1993) and there is a continuous electrical field between clouds and earth. (Oomori, 1992) In the presence of a thunder, the electrical field is enlarged very rapid (Ohanian, 1989) and normaly negative charged soil is covered with positive charges thus the plants are effected from this electrical field change.

By the way, it is well to explain some physical terms to make them clear; A current passing through a wire creates an electrical field around it. The same area can be also created by charging two aluminum plates with (+) and (-) charges. The electric field direction is from (+) to (-). Electrical and magnetic fields are similar physical forces in the means of their effects on living organisms although they are different from each other. A magnet's effected area is called the 'magnetic field' of the magnet. The lines that are formed in the surrounding of the magnet are called 'the magnetic field lines' of the magnet. The direction of these lines are from north to west. Low frequenced electromagnetic areas have lower frequences than 10^5 Hz. As this sources usually cover electrical transmission lines and some electrical devices, they can be called 'electrical fields'.(Kocaçalışkan, 2004)

It is reported that, all organisms including humans are effected from the electrical field and the effects of electrical and magnetic fields on biologic systems is an interesting field of study that can give important results.(Polk and Postow, 1995; Kodali, 1996).

The main reason that plants are effected from the electrical fields is the industrialism. In our modern and industrial world, the electrical field in areas can vary between 0 – 3 x 10^6 V/m.(Benson, 1991) And there is many information missing of the effects of electrical areas to living systems. Especially, there are not enough studies about the long term exposure but it is known that values above 25 kV/m are due to result in dangerous results.(Kocaçalışkan, 2004)

Today, the electric transmission is generally supplied with high voltaged lines. These lines carry about 380 – 700 kV electrical energy. In this case, the electrical field under the transmission lines are supposed to be 5 – 12 kV/m. The study of the effects of this field on living organisms in that area is continuing.(Foster, 1996; Koçyiğit, 2000)

In some studies about the security standards made in USA and Japan, the upper limit of the electrical field between the high voltage lines is 3 kV/m. Although under this level, no serious health problem was observed; above this level, it was obseved that especially in blood cells, there were health problems observed in living organisms.(Kocaçalışkan, 2004)

All biological systems consist of subsystems. To understand these systems functions, effects of fields on biological solutions must be known. These liquids include diversity of molecules. The transmission is changeable in these systems. By this changes, the organisms' life functions change.(Kocaçalışkan, 2004)

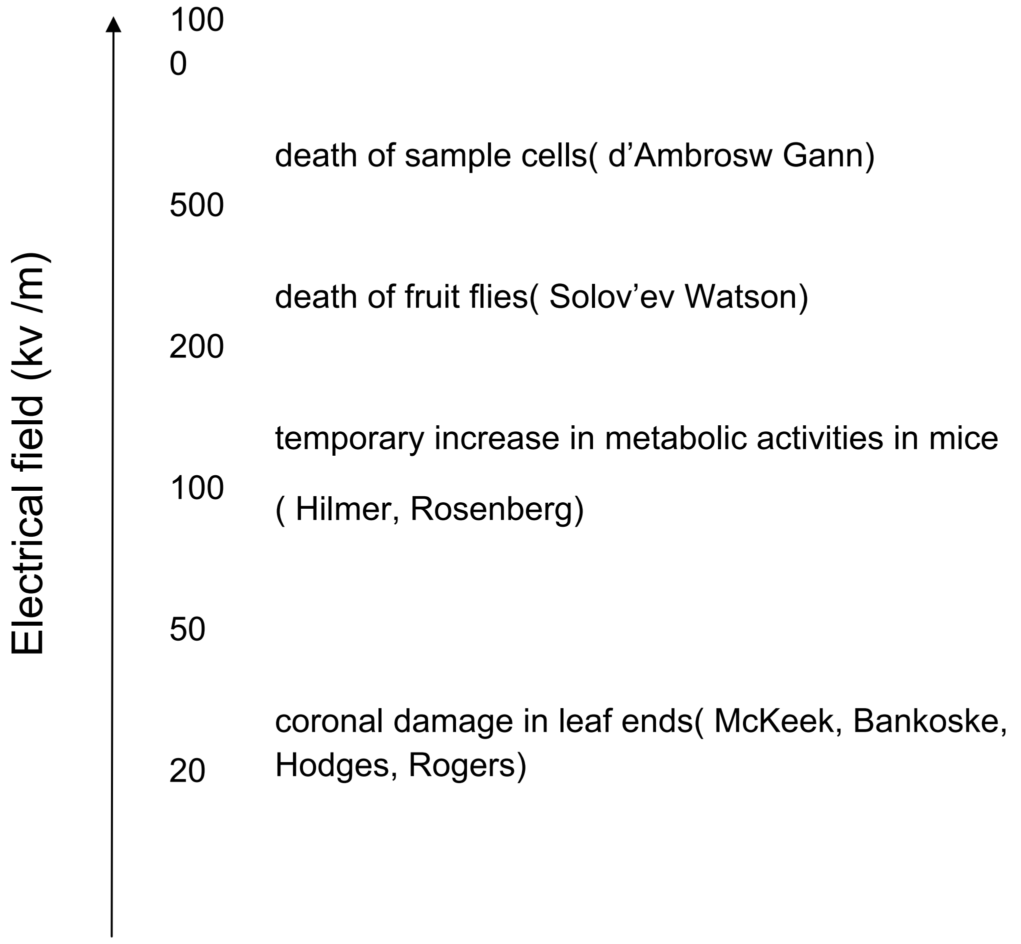


Illustration 1.1. – The diagram of effects of electrical fields from the high voltage lines to its surroundings that was observed by some researchers.(Şeker and Çerezci, 1991)

In the nature, the plant species that are living in an area is designated by the natural selection that arises from the ecological circumstances of that area. As a result, humans are creating artificial areas to breed plants that they need. In areas that several factors affecting the plant growth, biotechnological ways are used aside conventional ways. On the contrary however, preventing the damage of chiling temperatures to plants is still an obstacle and to overcome that problem, the studies about cold's biological effects on plants that are resistable and irresistable to cold must be enlarged.(Dumlupınar, 2000)

In our current knowledge, the plants can be classified in three groups on their resistance to cold; sensitive, semi-sensitive, resistant. This grouping is made by looking their surviving times without getting any damage and it is seen that there is a 'getting cold' limit temperature for every variations of plants. The resistance to cold ability can even show differences in the same kind of plant.(Guy,1990) Plants' 'cold' limit is based on the level of cold, exposure time, also the humidity of the surrounding, the plant's maturity, the sugar level in the structure of the plant, its cell wall's saturated fat rate and value, the soil's nutriently value of saturation and the plant's ability to change its hormones.(Wang, 1982)

In the studies, it was seen that about the cold resistance of a plant, the effects of biological and physyological cahanges are vital because it was also seen that, there is a difference in resistance between the tissues of the plant and that factor makes the subject impossible to be carried out by just genetical methods.(Guy, 1990)

PLANTS' SENSITIVITY TO COLD

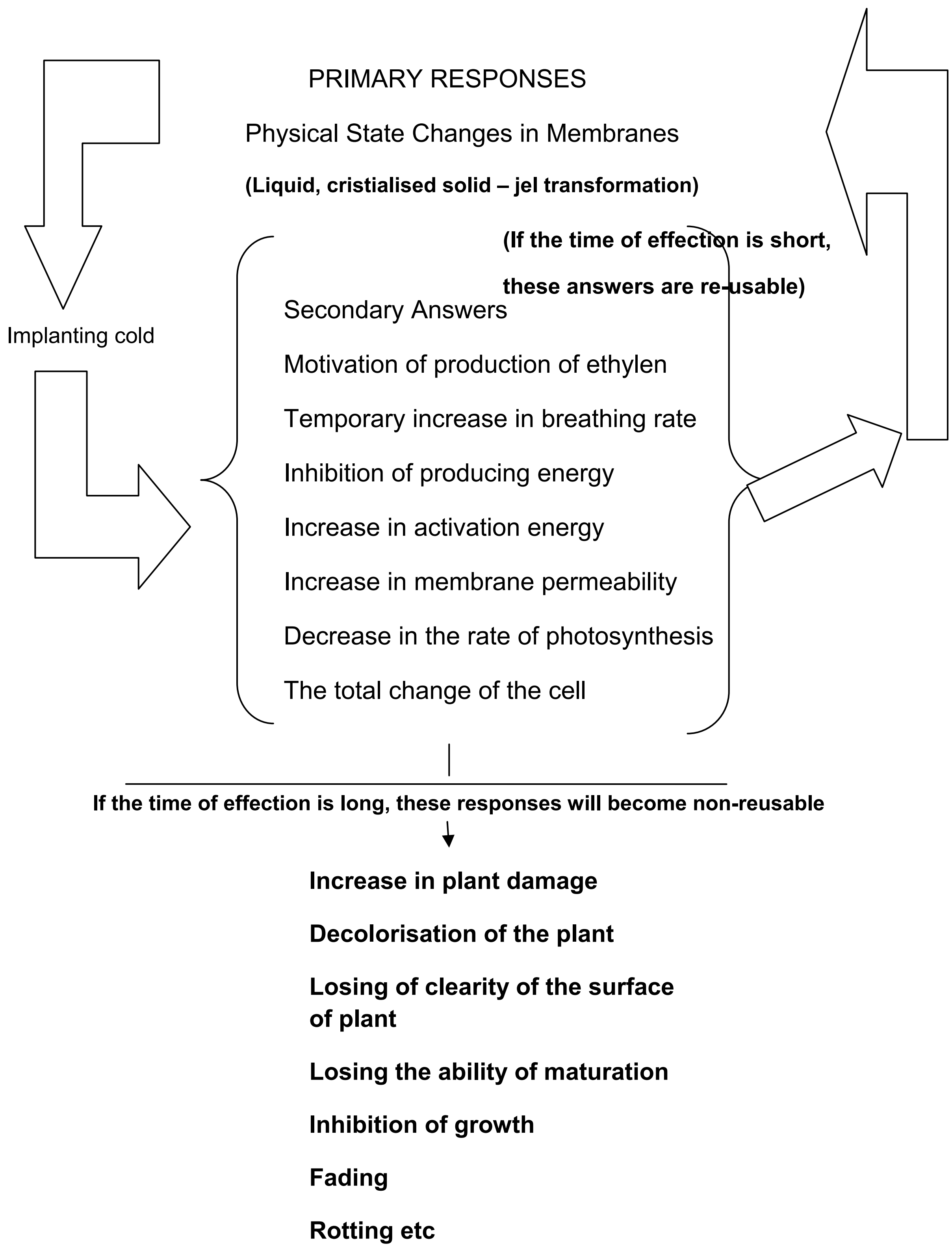


Illustration 1.2. – The diagram showing responses of sensitive plants to t he process of undergoing ' getting cold' temperatures.(Wang, 1982)

In the plants that are influenced by chiling colds, the primary response is observed to be changes in the membrane structures. Also, by the change of the membrane structure in the plants that are sensitive to cold, the enzyme system is influenced. Therefore, the enzyme activity is shown to be related with the membrane. However, it is seen that there is no membranous change and enzyme activity change in plants that are resistant to cold. (Raison *et al.,* 1971)

The chiling temperatures have effects on a plants physical and biochemical mechanisms alongside with their cell membranes. In the development of the resistance, one important factor is the increase of the soluble amount of proteins. The studies showed that, the resistance occurs from the synthesis of resistable proteins.(Kocaçalışkan, 2004)

In the studies on this subject, it was seen that by the effect of cold, there are many biochemical and physical changes occur; the positively and negatively external effects on the resistance mechanism. The plants are not encountered by the galvanic cold changes without the presence of frost. Usually, the heat decreases slowly. In this process, the plant detects the decreasing heat and starts to react. Although this process is not very vital to resistant plants, the sensitive plants need this biochemical and physical changes. The exposure period is even so important for this sensitive plants. If this period is not sufficient for the plant to react, crucial damages will occur.(Dumlupınar, 2000)

In this process, to prevent the cold stress on the plant, some regulating substances are used and some important results were obtained.(Waldmen, 1975; Young and Lee, 1979; Abromeit, 1992; Dumlupınar, 2000) But the reality is that, these studies are based on agricultural plants and the aim is to protect the plants from human consume in their natural areas. But many science authorities are taking this usage suspicional. The usage of this regulating substances is considered to effect the human health. In addition, there were many knowledge gained about the plants resistance but there is almost no researches about the electrical field effects on plants resistance to cold.

In this study, the effects of an electrical field which is a physical force to the plants resistance to the chiling temperatures will be elaborated. To do that, we need to use a plant that is sensitive to cold and the easiest one to find is the cactus plant.

Plant:

A cactus (plural: cacti') is any member of the plant family Cactaceae, native to the Americas. They are often used as ornamental plants, but some are also crop plants. Cacti are grown for protection of property from wild animals, as well as many other uses. Cacti are part of the plant order Caryophyllales, which also includes members like beets, gypsophila, spinach, amaranth, tumbleweeds, carnations, rhubarb, buckwheat, plumbago, bougainvillea, chickweed and knotgrass.(Eggli, 2003).

Cacti are distinctive and unusual plants, which are adapted to extremely arid and hot environments, showing a wide range of anatomical and physiological features which conserve water. Their stems have adapted to become photosynthetic and succulent, while the leaves have become the spines for which cacti are well known.(www.wikipedia.org) The cacti are very irresistable to two features therefore; excess watering and cold temperatures.

The cacti are used to be watered mainly in the seasons of summer and spring when they start growing but excess watering in other seasons causes the cactus to get damage and eventually, die. On the other hand, insufficient water causes the cactus to enter a sleep mode that doesn't give permenant damages to cactus afterwards.

In my study, the cacti are plants that are very resistable to very high temperatures but their minimum average living temperature is 0ºC.(by the way, their optimum growing temperature is 16ºC) There are some cactus species that can resist up to -15ºC but they are very rare. In winter, the cacti enter a sleep mode to survive winter conditions but if they are effected by chiling temperatures for a long period of time, they start to get damage. At first, wounds start to appear on the mid-section and then, by the damage of this section, the plant collapses.

History

There weren't any studies made before 1960s except some exceptions. Until then, there were many studies have been made. Some researchers studied about the effects of electrical field on the environment.(Navy sponsored ELF Biological and Ecological Research Summary, 1977) And some researchers studied about the effect of the field on growing and maturing process.(Murr, 1963; Barthony, 1969). It is therefore stated that the electrical field has an influence on the cell reproduction.

Lebedev(1930) has used low frequenced, short-term elecrical waves on a plant and observed that growing is 20-45% more compared to the control group.(Nelson, 2000)

Lazarenko and Gorbatovskaya(1966) observed that the adaptation gained by the effected plants can be transferred up to the 3rd generations.

On the other hand, by some high voltage applications by Solov'ev(1967), the effect on the living organisms are observed to be deadly.

There are some studies continuing about speeding or delaying the growth of plants.(Bachman and Reichmanis 1973; Murr 1963, 64, 65, 66) In some studies, it is observed that the electrical field causes inhibitory effects.(Murr, 1965; Hart and Schottenfeld, 1979).

There are also some knowledge that the electrical or magnetic applications increase the rate of the enzyme that cause an increase of the plant's metabolic activities.(Murr, 1965; Jia Ming, 1988; Kurinobu and Okazaki, 1995)

Azin and Izakov(1995) observed that the efficiency in agriculture has increased 15-20% when they applicated electrical field on the seeds.(Nelson, 2000)

With related to our study, when plants are exposed to cold temperatures, it is seen that they give primary responses and when the exposing time of chiling temperatures is long, they give secondary responses(Pantastico *et al*., 1967; Eaks, 1980) and it was stated that the secondary responses are good parameters of obtaining the cold heat damage on the plant.(Eaks,1980)

When a plant is effected by a cold temperature, it is observed that the primary response is a change on the membrane structure of their cell and also enzyme activity is related with the components of the cell membrane.

When a study was made on both sensitive and insensitive plants to cold, it was observed that some protein models had been changed whereas some proteins increased and some decreased.

2. MATERIALS AND METHODS

2.1. Materials

- 2 cereus fairy castle *Cactus Suculent* (with 2 pots and soil including part potting soil and one part sand with little gravel)
- 2 series connected cells worth 1.5 V each
- aliminum folio(to create a field)
- metal wire
- degreed cooler

2.2 Methods

2.2.1 Plantation and breeding of the plants

Cacti can be produced as generative (with seeds), as well as vegetative (steel, vaccine, with separation). Vegetative production is more useful in small amounts. However, when a lot of production is concerned, the generative production method is preferred. (http://egitek. meb.gov.tr/aok/ Aok_Kitaplar /AolKitaplar / Cografya_3/3.2007)

With seed production: Seeds are usually added only after waiting 1 year. However, Epiphyllum (Atlas Flower) and Zygocactus (New Year's Eve Flower) seeds should be added when they are still fresh. To shorten the germination period, large and hard-shelled seeds are soaked in water or eroded by mechanical ways before sowing. Sowing is made in the spring (March-April). In seed germination, equal amounts of forest soil, peat and sand mixture mortar in volume can be used. It is useful to add wood coal powder to this mixture. Seeds, still equal amounts of volume of rotten leaves, geared river sand and charcoal can be added to the mix. Seeds are sowed with 3-4 mm spaces and they are covered with the mixture according to their size. Very fine seeds are not covered up, they are suppressed lightly with a smooth wooden block. After finishing sowing, seed pad is watered with sponged bucket and it is covered with a glass upon. As most of the cactus types germinate in illuminated areas, pads or cases are kept in an illuminated area. While germination, the system must stay moisturied as the same; the temperature must be 20 - 30º C in daytime and 18 - 20º C in nights. Germination occurs in 4 days to 1 years according to the cactus type. In the type of *Cactus Suculent*, the germination occurs in 4 days. Until the seeds make contact, they shold be untouched in the seed pad, after, they must be carried to another cases without making damage to their roots. Young plants are carried to little pots after 1 or 2 years. (http://egitek. meb.gov.tr/aok/ Aok_Kitaplar /AolKitaplar / Cografya_3/3.2007)

2.2.2. Sampling

Cactus Suculent **Pairs**	***Cactus Suculent*** **Height (cm) of the plant ±0.5**	***Cactus Suculent*** **Width (cm) of the plant ±0.5**
1 A1+B1	8.4	2.3
2 A1+B1	8.3	2.2
3 A1+B1	8.4	2.3
4 A1+B1	8.5	2.1
5 A1+B1	8.2	2.4
6 A2+B2	8.4	2.3
7 A2+B2	8.2	2.2
8 A2+B2	8.2	2.3
9 A2+B2	8.1	2.1
10 A2+B2	8.4	2.2

(Table 2.1: The height and width of young cacti that are carried to little pots)

The pairs that are in the table 2.1 are combined due to; A1 has been effected for 10 minutes of E.F. but B1 was not effected so they were observed together.

Similarly, A2 group was effected for 40 minutes whereas the similar plant group of B2 was not effected and these two groups were observed together as well.

2.2.3 Treating the plants

To cacti that reached the values in the table 2.1, the groups of 1, 2, 3 and 4 had been taken as experimental all groups. first group (10 plants) had been effected for 10 minutes, second and fourth groups (10 plants each) were not effected by the field and the third group was influenced by 40 minutes by the electrical field.

(Illustration 2.1: the E.F. application process of cacti)

In progress;

The cacti are put between two parallele aluminum plates and influenced by the electromagnetic field by designated time intervals for groups in the table 2.1.

	10 minutes of electromagnetic field (A1 group plants)	40 minutes of electromagnetic field (A2 group plants)
Exposure time 1	30 sec	30 sec
Pausing time	5 min	5 min
Exposure time 2	1 min	1 min
Pausing time	5 min	5 min
Exposure time 3	1,5 min	1,5 min
Pausing time	5 min	2 min
Exposure time 4	2 min	2 min
Pausing time	5 min	5 min
Exposure time 5	2,5 min	2,5 min
Pausing time	5 min	5 min
Exposure time 6	2,5 min	2,5 min
Pausing time	not available	5 min
Exposure time 7	not available	3,5 min
Pausing time	not available	5 min
Exposure time 8	not available	4 min
Pausing time	not available	5 min
Exposure time 9	not available	4,5 min
Pausing time	not available	5 min
Exposure time 10	not available	5 min
Pausing time	not available	5 min
Exposure time 11	not available	6 min
Pausing time	not available	5 min
Exposure time 12	not available	7 min

(Table 2.2: The affectance periods of the electromagnetic field)

Treatments to plant types are shown in the table 2.3. The plants that are influenced by the electromagnetic field, the ones that are to be influenced by the cold (B group plants) put in temperature of -18º C, a day length of 14/10 hours (14 hours of daylight, 10 hours of dark; it is selected as it is usual for a spring day) and put in a cooler.

	Cold Affection (-18 C)	**10 min E.F. Application +cold**	**40 min EF Aff. Application +cold**
Control Group (A)	-	-	-
Group A1 Plants	+	+	-
Group A2 Plants	+	+	+
non EF affectance (B)	-	-	-
Group B1 plants	+	-	-
B2 Group plants	+	-	-

(Table 2.3: The differences in the means of cold and electromagnetical affectance between plant groups)

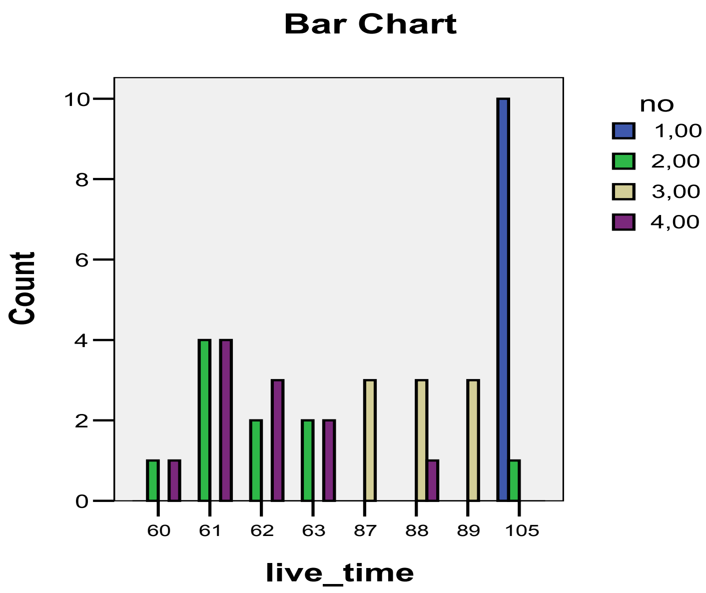
APPLICATIONS	**LIVING SITUATION**										
	10th DAY	20th DAY	30th DAY	40th DAY	50th DAY	60th DAY	70th DAY	80th DAY	90th DAY	100th DAY	105th DAY
A1-10 (10)	1	1	1	1	1	1	1	1	1	1	1
B1 (10)	1	1	1	1	1	1	1	0	0	0	0
A2-40 (10)	1	1	1	1	1	1	1	1	0	0	0
B2 (10)	1	1	1	1	1	1	1	0	0	0	0

(Table 2.4: The living periods of plant groups (1 = living, 0 = dead))

The experiment was carried out for 105 days and in both groups, the temperature is varied between -18 to 21º C in 3 day periods.

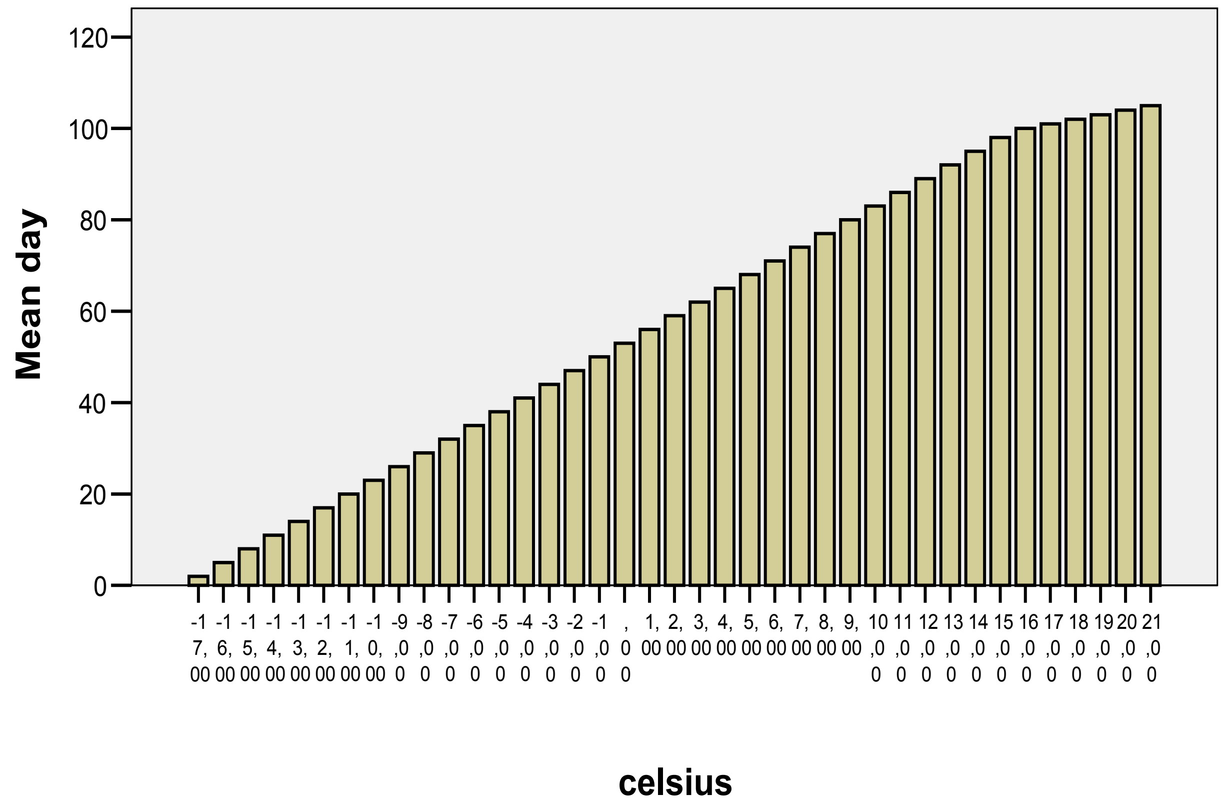
(Illustration 2.2: Temperature changes)

In the group A1 (10 min effectance by E.F.) 10 trials, in the group B1(no affectance by E.F.) 10 trials, in the group A2 (40 mi effectance by E.F.) 10 trials, in the group B2 (no affectance by E.F.) 10 trials were made to obtain a total trial number of 40. These groups' life situation graphs are illustrated in the graph 2.3.



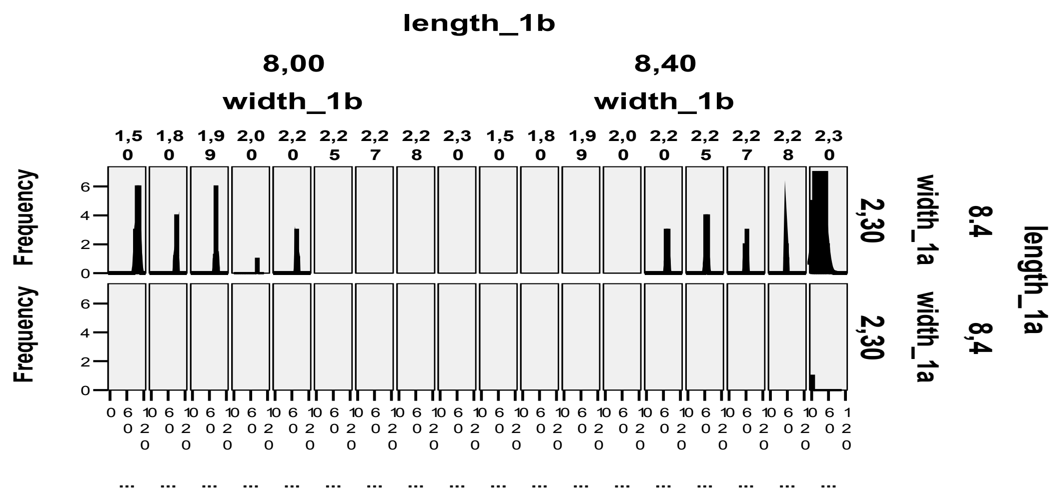
(Graph 2.3: The living length of the plants; the living times of the groups A1, B1, A2, B2 respectively)

The graph illustrates the living time and the number of the cacti. There are 10 groups; first, second, third, fourth and fifth illustrates A1 and A2. Sixth, seventh, eighth, ninth illustrates A2+B2. The x-axis shows the number of the day.



(Graph 2.4: the temperature variance graph; the temperatures between -17ºC to 21ºC are shown in the y-axis whereas, the presence time with this temperature values in the means of days are shown in the x-axis)

The temperature varied for the plants for 105 days. The plants' temperature that are influenced by E.F. increased 1ºC for every 3 day from an initial degree of -18º C for 105 days to finally reach the temperature of 21ºC. This temperature varience is seen in graph 2.4.



(Graph 2.5: The change of size in plants that are influenced and not influenced; the comparison of the height and width values of the groups A1 and B1)

2.3. Analysis Teqniques

All experiments are carried out for 10 times and the average results are given in the graphs. A varians analysis is made by using two factored interaction model. Factoriel Anova, considered the interactions to designate the effects that has influence on the controlled variable. For temperature changes; Independent – Semples t Test is applied. Also, the Frequency Table is used with the plants.

3. THE DATA OF THE EXPERIMENT

The findings are given in the form of tables and graphs and for further comprehensions, they are explained.

The codes used in the graphs;

A	Control Group
A1_10	10 min e.f. + cold
A2 _40	40 min e.f. + cold
B	no e.f. affectance
B1	only cold
B2	only cold

3.1. Hypothesis, analysis and evaluation

H0: *There are no statistically valid differences between the groups' average lifetime*

H1*: There are differences between the groups' average lifetime that cannot be explained as a result of coincidances*

	Cases					
	Valid		Missing		Total	
	observed day number	Percent	N	Percent	N	Percent
10min elc apl. * B1	105	100,0%	0	0,0%	105	100,0%

(Table 3.1: case processing summary) The observe period of plants that are not influenced by E.F. The 105 days of observation can be seen on the table

		B1		Total
		dead	live	
10min elc apl.	Live	Count	44	61	105
		Expected Count	44,0	61,0	105,0
Total		Count	44	61	105
		Expected Count	44,0	61,0	105,0

	Value
Pearson Chi-Square	.(a)
N of Valid Cases	105

No statistics are computed because 10min ELC. APL. is a constant.

Symmetric Measures

		Value
Nominal by Nominal	Contingency Coefficient	.[a]
N of Valid Cases		105

a. No statistics are computed because 10min elc apl. is a constant.

(Table 3.3: Chi-Square Teste for B1)

- Frequencies;

		10 min ELC. APL.	40min ELC. APL.	B1	B2
N	Valid	105	105	105	105
	Unobserved day count	0	0	0	0

(Table 3.4. Statistics about 10 and 40 minutes of E.F. applied and non-applied B1 and B2 groups’ experiment time)

Cold application is made to B2 group plants (10) and their average lifetime is seen to be B2.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid live	105	100,0	100,0	100,0

(Table 3.5: 10min e.f. application)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	dead	18	17,1	17,1	17,1
	live	87	82,9	82,9	100,0
	Total	105	100,0	100,0	

(Table 3.6: 40min elc application)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	dead	44	41,9	41,9	41,9
	live	61	58,1	58,1	100,0
	Total	105	100,0	100,0	

(Table 3.7:B2 values)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	dead	43	41,0	41,0	41,0
	live	62	59,0	59,0	100,0
	Total	105	100,0	100,0	

(Table 3.8: B2 values)

ONEWAY

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
death day	Between Groups	41538	3	13846	767,52	1E-32
	Within Groups	649,45	36	18,04		
	Total	42188	39			
dead	Between Groups	738,9	3	246,3	113,39	2E-18
	Within Groups	78,198	36	2,172		
	Total	817,1	39			
life time	Between Groups	11629	3	3876	59,261	5E-14
	Within Groups	2354,9	36	65,41		
	Total	13984	39			
exp. day	Between Groups	0	3	0	.	.
	Within Groups	0	36	0		
	Total	0	39			

(Table 3.9: Oneway Anova)

In tables 3.1/3.8, all groups are compaired with annova analysis teqnique.

As seen, there is no living in the plants that had not been influenced by e.f.in the final time of 105 days. As average, they seem to be living for 61 days. As seen in the table 3.9, death day and degree, lifetime and experimental time is tabled as oneway. Results of frequency table is compaired with valid numbers 00 $\leq$ 0.05. As a result, sig = 0.000 and H1 hypothesis is accepted.

H2*: There is a relation between temperature and the continuity of the plants' living activities.*

Group Statistics

		B1	N	Mean	Std. Deviation	Std. Error Mean
celsius	live	61		-7,3279	5,92093	,75810
	dead	44		10,4318	4,77103	,71926

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
celsius Equal variances assumed	4,161	,044	-16,414	103	,000	-17,75969	1,08198	-19,90553	-15,61384
Equal variances not assumed			-16,995	101,677	,000	-17,75969	1,04501	-19,83254	-15,68684

T-Test values values for the groups are investigated on the table above.

t-Test Group Statistics

B2		N(days)	Mean	Std. Deviation	Std. Error Mean
celsius	live	62	-7,1613	6,01690	,76415
	dead	43	10,6047	4,68605	,71462

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
celsius	Equal variances assumed	5,258	,024	-16,238	103	,000	-17,76594	1,09412	-19,93587	-15,59602
	Equal variances not assumed			-16,981	101,547	,000	-17,76594	1,04623	-19,84124	-15,69064

(Table 3.10: t-Test: A1-A2-B1-B2 groups' control of their living activities on the variation of temperature with t-Test)

There is a relation between temperature and plants' living. As a result of independent-samples t-Test, semantic is 0.044 < 0.05. H2 hypothesis is accepted.

H3: *There is a relation between 40 minutes electrical field effected and 10 minutes electrical field effected plants.*

As seen on the frequency table, 10 minutes e.f. influenced plant continued living whereas 40 minutes e.f. influenced plants did not. Plants that are influenced to E.F. for 40 minutes' living time and percentage is shown on the table 3.11. Due to undesired results, H3 hypothesis is denied.

10min electric application

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid live	105	100,0	100,0	100,0

40min electric application

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	dead	18	17,1	17,1	17,1
	live	87	82,9	82,9	100,0
	Total	105	100,0	100,0	

(Table 3.11: frequency table: The observation of the relationship between A1 and A2 groups)

H4: *There is a difference between the experiment groups*

According to the anova test, there is a valid difference between 95% trust area (with 95 % confident interval consistment of 40 plants, 4 groups (10 A1 + 10 B1 + 10 A2 + 10 B2 = 40). The degree of validity is sig=0.000. As seen in the table 3.13, H4 is accepted.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
dead_day	1,00	10	,00	,000	,000	,00	,00	0	0
	2,00	10	61,90	1,524	,482	60,81	62,99	60	65
	3,00	9	88,33	,707	,236	87,79	88,88	87	89
	4,00	11	64,36	7,903	2,383	59,05	69,67	61	88
	Total	40	53,05	32,890	5,200	42,53	63,57	0	89
dead_c	1,00	10	,0000	,00000	,00000	,0000	,0000	,00	,00
	2,00	10	3,4000	,51640	,16330	3,0306	3,7694	3,00	4,00
	3,00	9	12,1111	,60093	,20031	11,6492	12,5730	11,00	13,00
	4,00	11	3,9091	2,70017	,81413	2,0951	5,7231	3,00	12,00
	Total	40	4,6500	4,57726	,72373	3,1861	6,1139	,00	13,00
live_time	1,00	10	105,00	,000	,000	105,00	105,00	105	105
	2,00	10	65,90	13,772	4,355	56,05	75,75	60	105
	3,00	9	88,00	,866	,289	87,33	88,67	87	89
	4,00	11	64,00	8,012	2,416	58,62	69,38	60	88
	Total	40	80,13	18,936	2,994	74,07	86,18	60	105
ex_day	1,00	10	105,00	,000	,000	105,00	105,00	105	105
	2,00	10	105,00	,000	,000	105,00	105,00	105	105
	3,00	9	105,00	,000	,000	105,00	105,00	105	105
	4,00	11	105,00	,000	,000	105,00	105,00	105	105
	Total	40	105,00	,000	,000	105,00	105,00	105	A

(Table 3.12. Descriptives) (A1-A2-B1-B2 groups' differences' observation with ANOVA test)

		Sum of Squares	df	Mean Square	F	Sig.
dead_day	Between Groups	41538,455	3	13846,152	767,519	,000
	Within Groups	649,445	36	18,040		
	Total	42187,900	39			
dead_c	Between Groups	738,902	3	246,301	113,389	,000
	Within Groups	78,198	36	2,172		
	Total	817,100	39			
live_time	Between Groups	11629,475	3	3876,492	59,261	,000
	Within Groups	2354,900	36	65,414		
	Total	13984,375	39			
ex_day	Between Groups	,000	3	,000	.	.
	Within Groups	,000	36	,000		
	Total	,000	39			

(Table 3.13: Anova: **A1-A2-B1-B2 groups' differences' observation with ANOVA test)**

(Illustration 3.1: Experiment photos: The loss of health of the groups B1-B2)

4. RESULTS AND SUGGESTIONS

In this study, the effects of the electromagnetical field that is applied in different periods to the cactus plants' resistance to cold is investigated. With this aim, electromagnetical field and chiling cold is applied to the plants. While doing this experiment, plants are effected by 10 and 40 minutes electrical field influence and then their lifetime is observed. The time of influence of E.F. to the plants is designated as 10, 40 minutes for different groups. Each experiment was retried for 10 times.

4.1 The Effects of Electromagnetical Field

In comparison to control group, 10 minutes of E.F. application had influenced cactus plant to continue living after 65 days with cold application. With the application of the E.F. it is possible to speed or stop the plant's growth. (Bachman and Reichmanis, 1973; Murr, 1963, 1964, 1965, 1966; Brayman and Miller, 1990; Stennz et al., 1997; Nelson, 2000). It is stated by Murr (1964, 1965) and Nelson (2000) that low and moderate E.F. application makes an improvement on plant's growth. As accordingly, applied E.F.'s effects on improving plant activity does not contradict with the past observations.

10 minute e.f. application does not show an improved effect on plan's growth (and that is probably the plant's were in undesired conditions) but it is observed that it had increased the plant's activity. There are some studies that suggest E.F. increase the activity of plant's enzyme and protein activity to cause a change in plant's activity (Murr, 1965; Jia_ming, 1988; Kurinobu and Okazaki, 1995).

40 minutes of E.F.. influence has no further improvements in the means of increased lifetime in cold of the plant rather than the control group (B), is observed. On the other hand, 40 minutes of E.F. influence has similarities in general with 10 minutes of E.F. application but it was observed that it has more negative results. It is stated by Nelson (2000) that e.f.'s frequency, strength and application time has mass differencies of effects on varying organisms.

4.2. The Effects of Cold and E.F. Application

As the results gained from the study, cold has caused damage on mid-section of the cactus suculent plant (table 2.4.). It is reported by Christiansen (1963) and Wang (1982) that cold has inhibitory effects on growth of plant.

The aim of this study; E.F. influence icreased the plant's resistance to cold and causing the pot plant of cactus to live in the undesired conditions so it can be regareded as an alternate breeding method.

As a result:

1. The plants that are influenced by E.F. and then left to cold has increased lifetime and can continue living in some chiling temperatures.

2. As the result of the first clause, this applicatin can take place of greenhouses or increase the yield of production in the field condition as the E.F. has increased the resistance to cold in a noteworthy manner. But there must be further studies and trials in that conditions.

3. The inhibitory effects of 40 minutes E.F. application rather than the desirable effects of 10 minutes had showed that there is an optimum density and time of E.F. so it is more appropriate to further study and trying to find that optimum values.

4. As E.F. has effects of improved growth on normal conditions, it is suggested that one e.f. frequency can have desirable effects on different conditions that would cause further economical advantages. To make this point more valid, further study is needed.

5. The E.F. is applied in some periods due to the plants' properties. It can be designated to optimize these periods in relation to frequency and influence time.

The statistically observation of 10 and 40 minutes of e.f. applicated plants and non-effected plants is made and it was seen that the optimum results were obtained in the 10 minute of E.F.. applicated group.

5. EXPERIMENT LIMITATIONS AND CHANCES OF MISTAKES

1. The fact that the experiment is carried out for Ankara's winter conditions and one type of plant usage are the limits that prevent making generalisations.

2. 40 minutes of E.F. had improved the ability of resisting to cold on cacti but it was not enough.

3. We support the fact that E.F. application can replace the cold preventing treatments and this application also can supply desirable results in the greenhouses and even in the fields but there must be additional studies on those places.

4. It was observed that after an intensity value, E.F. causes harming to the plant. As a result, we strongly recommend that the intensity and the time of E.F. application for the best results must be investigated.

5. We support the idea that different frequencies of E.F. will supply different effects on different field conditions. For this idea to be proved, there must be studies in micro level.

6. In our study, the plant of *Cactus Suculent* is investigated. There are no studies made for other kinds of plants.

7. There were 10 trials made in our study. The number of trials might need to be increased.

8. The temperatures can be selected differently from our study.

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