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# THE EFFECT OF ELECTRICITY ON PLANT GROWTH

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## Introduction

The application of electricity, magnetism, monochrome light, and sound can stimulate the growth of plants to a great extent. This little-known technology, called Electro-culture, can accelerate growth rates, increase yields, and improve crop quality. Electro-culture can protect plants from diseases, insects and frost. These methods also can reduce the requirements for fertilizer or pesticides. Farmers can grow bigger and better crops in less time, with less effort, and at a lower cost. The several approaches to Electro-culture include: antennas, static electricity, direct and alternating current. The energies are applied to the seeds, plants, soil or the water and nutrients.

## Antenna Systems

The French farmer Justin Christofloreau attracted attention in 1925 with his apparatus to collect atmospheric energy for his crops. Clover treated by his method grew 7 feet high. Christofloreau's apparatus consisted of a 25-ft wooden pole; at the top was a metal pointer aligned north-south, and an antenna. Copper and zinc strips were soldered together to generate electricity from solar heat. Several of the poles were set about 10 ft apart, and the wires leading from them extended about 1000 yards. Christofloreau claimed that the accumulated electricity destroyed parasites and promoted beneficial chemical processes in the soil.(2)

In 1924, Georges Lakhovsky devised his Oscillator Circuit, a one-turn copper coil with overlapping ends separated by a gap. Capacitance generates oscillating currents that benefit the plants. The ring is supported by an insulator such as a plastic rod. This extremely simple arrangement stimulates plant growth (Fig. 5.1). (3) Other configurations also enhance plant growth. A conical coil of stiff wire wound with 9 turns (counter-clockwise in the Northern Hemisphere, clockwise in the Southern), when stuck in the ground about 1 ft north of a plant, will collect atmospheric electricity. Connect a wire from the fence to a metal rod near the plants. A tv antenna also can be used. Rebar can be sunk into the ground at each end of a row of plants, connected by a bare wire under the soil and/or in the air. A north-south orientation will take advantage of geomagnetic polarity.

**Electrostatic Systems**

Experimental study of the effects of electricity on plant growth began in 1746, when Dr. Maimbray of Edinburg treated myrtle plants with the output of an electrostatic generator, thereby enhancing their growth and flowering. Two years later, the French abbot Jean Nolet found that plants respond with accelerated rates of germination and overall growth when cultivated under charged electrodes. Beginning in 1885, the Finnish scientist Selim Laemstrom experimented with an aerial system powered by a Wimhurst generator and Leyden jars. He found that the electrical discharge from wire points stimulated the growth of crops such as potatoes, carrots, and celery for an average increase of about 40% (up to 70%) within 8 weeks. Greenhouse-grown strawberry plants produced ripe fruit in half the usual time. The yield of raspberries was increased by 95%, and the yield of carrots was increased by 125%. However, crops of cabbage, turnips, and flax grew better without electrification than with it. The Laemstrom system comprises a horizontal antenna suspended high enough to permit plowing, weeding and irrigation. The voltage applied to the antenna varies from 2 to 70 KV, depending on the height of the antenna. The current is about 11 amps. (4, 5)

Spechniew and Bertholon obtained similar results a few years later, and so did the Swiss priest J.J. Gasner in 1909. Also that year, Prof. G. Stone showed that a few sparks of static electricity discharged into the soil each day increased soil bacteria up to 600%. In the 1920s, V.H. Blackman reported his experiments with an aerial system similar to that of Laemstrom. He applied 60 volts DC/1 milliamp through 3 steel wires each 32 ft long and suspended 6 ft apart and 7 ft high on poles. This arrangement yielded an average increase of about 50% for several plant types. (6) In 1898, Grandeau and Leclerq studied the effect of atmospheric electricity on plants by covering part of a field with a wire net which shielded them from natural electrical action. The uncovered plants grew 50-60% better than the shielded plants.

Wet soil improves current flow. Electro-cultured plants require about 10% more water than control plants because the charged water is perspired more rapidly than under normal conditions. Positive results are always obtained except when ozone is formed by ionization. Negative aero-ions intensify cellular oxidation reduction processes, while the positives depress them.

**Direct Current**

In the 1840s, W. Ross of New York reportedly obtained a severalfold increase in the yield of a field of potatoes when he buried a copper plate (5 ft x 14 ft) in the earth, and a zinc plate of the same dimensions 200 ft away. The two plates were connected by a wire above ground, thus forming a galvanic cell. In similar experiments by Holdenfleiss (1844) with battery-charged zinc and copper plates, yields increased up to 25%.(7) From 1918 to 1921 some 500 British farmers developed a shared system to treat their grain in an electrified solution of nutrients. The grain was dried before sowing. The farmers cultivated about 2,000 acres with the seed. The results were reported in Scientific American (15 February 1919): "In the first place, there is a notable increase in the yield of grain from electrified seed... the yield of the electrified seed exceeds that of the unelectrified by from 4 to 16 bushels... The average... is between 25 and 30 % of increase... The increase in weight has ranged from 1 pound to as much as 4 pounds per bushel... Besides the increase in the bulk of the yield and the increase in the weight per bushel, there is an increase in the straw... whereas the bulk of the unelectrified seeds had thrown up only 2 straws per seed, the electrified had thrown up 5.... The straw growing from the electrified seed is longer... The stoutness and the strength of the straw is increased... the crop is less likely to be laid by storms... Corn growing from seed thus treated is less susceptible to the attacks of fungus diseases and wireworm.

"The effect produced upon the seed is not permanent; it will retain its enhanced efficiency only for about a month after electrification, if kept in a dry place. It is therefore desirable that the seed be sown promptly after it has been electrified... The grain must be steeped in water that contains in solution some salt [sodium nitrite] that will act as a conductor... The seed is steeped in it, and a weak current of electricity is passed by means of [iron] electrodes of large surface attached to two opposite end walls of the tank. The seed is then taken out and dried.

"Seed that is to be sown on one kind of soil will yield better results with a calcium salt, and seed that is to be sown on another kind of soil will yield better results with a sodium or other salt. One kind of seed will need treatment for so many hours, and another kind for many hours more or fewer. Barley, for instance, needs twice as long treatment as wheat or oats. The strength of the solution and the strength of the current must be appropriate, and are not necessarily the same in each case. The drying is very important. The seed must be dried at the right temperature, neither too rapidly nor too slowly; and it must be dried to the right degree, neither too much or too little." (8, 9)

In 1964, the USDA performed tests in which a negative electrode was placed high in a tree, and the positive electrode was connected to a nail driven into the base of the tree. Stimulation with 60 volts DC substantially increased leaf density on electrified branches after a month. Within a year, foliage increased 300% on those branches! (10)

Electricity also can cure trees of some diseases. A method was developed in 1966 to treat avocado trees affected with canker and orange trees with scaly bark. An electrode was inserted into the living cambium and phloem layers of the tree and the current passed into the branches, roots or soil. The treatment is best administered in the spring. The length of treatment depends on the size and condition of the tree. New shoots appeared after only one cycle of treatment. After the bark was removed, the trees began to bear fruit! The period of grafting stratification also can be shortened in this way.

Brief exposure of seeds to electric current ends their dormancy, accelerates development throughout the period of vegetation, and ultimately increases yields. The effect is greater with seeds that have a low rate of germination. The metabolism of seedlings is stimulated; respiration and hydrolytic enzyme activity is intensified for many types of plants. Lazarenko and Gorbatovskaya reported these results: "Reports that the characteristics acquired by the plants in electrically treated soils are transmitted by inheritance to the third generation are particularly interesting.

“Under the influence of the electrical current, the numerical proportions between hemp plants of different sexes was changed by comparison with the control to give an increased number of female plants by 20-25%, in connection with a reduction in the intensity of the oxidative processes in the plant tissues.”

"At the end of vegetation the experimental cotton plant possessed twice or three times as many pods as the control plant. The mean weight of the seeds and fiber was greater in the experimental plants also. In the case of sugar beet the yield and sugar content were increased, and in places near the negative pole the increase in sugar content was particularly high. The tomato yield increased by 10-30%, and the chemical composition of the fruit was modified. The chlorophyll content of these plants was always greater than that of the control... Corn plants absorbed twice as much nitrogen as control plants during the vegetative period... The transpiration of the experimental plant was higher than that of the control, especially in the evening...

An electrified fence was invented by Henry T. Burkey in 1947 to keep fish out of irrigation ditches. The fence consisted of a free-swinging row of electrodes connected to a generator which slightly charged the water to shock fish without hurting them.(12)

**Alternating Current**

When using AC, great care must be taken to prevent electrocution of oneself and the plants. AC generally tends to retard plant growth except within certain narrow parameters of voltage and amperage. Dicotyledon plants increase in weight at 10 KV and 100 KV, but decrease in weight (as much as 45%) between 20 to 60 KV. Current must be very low, or plant growth will be retarded. L.E. Murr used aluminum wire mesh electrodes charged up to 60 KV, and found that monocotyledons increase in dry weight in an electrostatic (ES) field, but decrease in weight in an oscillating field. The dry weight of dicots increases about 20% when grown in an oscillating field, but decreases above 50 KV. The concentration of minor elements (Fe, Zn, Al) increases several hundred percent in active leaf tips, due to an increase in oligo-enzymes. The activity of these substances is accelerated so much that cellular respiration is impeded, resulting in deterioration and death. There appears to be no benefit from continual exposure of plants to an alternating electrical field. If such a system is used, voltages should not exceed 10 KV, and the current must be very weak.(13-15) However, the results can be worthwhile. In a similar system, the maximum energy supplied was 50 watts (50 KV/1 mA) per acre for 6 hours daily for 6 months. The total energy supplied was less than 0.2% of the energy actually absorbed by the plants from sunlight alone. Only a fraction of this additional energy was available to the plants, yet the increase averaged above 20%, up to 50%! Furthermore, it was found that an electrical discharge applied during the first month of the growing season may be as effective as continued treatment throughout the season.

In November 1927 and January 1928, Popular Science Monthly announced H. L. Roe's invention of an electrified plow which sent 103 KV between the plow shares to kill pests in the soil. In 1939, Fred Opp invented a garden cultivator that used high-tension electric current to increase the nitrogen content of the soil. The system was described in Popular Science Monthly (October 1939): "A generator with an output of 110 volts AC, a storage battery for exciting the armature field, and a transformer that steps up the current to 15 KV... [is] mounted on a walking-type garden tractor equipped with a small gasoline motor that drives both the tractor and the generator. Current is conducted through a pair of electrodes to furrows in the soil made by a cultivator. As the electrodes are dragged along, soil falls on top of them, making the contact"

The same method was incorporated into the "Electrovator" built by Gilbert M. Baker, as reported in Popular Science (September 1946):

"It is a trailer containing a... 12.5 KVA generator and a special transformer. Two rakes with copper electrodes for teeth apply the high-voltage, low-amperage current to weeds as the machine is drawn at 1 mph... The weeds burn, from the tops to root-tips, leaving the land ready for new crops. The treatment can be repeated for successive growth."

In 1911, Emilio Olsson patented an irrigation system using electrified rain. The water was contained in an insulated iron tank, positively charge with 110 V/0.5 A. The negative pole was insulated copper wire, stripped bare at the tip. The sprinklers were mounted 5 meters high. Olsson successfully cultivated a 600-acre plantation with this method. The city of Buenos Aires adopted the system for use in its parks.(16)

The treatment of seeds in an electric field before sowing gives a consistent increase in yield, usually about 15-20%. L.A. Azin and F.Y. Izakov reported these results of their research: "The electric field of the corona discharge differs from the electrostatic field by possessing considerable homogeneity and by the precession of space charges of the same sign in its working zone. Because of this any particle, including a seed, receives a charge of the same sign in such a field. The [ES] field is homogenous and does not possess space charges, although charging may take place here because a seed, if placed on the metal electrode, acquired a charge by contact, corresponding in its sign to the polarity of the electrode.

N.F. Kozhevnikova and S.A. Stanko experimented with AC effects. They found:"After treatment in optimal conditions, the yield of green mass is increased by 10-30%, and the yield of grain by 10-20%. Besides the increased yield, treatment of seeds with an alternating current may improve other economically valuable properties of cultivated crops: the leaf cover of  the plants may be increased, the vegetative period may be shortened, the absolute weight of the grain may be increased, and so on..."

The seeds were treated with 2-4 KV/cm, with 8 KV on the electrodes of the working chamber. Exposure was for 30 seconds, or for 1 hour. It was found that if treated seeds were kept for 10-17 days before sowing, the mature plants would contain up to 86% more chlorophyll and 50% more carotenoids than the controls! (17)

B.R. Lazarencko and J.B. Gorbatovska reported similar results achieved under various conditions of corona discharge treatments of seeds: "After electric treatment of this type, an increase in their germination rate and, in particular, in the energy of germination was observed. The improvement was especially marked in the properties of seeds located on the negative electrode during treatment. In this case an increase in yield of 2-6 centners/hectare was obtained with nearly all the conditions of treatment used. The increase in yield was smaller for plants whose seeds were treated on the positive electrode. Corn seeds, treated in a constant electric field, gave good yields which developed rapidly. Green tomatoes ripen faster if they are placed in an electric field close to the positive electrode or between the poles of a magnet, especially close to the south pole.

The viability and the fertilizing power of the pollen at first increased and then decreased as the duration of its treatment in a constant electric field was lengthened. In optimal conditions this fertilizing power was increased from twice to four times. The use of high voltage electric fields for the treatment of pollen has led to the modification of its bioelectrical properties and has made it possible to influence the fertilization process: the setting rate of fruit has been increased during hybridization of varieties of more distant forms, and the failure to cross distant species of fruiting plants has been overcome. (18)

Seed-borne bacteria, fungi and insects can be destroyed without injuring the seeds, by application of high-frequency ES fields between capacitor plates. Pests are destroyed when a lethal degree of heat is developed within a few seconds. A longer exposure is required to cause decreased germination of seeds than is necessary to kill pests. (19, 20)

The effects are thought to be caused by conduction currents or dipole antenna resonance. The lethal effect begins at about 10.4 meters wavelength (29 MHz) when the condensor plates are 2-3 cm apart. Other researchers have reported similar effects with the following parameters: Plates, 12 cm diam.; Current, 5.5 amps; Wavelength, 5.6 meters (50 MHz); Temperature, 30-40o C. The lethal effects depend on the wavelength and the voltage gradient of the field strength (the distance between the condensor plates). Increasing either the frequency or the field strength while other factors remain constant increases the speed of the effect on pests. An increase of either factor requires more current, yet at certain frequencies (around 3 MHz), much less current is required for effective results (about 4 KV per linear inch). The higher the frequency, the shorter the lethal time. The thickness of the seeds and their moisture content also changes a lethal dose. The temperature of the seeds and pests may rise up to 60o C. A similar method was developed to destroy termites in wood, using a 20 MHz signal for the purpose.

Experiments conducted by H. Kronig showed that after a week of development, seeds exposed to extremely low frequency (0.5-20 Hz) fields, wheat seeds grew an average of 23% greater length than non-electrified controls.

Other experimenters have found that the high-frequency currents generated by a Tesla coil will protect plants from temperatures as low as 10o F, which destroyed unprotected plants. (28) In 1920, Thomas Curtis used a large, oil-immersed Tesla coil (10 KV/500 W) to supply high-tension current over a 200 sq ft plot planted with radishes and lettuce. The electrified crops were at least 50% larger than the normal crops.

**Electrogenic Seed Treatment**

In the 1970s, Andrew Zaderej and Claude Corson formed Intertec, Inc., to develop and market their "Electrogenic Seed Treatment", based on Zaderej's US Patent 4,302,670. A variety of atmospheric conditions are known to benefit plant development; the Intertec system simulates these. The seeds are conditioned and rejuvenated, resulting in more rapid germination and increased yields. Seeds are sprayed with a solution of minerals and enzymes which is implanted into the seed coat by electrophoresis; this accelerates chromosomatic activity. A second exposure to high voltage negative ions increases the implantation. Then the seeds are exposed to infrared radiation in order to reduce the hard-seed dormancy and increase the metabolism of ATP.

The next stage uses an electrostatic charge to give cathodic protection. This reduces the mortality rate of seeds by providing a source of electrons to buffer the reaction with free-radical nutrient ions. Seeds must be moist when treated with cathodic protection. Dry seeds may be damaged by this treatment, but damaged seeds can be repaired somewhat if they are moistened. Cathodic protection increases viability and germination up to 200%.

The final stage of the Electrogenic process treats seeds with select radio frequencies which stress the memory of DNA molecules, charges the mitochondria, and intensifies other metabolic processes. This treatment increases the degree of water absorption, electrical conductivity, and oxygen uptake. The frequencies range from 800 KHz to 1.5 MHz with a field intensity of 3.2 W/sq cm. The seeds need to be treated at or near where they are to be sown. For some unknown reason, the effects of Electrogenic treatment apparently do not travel well.

## Practical Part

Our science project was conducted to find out how electricity affects the growth of plants. The experiment was done by supplying DC 9V radiation to the soil containing radish and observing the rate of plant growth.

### Hypothesis

Radish seeds that are induced with DC voltages grow more quickly.

### Overview

Electroculture involves the study of the effects of electricity and electric fields on the rate of seed germination and plant growth. This is an area of science where a lot of experimentation is being conducted. Researchers are starting to find evidence that plant growth can be enhanced by taking advantage of the sensitivity of plant cells to electric currents.

Observations have been made that certain types of grass appear healthier after a thunderstorm and grass that grows below an electric power cable generally look greener. However, these observations have been disputed by skeptics claiming that grass appear healthier after a thunderstorm as they have been given a good wash by the falling rain. As for the grass that grows under electric power cables, skeptics allege that the droppings from birds that sit on the power lines act help fertilize the grass.

Certain scientists suggest that while plants need all the known conditions such as sufficient sunlight, air, water and nutrients to grow, the presence of an electric current help to enhance plant growth. However, if the other conditions are not available, the presence of an electric field will not make a difference.

### Materials

The materials required for this science fair project:

- 3 packets of radish

- 3 plastic pots

- Soil required for the 2 pots

- A DC 9V battery
- A TV
- A Computer
- Tap water
- Ruler (1 meter)

Procedure

1. For this science project, the independent variable is the amount of electrical stimulation given to the plants. The dependent variable is the height of the bean plant. This is determined by measuring the height of the 10 plants in each group and calculating their average height. The constants (control variables) are the amount of water used, the amount of sunlight received and the type of plants used.

2. Two pots are labeled A and B. The same amount of soil is filled into both the pots. Ten radish seeds are then planted in each of the pots. (More than 10 radish seeds can be planted and the extra seeds that germinate can be removed later). The radish seeds that are planted in the same pot should be placed at least 20mm apart from one another.

3. For this science project, the independent variable is the amount of electrical stimulation given to the plants. The dependent variable is the height of the radish plant. This is determined by measuring the height of the 10 plants in each group and calculating their average height. The constants (control variables) are the amount of water used, the amount of sunlight received and the type of plants used.

4. Two pots are labeled A and B. The same amount of soil is filled into both the pots. Ten bean seeds are then planted in each of the pots. (More than 10 radish seeds can be planted and the extra seeds that germinate can be removed later). The radish seeds that are planted in the same pot should be placed at least 20mm apart from one another.

Conclusion

1) The hypothesis that radish seeds induced with DC electric voltages will grow more quickly, is proven to be true.

2) Many electroculture experiments are being done in laboratories to show that introducing an electric or magnetic field will enhance plant growth and seed

germination. This method can be used in plant nurseries to improve the yield of plants being nurtured.

3) The same hypothesis was proven on bean seeds.

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