Solar-Powered Electroculture Technique For Backyard Farming

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Abstract: To make crops grow larger and faster has been the primary concern of agriculture for ages. All methods of cultivation techniques and technologies have been developed to fulfill this aim; from simple crop rotation to complex synthetic fertilizers. Another cultivation technology discovered in agriculture is the application of electricity and magnetism that can accelerate growth rates, increase yields, and improve crop quality. This technology is called electroculture. Electroculture can protect plants from diseases and insect and likewise 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. Rationalizing the concept of electricity's role in plant growth stimulation and application of solar technology, the researcher designed and developed a project that would help increase the growth of plants without losing their quality and nutrition. Electroculture with proper watering system will help the plants grow faster. Moreover, the portable solar power supply may be used to power up the project for a more cost effective operation. With this project, there will be an increase in the production of crops and may help resolve the shortage of food in the years ahead.

Keywords: solar energy • electroculture • farming

1. Introduction

One major factor contributing in the increase in food demand is world population growth. Demographic projections have a high degree of certainty, so projections of future world food needs based on population growth are quite reliable. Demand for food in the Philippines is expected to rise because of the expected growth in the economy. The country's growing population shall require greater food supplies. With the fast increasing population, the need for food will become increasingly urgent as several factors such as pests, climate change and the like, force the change of the approach to agriculture, creating or developing new agricultural techniques or strategies to ensure enough food supply for the people. Experts say that farmers now lack the ability to yield good quality edible plants. Electroculture is one of the potential solutions to help solve this crisis. Electroculture includes the study of the effects of electricity and electric fields on the rate of seed germination and plant growth. For centuries, farmers had sworn that thunderstorms make crops grow quicker. Observations have been made that certain types of grass appear healthier after a thunderstorm and grass that grows below an electric power cable generally looks greener. The reason is that after a thunderstorm, the plants make use of the electric current produced by the lightning, then the plants widely open their roots containing the guard cells which allow the passage of electric current to increase the speed of production of their food. The application of electricity, magnetism, monochrome light, and sound can stimulate the growth of plants to a great extent[1]. This little-known technology, called electroculture, can accelerate growth rates, increase yields, and improve crop quality. Electroculture 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 .[2] It is the researchers' aspiration to design and develop a project that will quickly increase the growth of plants without losing their quality and nutrition. Electroculture with proper watering system will help the plants grow faster.[3] Moreover, a portable solar power supply may be used to power up the project for a more cost effective operation. With this project, there will be an increase in the production of crops and may help resolve the shortage of food in the years ahead.

2. Material and Methods

The project study used engineering and planning type of research which involved the use of plans, procedures and strategies to come up with the working prototype. Conceptual literature and related studies were considered in the construction of the proposed project. The evaluation of the existing electroculture included the analysis of the design, construction and operation of the previous models. Some modifications for improvement on the previous models were also included. The study also took into consideration the requirement and standards of the electrical engineering and agriculture and the knowledge of the existing technology to be modified to come up with the design of the electroculture on plants. After gathering different information from different references, the design layout and specifications has been conceptualized and carry out. Computation and technical analysis are important to have accurate results and to minimize actual problems that may arise throughout the operation of the project. Bit-by-bit process and the proper machines and tools to be used in the project are given attention in the methods of fabrication and assembly. The fabrication of the project has been assessed accurately and the safety of the individual was prioritized. Some tests were performed to determine acceptability of the operation of the project and its efficiency. Furthermore, charging and discharging tests were done to measure the current drain capabilities of the solar panel and its auxiliaries.

3. Results and Discussion

3.1 Evaluation of the existing electroculture technique

3.1.1 Design. In the study of electroculture technique, the proponent planted a vegetable garden in their front yard. Tomatoes, eggplant, broccoli, peppers, and chard were planted. The plants were electrified by Samsung phone charger with a 5v, 550 mA output. The charger was connected to two three-inch nails by a 1.75 mm diameter conductor, one connected to each wire of the charger. The nails were buried in the east and west sides. The Samsung charger was plugged in an outside convenience outlet. The garden was manually watered 8:00 in the morning and at 4:00 in the afternoon.

3.1.2 Construction. The garden wherein electroculture technique was applied is about 25 feet by 14 feet. The long axis was east to west. The nails which are connected to the supply were positioned on the east and west sides. The positive electrode was about 8 feet away to the right. Figure 1 shows the garden where electroculture technique was applied.

Figure 1. *Plot where electroculture technique is applied*

3.1.3 Operation. The plants were electrified 24/7. The garden is manually watered 8:00 in the morning and at 4:00 in the afternoon. Three weeks later after the electroculture technique was applied, the plants grew faster. Figure 2 shows the effect of electricity to the plants. The row of plants closest to the path is taller than the rows further away. This was because the electric field was originating next to the path. As the field diminishes over distance, so does the growth amplification effect.

Figure 2. *Plot after electricity was applied*

3.1.4 Areas for Improvement. The past study concerned only on using electroculture as a technique for plant growing whereas the present study added other features such as solar power energy as the supply and an automated watering system. Using solar power energy as the supply is a means to conserve energy. A 12V DC, 40 AH deep cycle battery was used to store the energy that is generated by the solar panel. The copper rods used in the project and the trigger for the automatic watering system got their supply from the solar power connected to it. Having an automated watering system is one way to control or conserve water.

3.2 Design Consideration and Requirement

3.2.1 Philippine Electrical Code (PEC). In order to ensure the quality of the products, some provisions of the Philippine Electrical Code were cited and considered as guides for the development and operation of a solar-powered electroculture technique for backyard farming.
Researchers provided a functional prototype as to simulate final design, considering aesthetics, materials, quality and functionality. They reduced its size in order to reduce its cost. The provisions cited were on storage batteries, wiring and equipment supplied from batteries.

3.2.1.1 Storage batteries. Art. 4.80.18 provides that racks and trays shall comply with (a) Racks, as required in this article, are rigid frames designed to support cells or trays. They shall be substantial and be made of one of the following: (1) Metal, treated so as to deteriorating action by the electrolyte and provided with no conducting members directly supporting the cells or with continuous insulating material other than paint on conducting members; or (2) Other construction such as fiberglass or other suitable nonconductive materials. (b) Trays are frames, such as crates or shallow boxes usually of wood or other nonconductive material, constructed or treated so as to be resistant to deteriorating action by the electrolyte.

3.2.1.2 Wiring and equipment supplied from batteries. According to Art. 4.80.1.3, wiring and equipment supplied from storage batteries shall be subject to the requirements of this code applying to wiring and equipment operating at the same voltage, unless otherwise permitted by 4.80.1.4.

3.2.1.3 Wiring. Wires shall be identified by sleeve-wire markers or equivalent at each end. Wiring shall be thermoplastic and heat-resistant.

3.2.2 Institute of Electrical and Electronics Engineers (IEEE)

3.2.2.1 IEEE SA - 1562-2007 - IEEE Guide for Array and Battery Sizing in Stand-Alone Photovoltaic (PV) Systems. According to this IEEE Standard, a method for properly sizing the PV array and battery for stand-alone PV systems where PV is the only charging source is recommended (in conjunction with IEEE Std 1013TM). Load calculations and determination of solar radiation in the sizing of the system need special attention.

Additionally, the critical nature of the load in deciding an acceptable annual availability needs to be considered.

3.2.2.2 Department of Agriculture (DA). Under a Memorandum of Agreement (MOA) signed by former Secretary of Department of Agriculture Yap and AFI president Regina Lopez, the Department will set up home gardens at the resettlement site; train the beneficiaries on vegetable farming and teach them environment-friendly technologies to increase their production; and provide them with farm inputs in the form of assorted vegetable seeds, fish tank /fingerlings, shredder and vermicomposting units.

3.2.2.3 Pechay Production. Pechay can either be sown directly on the soil or transplanted. Direct seeding is carried out by broadcasting or by sowing in rows. Cover the seeds to a depth of about 1 cm by raking or spreading additional top soil. Water immediately after sowing. Plant spacing should be 10 cm between plants and 20 cm between rows. Afterwards, harvest in 45 days after sowing. Harvest methods are preferably done on the leaves and then remove roots. Pechay is about 15-30 cm tall in vegetative state. [4]

3.3 Design Plans and Specifications

3.3.1 General Description of the Project. The solar-powered electroculture technique for backyard farming is a project which aims to make crops grow larger and faster. It is powered by a 50 Watts solar panel connected to a 12 Volt DC deep cycle battery. The 12 Volt deep cycle battery supplies the copper rods planted in the soil through a charge controller. The project has three different plots planted with 24 pechay plants per plot. Plot A was intended for traditional plant growing without fertilizers. In plot B, two copper rods were planted in the soil of each pechay plant soil. The copper rods were placed at opposite sides of the plot and did not touch each other. Using a solar charge controller, the solar panel charges the battery while the battery supplies the microcontroller. It is programmed that every 8 am and 4 pm the microcontroller will allow the passage of electricity from the battery to the solenoid valve for the watering system and the copper rod for the electroculture technique for two minutes. Lastly, in plot C, liberal amount of organic fertilizer (compost) was applied at the base of the plants and covered lightly with soil and watered immediately to give the plants enough nutrients. In plot A, there was no fertilizer used. The plots were watered through an automated watering system. This system was done by a program using an Arduino supplied by the 12 Volt DC battery supply. This Arduino is connected to a solenoid valve which triggers every 8am and 4pm. The solenoid valve is connected to a hose that connects the water supply and the pulsating sprinkler in the end. The pulsating sprinkler automatically waters the plant whenever the solenoid valve triggers. The growth of the pechay plants is monitored by using a bullet type CCTV camera. The actual prototype of the project is shown in Figure 3.

Figure 3. *Solar Powered Electroculture Technique for Backyard Farming*

3.3.2 Design and computation analysis. For a better understanding of the prototype, the proponents provided computations of the components of the design.
Sizing of the Solar Panel. In order to determine the size of the solar module, the total load demand must be computed first.

Solenoid Valve = 4.8 W
Copper Rods = 12V x 2.5A = 30 W

The total demand load will be the sum of the individual load.

Total load = 4.8 W + 30 W = 34.8 W x 1.25 = 43.5 Watts (since 125% is the reciprocal of 80 percent and 80 percent of the rating of the solar panel shall be its maximum allowable load.

The researchers used a 50 W solar panel for further improvement of the prototype. Pmax = 50W and nominal voltage was 12V.

Sizing of the Charge Controller. The researchers came up with the size of the charge controller using the parameter computed in sizing the solar panel.

Solar Panel = 50 W
Battery = 12VDC
Ampere Rating:
= (50W / 12VDC) x 1.25 = 5.2083 A

Twenty five percent (25%) of the ampere rating should be added to take account the special conditions that could occur, causing the solar panel to produce more power than normally rated (e.g. due to sunlight's reflection off of water, extraordinary bright conditions, etc.).

Sizing of the Battery. The researchers provided batteries based on parameters computed in a worst case scenario that the solar panel will not be available due to insufficient sunlight. The battery at full charge condition is assumed to be used 360 minutes (non continuous).

Therefore:
Ampere-Hour
= (5.20A)(360 minutes x 1 hour/60 minutes)
Ampere-Hour = 31.2 AH

The researchers used 40 AH deep cycle battery because it is designed for solar applications and the rating is more than the computed rating.

3.3.3 Design layouts. The construction assembly of solar powered electroculture technique for backyard farming is shown in Figure 4. It consists of a solar panel, a storage battery, sprinkler, a greenhouse, a charge controller, and a microcontroller of irrigation. The greenhouse consists of three plots. It has also a CCTV for monitoring purposes only. Along with it are the dimensions of the prototype.

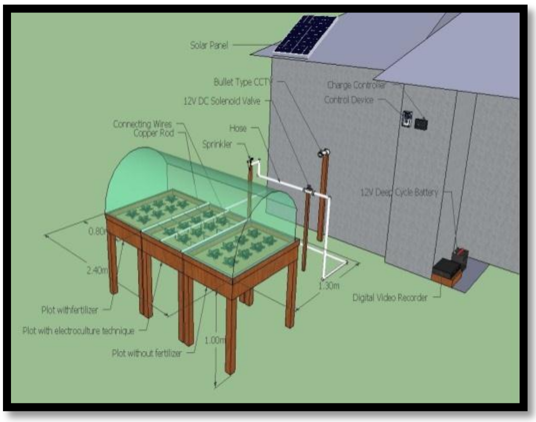


Figure 4. *Isometric View*

Figure 4 shows the isometric view of the project. The greenhouse is 2.4m x 1.3m x 1m with the three (3) partitions; Plot A, Plot B, Plot C. Electroculture plot has the copper rods installed 12cm from the base of the plant. The project study has additional features: sprinkle and CCTV camera. Sprinkler post of 1.25m and the solenoid valve post of 1m in height was installed 1.5m from the greenhouse while the CCTV camera post of 1.3m in height was installed from the distance of 2m from the greenhouse.

3.3.4 Circuit Diagram. The circuit diagram of the project and the connection of all components of project is shown in figure 4.5. It composes of a solar panel, charge controller, microcontroller, solenoid valve and the copper rods.

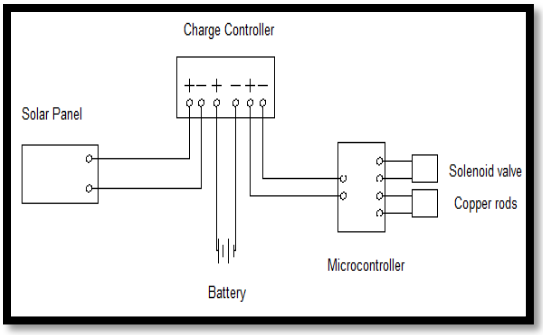


Figure 5. *Schematic Circuit Diagram*

3.3.5 Program and its Implementation. Figure 6 shows the flowchart of the operation of the microcontroller.

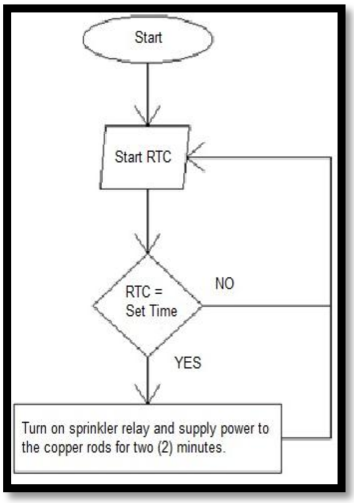


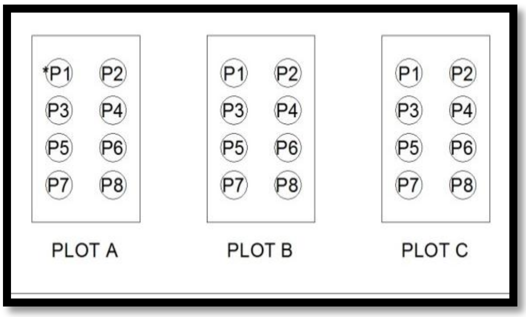
Figure 6. *Flowchart*

The battery supplies the circuit and initializes the device and is represented by a parallelogram. The RTC is a real time clock which tracks the current time even if the microcontroller does not have a power supply because it has a separate battery. The microcontroller operates based on real-time manner. The researchers set the time of watering the plants, 8:00am and 4:00pm only, and the duration of the process is set for two (2) minutes for each time set. The diamond indicates decision making process where the Arduino decides if the set time is equal to the current time in the RTC. If the Arduino decides that the set time is not equal to the current time, the Arduino repeats the process from the start until the Arduino reaches the set time equal to the current time in the RTC. When the real time clock (RTC) is equal to the time set, the Arduino sends electrical signal to the sprinkler's relay (the solenoid valve is directly connected to the sprinkler's relay), the sprinkler's relay will allow the electric signal to flow to the solenoid valve. The solenoid will open up and allow the water to pass through for duration of two minutes; the sprinkler is directly coupled to the solenoid valve, which will water the plants. The microcontroller is again returned to the start until it reaches the condition set by the proponents.

3.4 Testing Methodologies

Tests were conducted to determine whether the mechanism and output of the system reached the desired output. A growth test was conducted in order to establish the effectiveness and efficiency of the prototype. To confirm that the necessary output of the project was achieved, a CCTV camera was used to monitor the growth of the plants. Researchers will use a ruler to record the height of the plants in each plot. In the first test, the researchers provided seedlings of pechay and planted them in the three plots (plot A, plot B and plot C). All the plots were provided with same amount of water through an automated watering system. The plants in plot B were electrocuted 24 hours a day while plot A and plot C grew the plants in a conventional manner with and without fertilizer, respectively. The testing lasted only for two weeks. After such observations made for weeks, the following results for different parameters set by the proponents are drawn.

PLANT CONFIGURATION



* P1 – Plant 1 P2 – Plant 2 P3 – Plant 3
P4 – Plant 4 P5 – Plant 5 P6 – Plant 6
P7 – Plant 7 P8 – Plant 8
PLOT A – without fertilizer ; PLOT B – electroculture; PLOT C – with fertilizer

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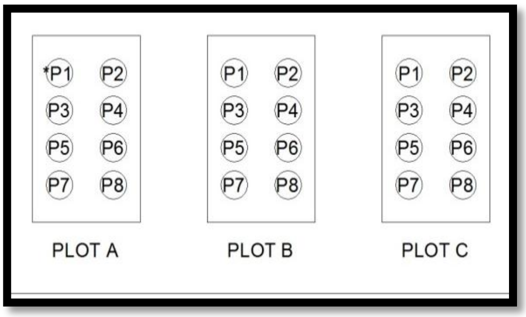
***Table 1:** Growth Test (Test I)*

PLOT	PLANT NO.	HEIGHT OF PECHAY PLANT (mm) WEEK NO. 1	2	3	4	5	6
A	P1	30	72				
	P2	44	86				
	P3	35	93				
	P4	45	78				
	P5	35	62				
	P6	43	105				
	P7	20	80				
	P8	30	81				
Average		**35.25**	**81.12**				
B	P1	42					
	P2	54	85				
	P3	60	120				
	P4	40	68				
	P5	60	90				
	P6	60	103				
	P7	60	112				
	P8	40					
Average		**52**	**96.33**				
C	P1	50	75				
	P2	55	150				
	P3	50	95				
	P4	45	117				
	P5	40	105				
	P6	60	108				
	P7	52	85				
	P8	70	85				
Average		**52**	**102.5**				

Table 1 shows the results of Test 1 of the growth test done in the three different plots. In the first week, the plants in Plot A have the lowest average growth while the plants in Plot C have the highest average growth. In the second week, all the plants in the three plots grew but plant 1 and plant 8 in Plot B died. Plot C still had the highest growth average. After the second week of testing in Test 1, the researchers looked for other references on how to improve the design of the project. Plot B was divided into 8 different sections by a plywood. The copper rods were placed 12 cm from the base of the pechay plants. Instead of supplying the copper rods by DC voltage source for 24 hours, it was minimized for only about four minutes a day using the microcontroller. For Test II of growth test, the researchers set the automated plant watering device using a sprinkler for four (4) minutes a day. In this sense plant growth are being stimulated by electricity because wet soil improves current flow.

PLANT CONFIGURATION



* P1 – Plant 1 P2 – Plant 2 P3 – Plant 3
P4 – Plant 4 P5 – Plant 5 P6 – Plant 6
P7 – Plant 7 P8 – Plant 8
PLOT A – without fertilizer ; PLOT B – electroculture; PLOT C – with fertilizer

***Table 2:** Growth Test (Test II)*

PLOT	PLANT NO.	HEIGHT OF PECHAY PLANT (mm) WEEK NO. 1	2	3	4	5	6
A	P1	20	38	70	70	95	
	P2	17	35	70	110	115	
	P3	20	33	70	70	80	
	P4	28	51	88	10	120	
	P5	19	42	70	100	120	
	P6	30	50	90	130	135	
	P7	20	40	68	80	96	
	P8	15	30	60			
Average		**21.1**	**39.9**	**73.3**	**95.7**	**108.7**	
B	P1	37	70	125	150	160	
	P2	34	90	120	135	150	
	P3	33	80	110	125	160	
	P4	45	85	120	150	155	
	P5	34	60	90	100	150	
	P6	35	80	110	130	142	
	P7	30	55	100	130	165	
	P8	40	70	130	165	170	
Average		**52**	**32.3**	**73.8**	**113**	**136**	
C	P1	25	50	90	140	160	
	P2	15	30	70	120	125	
	P3	20	50	80	115	125	
	P4	12	20	60	65	70	
	P5	28	40	80	113	120	
	P6	20	40	80	110	130	
	P7	32	45	90	120	125	
	P8	40	60	128	155	160	
Average		**52**	**24**	**41.9**	**84.8**	**117**	

Table 2 shows the results gathered in the second testing of the project. In first week, plot B had the highest average of growth test. The second was plot C and plot A had the lowest among the three. Based on the plant monitoring system the pechay plants planted on plot B grew faster than the two other plants. The ranking of the average growth of the plants was the same from first week to fifth week. According to department of agriculture, pechay plants may be assumed fully grown after 45 days or six weeks. As gleaned on the results above, plants in plot B grew faster compared with the other two plots and reached its full grown state for around five (5) weeks only. Moreover, it was observed that watering for four (4) minutes a day and application of electricity stimulates plant growth faster because wet soil improves electric current flow. Electro-cultured plants require about 10 percent more water than control plants because the charged water is perspired more rapidly than under normal conditions [6] Furthermore, the passage of currents through the soil was beneficial to plant growth. As observed, plants subjected to electric current for 4 minutes daily results to about four times the healthier than plants grow the conventional way.

Conclusion

A well designed electroculture technique has great impact on household income. As observed in the study, the normal harvesting time of pechay plants is reduced by a week. This means reduction in the consumption of water, fertilizers and pests controls. Moreover, electroculture technique illustrates low maintenance and operating cost that best fits for every farmers growing vegetables plants. It will give farmers a chance to grow high quality crops faster, reduce environmental problems caused by using organic fertilizers and increase their income.

References

[1]. Diprose, M. F., Benson, F. A. And Willis, A. J., The Effect of Externally Applied Electrostatic Fields, Microwave Radiation and Electric Currents on Plants and Other Organisms, with Special Reference to Weed Control, 1984

[2]. Nelson, Robert A., The Next Bigly Thing: ElectroCulture, 1982

[3]. https://www/electrocultureandmagnetoculture.com /science .hmtl

[4]. http://agris.fao.org/agris-search

[5]. Butchbaker , Allen F., Electricity and Electronics for Agriculture, (1976)

[6]. Lakhovsky, George,, The Secret Of Life, 2010

[7]. Villaluna, Menchie C.,, Growth of Corn planted in lahar applied with organic and inorganic fertilizers, 2009

[8]. Electroculture, good vibes for agriculture: retrieved from http://www.electrocultureandmagnetoculture.com/

[9]. Electropism: retrieved from http://en.academic.ru/