

# Fertility Control System and pH Value for Hydroponics Cultivation

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**Abstract.** *This research presents the application of soil nutrient sensors in electrical conductivity and pH level measurement of the water solution in the hydroponics system. The micro-controller was set to processes the raw sensor data and converts it into a readable format. The results revealed that the electrical conductivity was measured between 90-120 millivolts while the EC values were measured between 67 to 138 us/cm. To investigate the pH level, the electrical conductivity was measured between 43-60 millivolts which the pH level was 6.52-7.22. Moreover, it was noticed that the values from the sensors and the EC meter were inversely variation. It could be concluded that there are some potentials in applying soil nutrient sensors in electrical conductivity and pH level measurement of the water solution in the hydroponics system.*

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## Keywords:

Fertility sensor, Automatic control system, Hydroponics Cultivation

## 1. Introduction

At present, consumers around the world have more awareness and realizations of the effects of residues toxins inside your foods, especially in the category of vegetables and fruit. There has been accordingly the tendency of the need to consume toxin-free vegetables increasingly. The ever-increasing worry from around the world is concerned with factors from ailments and health risks that are caused by pesticides. In the recent event, researchers from an epidemic center and statistics in Paris France have made the record for academic study research in an international medicine magazine [1] Regarding factors which call sickness as well as factors from the way of living, lifestyle, and family background. In the group of adults' demographics between the year of 2009 - 2016, it suggests that eating segmentation which lives off toxin-free foods, or commonly known as organic food, has lower risk than general consumers about 25% in contracting sickness [1]. This research suggests that by increasing the contamination of chemicals inside of foods which are planted inside the

level of soils is the key factor for reducing the risk for certain illness. Having stated that, organic food has become more and more popular as a present day.

Cultivating plans without the use of soil has the objective of decreasing the contamination of chemicals as well as pesticides that are contaminated inside soils. Whereas in the current situation, planting vegetables using Hydroponics is a very popular method and widely spreading. Through this Hydroponics method, minerals for plants are dissolved inside water for the growing of plants, thus reduces the amount of chemical contamination that comes from inside soils [2]. Apart from reducing the amount of contamination inside the soil for the planting of vegetables, the Hydroponics method has a lot of other advantages such as the ability to produce an agricultural outcome with small use of the area or unsuitable area. This approach can also increase the number of plans for planting for the community as well as household units, decreased the rate of water consumption as well as chemicals fertilizing the soil. Overall, the hydroponics planting method has a charter span of harvesting time than other methods of plantation since we are capable of controlling other factors associated with the production of plants efficiently [3] by relying on dissolved minerals inside water under the control of dissolution quality.

From past research, it is found that the control of dissolution quality in the plantation of vegetables by method hydroponic has several measurements and factor controls systematically and efficiently. The hydroponics method relies on electric conductivity, EC [4-7], and the acidity value [9] relies on receptors in the form of the active component which utilizes energy to activate the function of input of data into the controlling system. While the temperature measurement depends on receptors in the form of passive components [11] Which does not rely on the outside entity to stimulate the function of data input into the controlling system. At present, there has been a proposed idea for bringing in passive component receptors to take the place of active component receptors in case of electricity cannot be charged as input for the active form.

This research article thus has the objective of applied presentation for passive component receptors in controlling and monitoring the quality of the solution for the hydroponic method of the plantation. Nevertheless, researchers who are interested in bringing in passive component receptors into the measurement of soil fertility (fertility sensor), use this

method to measure and control the fertility of dissolution used for plantation via the Hydroponics method.

Therefore, this paper is intended to present the application of the electrical conductivity to measure and control the quality of plant solutions in hydroponics. The researchers were interested in using a passive sensor, which is used to measure soil fertility (fertility sensor), to measure and control the fertility of the hydroponic solution. Instead of conductivity measurements, conductivity measurements cannot refer to solution quality including the measurement of the pH value of the solution. The data obtained from the sensor can be transmitted to the dosing control system and to control the pH adjustment in the solution to the desired value of the plant.

## 2. Experiment and Methodology

The designation of a control system for fertility and pH value for the plantation of vegetables through hydroponics Method using receiving censored & signaled figures of fertility and pH value measurement and then processed for results analysis by comparison with the setup number by Arduino Mega 2560 board. The operation is done according to the conditions set forth in Table 1 and the control of function for solenoid valve which in turn monitor the flow of dissolution AB, Nitric Acid (HNO<sub>3</sub>), and water, all mixed inside the blending bucket for displaying the performance function through LCD screen like Fig. 1 and Fig. 2.

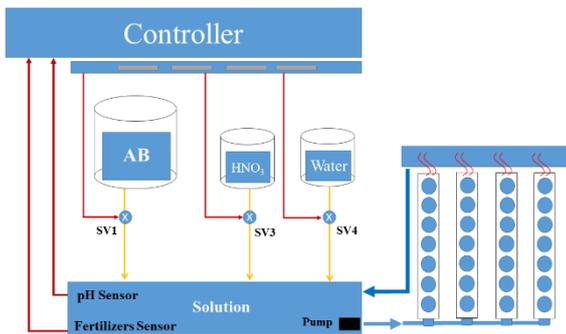


Fig. 1: photo of the designation for the control system of fertility value and pH value

Controlling Device	Working Conditions
Solenoid Valve SV1 Container Fertilizer AB, Concentration of 5%	On : AB is below standard value Off : The value is higher or equal to standard
Solenoid Valve SV2 Nitric Acid Container 5%	On : pH is more than or equal to standard Off : pH is less than or equal to standard
Solenoid Valve SV5 Tap Water Container or Plain Water with pH around 7	On : pH is lower than standard Off : pH is higher than standard

Table 1 Conditions of controlling procedures for fertility value and pH value which function automatically



Fig. 2 : Picture of the designation of outcome screen system and the system that has been created

For the measurement of fertility and pH value by the use of censoring of fertility and pH measurement in soil, the values are taken for measurement of dissolution where the experiment is divided into two parts. The experiment is carried out by using dissolution hydroponics AB with a concentration of 1: 200, Easy Plants brand, In 1 liter of water. The signal from the sensor will be transmitted in the form of electric conductivity from the device which measures the value of electric conductivity (Fig. 3).



Fig. 3 : Dissolution B the censor measurement for fertility and pH value

The experiment methods are as follows:

**Experiment 1:** measure the value of electrical conductivity in this solution AB from use of the sensor for fertility and pH value by adding dissolution A, total one cc in 1 L of water, then add dissolution B total 1 cc each time, from the volume of 1 cc to 10 cc then measure the electric conductivity value through sensor in comparison with equipment for every ratio of dissolution.

**Experiment 2:** measure the value of electrical conductivity in this solution AB from use of the sensor for fertility and pH value by adding dissolution B, total one cc in 1 L of water, then add dissolution B A total 1 cc each time, from the volume of 1 cc to 10 cc then measure the electric conductivity value through sensor in comparison with equipment for every ratio of dissolution.

## 3. Experiment Outcomes and Analysis

From the study of using censor in measuring fertility and pH value by comparing with the equipment for measurement of dissolution AB as per Table 2 and Table 3, which have details as follows:

Fertilizer A:B	Fertilizer (mV)	Fertilizer (us/cm)	pH (mV)	pH
1 : 1	120	56	44	7.21
1 : 2	118	67	45	6.95
1 : 3	115	78	47	6.87
1 : 4	110	88	49	6.77
1 : 5	108	95	50	6.74
1 : 6	102	106	52	6.66
1 : 7	100	113	54	6.62
1 : 8	98	122	55	6.58
1 : 9	95	130	57	6.61
1 : 10	90	135	58	6.52

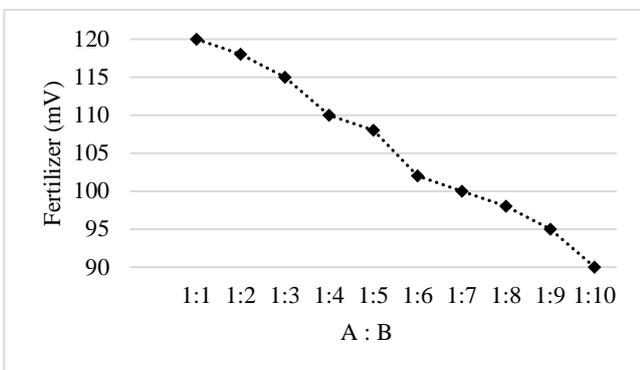
**Table 2** Voltage values from experiment 1, the proportion of solution A is constant and add solution B.

Fertilizer B:A	Fertilizer (mV)	Fertilizer (us/cm)	pH (mV)	pH
1 : 1	131	41	43	7.22
1 : 2	125	53	45	7.03
1 : 3	120	64	48	6.95
1 : 4	116	78	49	6.98
1 : 5	113	87	51	6.98
1 : 6	106	99	53	6.97
1 : 7	102	111	55	7.03
1 : 8	100	118	57	7.03
1 : 9	98	133	58	7.05
1 : 10	96	138	60	7.03

**Table 3** Voltage value from Experiment 1, ratio of dissolution B is stable while adding dissolution A

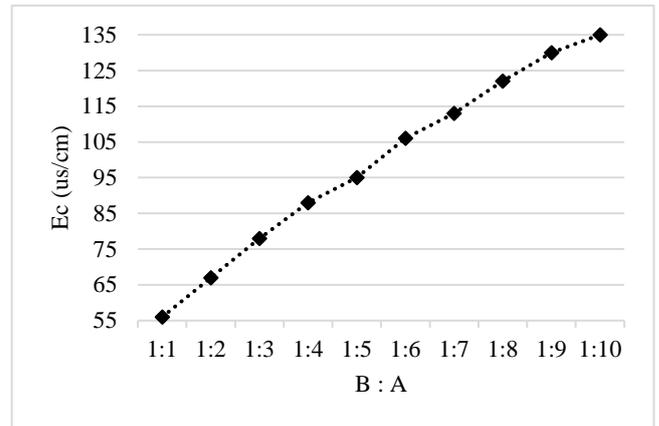
**Fertility Values**

From the study of for fertility value using the sensor in the solution using measuring electric conductivity by adding the concentration of dissolution B volume 1 cc. Finding suggests that when adding dissolution be at a higher level of concentration, electric conductivity decreases whereas the maximum electrical conductivity value equals 120 Milli Volts at the proportion of 1:1 and lowest electric conductivity value equals 90 Milli Volts at proportion 1:10.



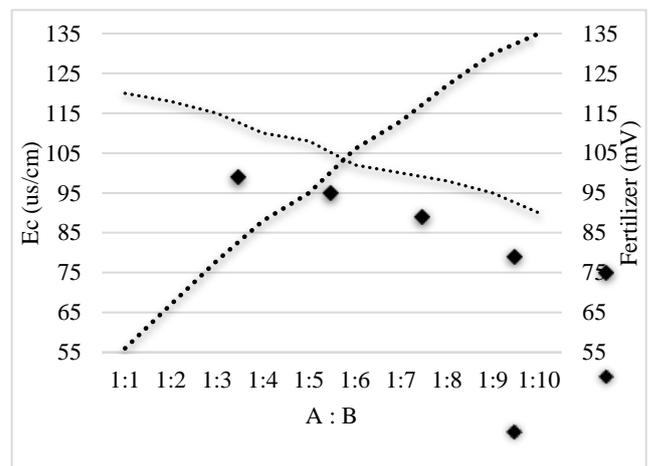
**Fig. 4 :** The electric voltage value of dissolution AB where the proportion of dissolution A is stable

From the study of electrical conductivity value in the solution by measuring the degree of electrical conductivity from adding the level of concentration of solution B, volume 1cc. Finding suggests that when adding dissolution be at a higher level of concentration, electric conductivity increases whereas the maximum electrical conductivity value equals 41 micro cement per square meter at the proportion of 1:1 and lowest electric conductivity value equals 138 micro cement per square at proportion 1:10.



**Fig. 5 :** Electric conductivity value of dissolution AB where proportion of dissolution A is stable

From the study of for fertility value using sensor in comparison with equipment used to measure electric conductivity by adding a level of concentration of dissolution B, volume 1 cc. Finding suggests that when adding dissolution B at a higher level of concentration, the electric voltage tends to decrease and electric conductivity has a tendency to increase.



**Fig. 6 :** the comparison made between electric voltage value and electric conductivity value measured from dissolution AB

From the study of for fertility value using the sensor in the solution using measuring electric voltage by adding the concentration of dissolution A volume 1 cc. Finding suggests that when adding dissolution B at a higher level of concentration, electric voltage decreases whereas the maximum electrical voltage

value equals 131 Milli Volts at the proportion of 1:1 and lowest electric voltage value equals 96 Milli Volts at proportion 1:10 respectively as per Fig. 7.

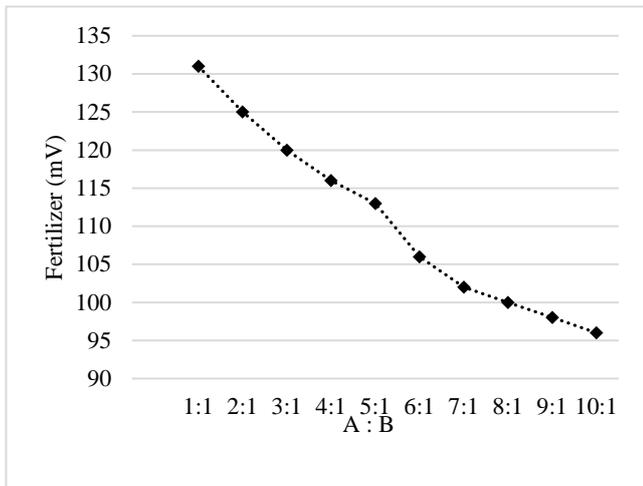


Fig. 7 : electric voltage value measured from dissolution AB with the ratio of dissolution B being stable

From the study of fertility value in dissolution through measuring electric voltage by adding the concentration of dissolution A volume 1 cc, it is found that by adding dissolution A at a higher level of concentration, the value of electric voltage will also increase respectively. The lowest value for electric conductivity equals 41 micro siemens per square meters at a dissolving proportion of 1:1 and the highest conductivity value equal to 138 micro siemens per square meters at a dissolving proportion of 10:1 respectively as per Fig. 8.

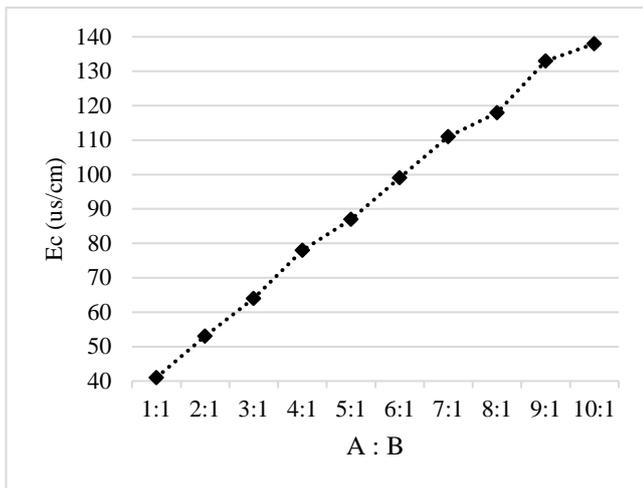


Fig. 8 : conductivity value measured from dissolution AB with the ratio of dissolution B being stable

From the study of fertility value in dissolution through measuring electric conductivity by adding the concentration of dissolution A volume 1 cc, it is found that by adding dissolution A at a higher level of concentration, the value of electric voltage will also decrease respectively as per Fig. 9.

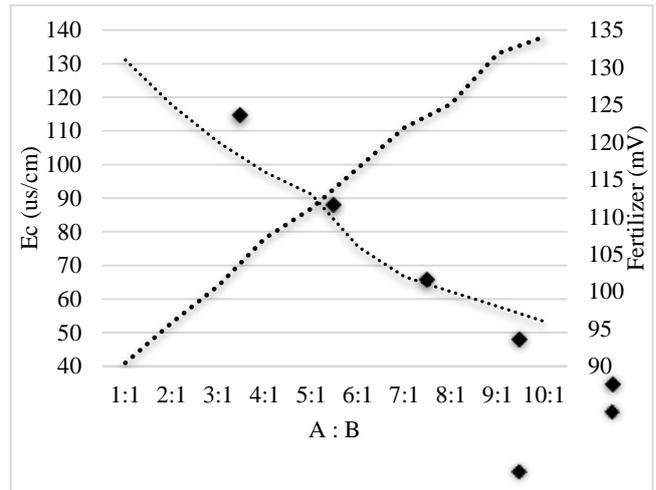


Fig. 9: the comparison made between electric voltage value and electric conductivity value measured from dissolution AB with a ration of dissolution B being stable pH value

From the study of pH value in dissolution through measuring electric voltage by adding the concentration of dissolution B volume 1 cc, it is found that by adding dissolution B at a higher level of concentration, the value of electric voltage will also increase respectively. The highest value for electric voltage equals 58 millivolts at a dissolving proportion of 1:1. The lowest value for electric voltage equal to 58 millivolts at a dissolving proportion of 1:1 as per Fig. 10.

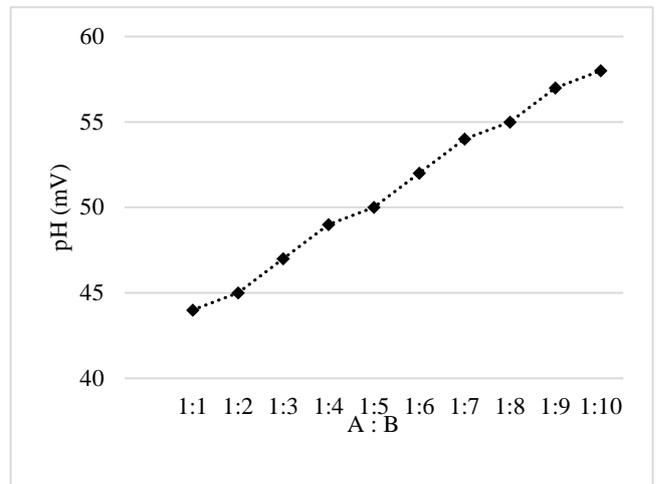


Fig. 10 : voltage value measured from dissolution AB with the ratio of dissolution A being stable

From the study of pH value in dissolution through measuring electric voltage by adding the concentration of dissolution B volume 1 cc, it is found that by adding dissolution B at a higher level of concentration, the value of pH will also decrease respectively. The highest value for pH is 7.21 at a dissolving proportion of 1:1. The lowest pH value equals 6.52 at a dissolving proportion of 1:10 as per Fig. 11.

From the study of pH value in dissolution through measuring electric voltage by adding concentration of dissolution B volume 1 cc, it is found that by adding dissolution B at higher level of

concentration, the value of pH will also decrease respectively. The highest value for pH is 7.21 at dissolving proportion of 1:1. The lowest pH value equals 6.52 at dissolving proportion of 1:10 as per Fig. 11.

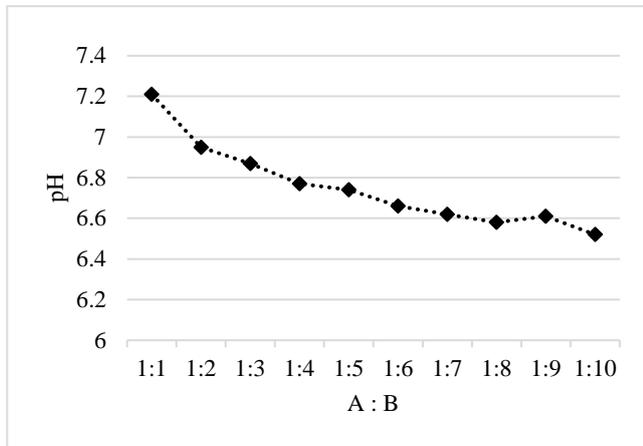


Fig. 11 : pH value measured from dissolution AB with the ratio of dissolution A being stable

From the study of censored pH value compared with pH value measure by equipment in dissolution by adding the concentration of dissolution B volume 1 cc, it is found that by adding dissolution B at a higher level of concentration, the value of electric voltage will increase and pH value will increase as well respectively as per Fig. 12.

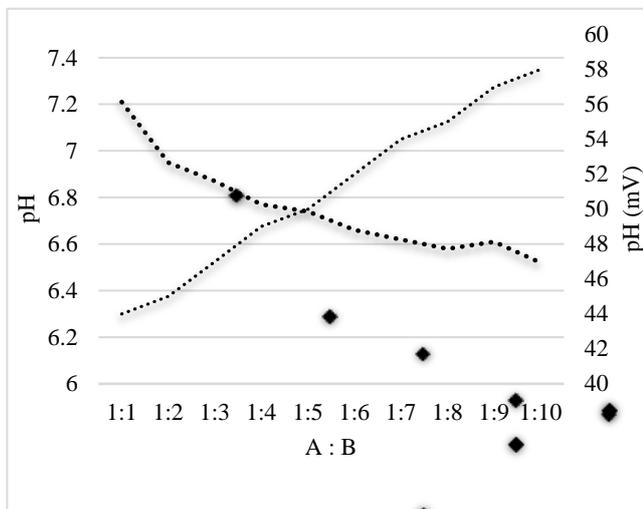


Fig. 12 : presents comparison made between voltage value and pH value measured in dissolution AB with a concentration of dissolution A being stable

From the study of censored pH through measuring electric voltage by adding the concentration of dissolution A volume 1 cc, it is found that by adding dissolution A at a higher level of concentration, the value of electric voltage will also increase respectively. The highest value for electric voltage equals 60 millivolts at a dissolving proportion of 1:1. The lowest value for electric voltage equal to 43 millivolts at a dissolving proportion of 1:1 as per Fig. 13.

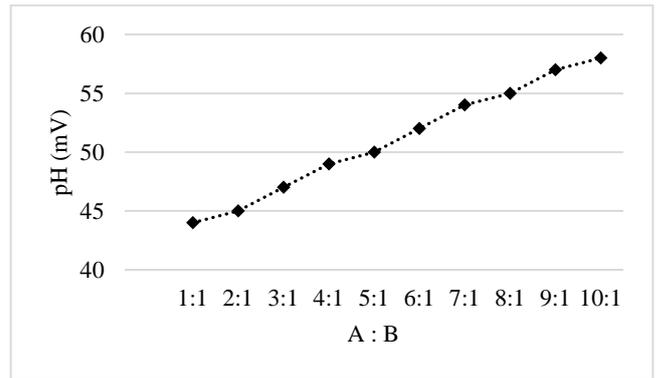


Fig. 13 : voltage value measured from dissolution AB with ratio of dissolution being stable

From the study of pH value measured by the device in dissolution by adding the concentration of dissolution A volume 1 cc, it is found that by adding dissolution A at a higher level of concentration, the value of pH will also increase respectively. The highest value for pH is 7.22 at the dissolving proportion of 1:1. The lowest pH value equals 6.9 at a dissolving proportion of 1:10 as per Fig. 14.

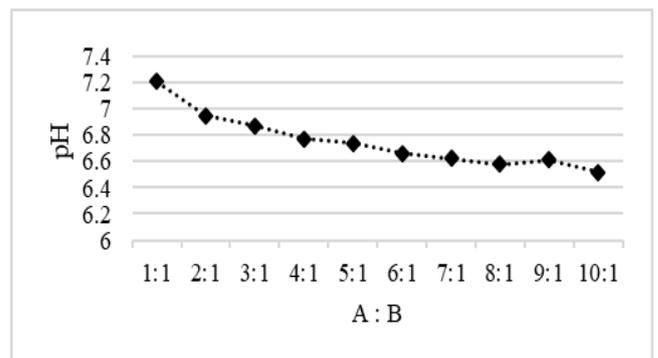


Fig. 14 : pH value measured from dissolution AB with ratio of dissolution B being stable

From the study of censored pH value compared with pH value measured by equipment in dissolution by adding the concentration of dissolution A volume 1 cc, it is found that by adding dissolution A at a higher level of concentration, the value of electric voltage will increase and pH value will decrease as well respectively as per Fig. 15.

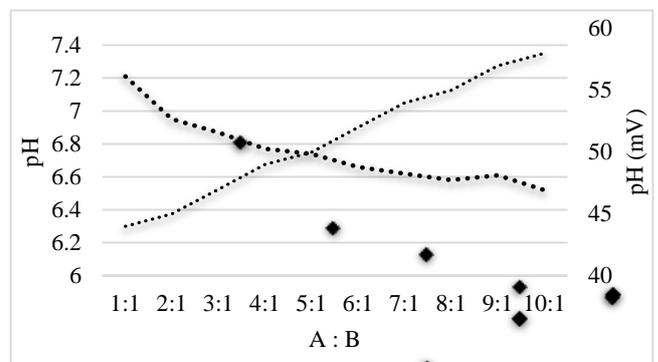


Fig. 15 : comparison made between voltage value and pH value measured in dissolution AB with concentration of dissolution B being stable

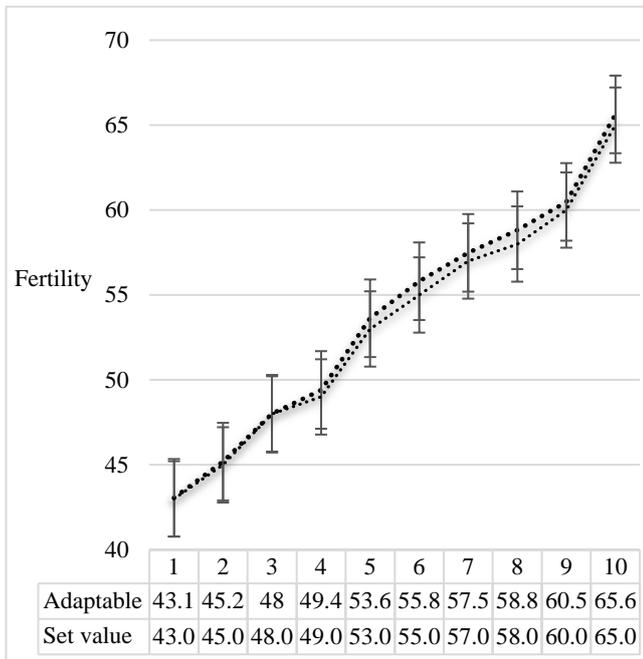
**Functioning of system which has been created**

Testing of systematic functioning by evaluation of fertility and pH set of total 10 times, it is found that when the sensor is not capable of reading values by the set conditions, the solenoid valve will emit dissolution inside the container until the adaptation of condition is complete as a set standard. This is shown in Table 3.

Time	Set value for fertility	Adaptable Value for fertility	Set value for pH	Adaptable value for pH
1	43	43.06	7.00	7.29
2	45	45.19	6.00	6.10
3	48	48.01	4.50	7.14
4	49	49.41	7.00	6.86
5	53	53.63	7.00	6.85
6	55	55.81	6.00	6.29
7	57	57.48	6.00	6.19
8	58	58.81	6.50	6.25
9	60	60.48	7.00	7.16
10	65	65.63	6.00	5.87

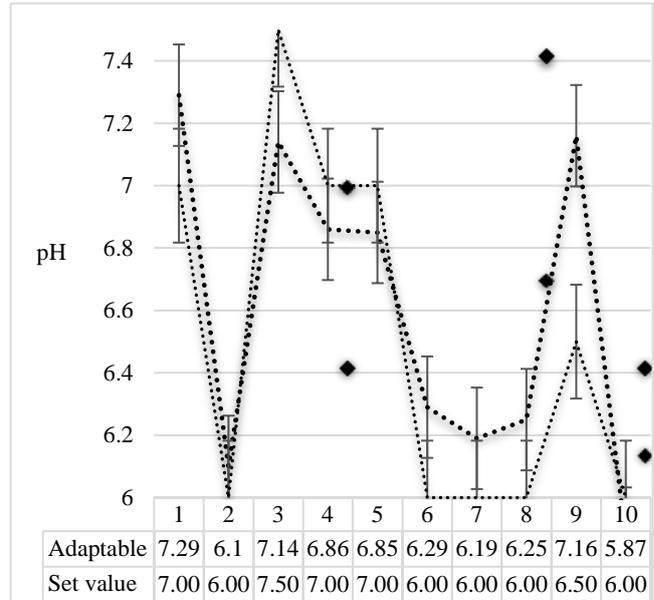
**Table 4** The experiment of controlling system for fertility and pH value, with set type

From Fig. 16, it suggests that the function of the controlling system for fertility by the set up made at the system of 10 times for automatic responsive operation. It is found that the established system can function as per prerequisite conditions.



**Fig. 16 :** the setup fertility value in comparison with the actual adaptable fertility value

Fig. 17 shows that The operation of the pH system by the set up made that the system of 10 times for automatic responsive operation. It is followed that the established system can function as per pre-requisite conditions.



**Fig. 17 :** the setup pH value in comparison with the actual adaptable pH value

**4. Conclusion**

Plantation by the method of hydroponics is the procedure of growing vegetables which relies on the control quality of dissolution. The quality values include electric conductivity, pH value, and temperature which count on active components receptors that use energy to stimulate the functioning of data input into the controlling system. The applied method for using sensor to measure fertility value and pH value in soils, which is considered receptors as passive components, to measure fertility value and pH value of dissolution. Signals obtained from sensors are used to construct a control system for fertility and pH value for growing plants through the Hydroponics method in the most optimal way. The results of this study could be applied for developing soil nutrient sensors in electrical conductivity and pH level measurement of the water solution in the hydroponics system.

**Acknowledgement**

Plantation by the method of hydroponics is the procedure of growing vegetables which relies on the control quality of dissolution. The quality The authors would like to extend my sincere thanks to dad, mom, teachers, and those providing data to support this study and for making this work possible and The Faculty of Engineering, Mahasarakham University, Thailand, for the experimental equipment and the technical supports.

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## Biographies



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