IOP Conference Series: Earth and Environmental Science

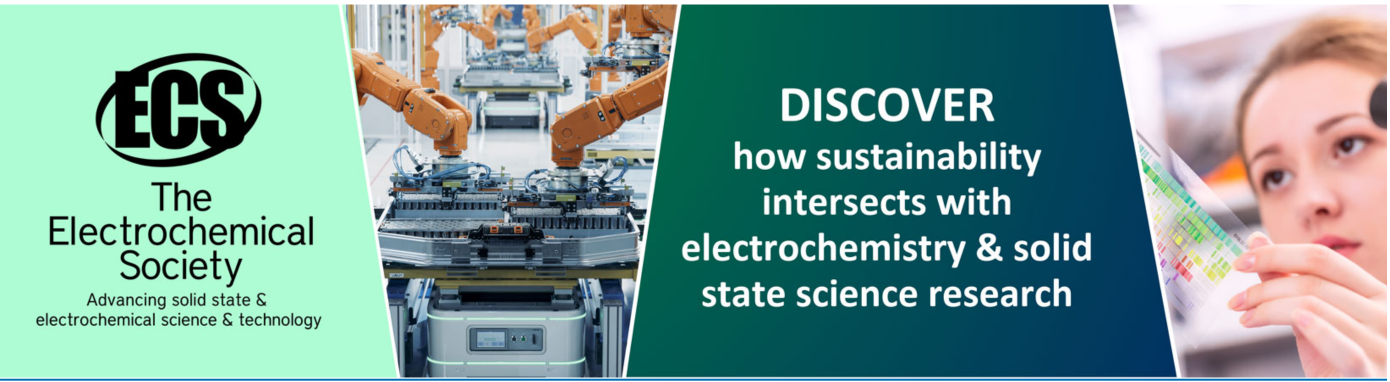
**PAPER** • **OPEN ACCESS**

# Internet of things: automatic sprinklers in prototyping greenhouse using smartphone based android

To cite this article: I S Nasution *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **425** 012069







IOP Conf. Series: Earth and Environmental Science **425** (2020) 012069 doi:10.1088/1755-1315/425/1/012069

# Internet of things: automatic sprinklers in prototyping greenhouse using smartphone based android

**I S Nasution[1]*, M R Iskandar[1], D S Jayanti[1]**

[1]Agricultural Engineering Department, Universitas Syiah Kuala, Jalan Tgk. Hasan Krueng Kalee No.3, Darussalam-Banda Aceh 23111, Indonesia

*Corresponding author's email: i.nasution@unsyiah.ac.id

**Abstract**. Automatic sprinklers using a soil moisture sensor is formed based on microcontroller technology.The hard- and software system were designed to adapt the greenhouse prototype. The sensors were calibrated by comparing the value with the standard instruments. Observations were conducted on the kale seedsand it monitored for seven days. Based on the observation result, the sensorsable tomeasure temperature, humidity, light intensity, and soil moisture in the greenhouse. The automatic sprinkle pumped the water according to the values of soil moisture sensor. The values of those sensors have been delivered to webserver and android application. Moreover, the system is able to grow the kale plant in the greenhouseprototypevery well.

## 1. Introduction

Automatic sprinklers using a soil moisture sensor is designed based on Arduino microcontroller technology [1]. The microcontroller board uses AVR ATmega328 and it has fourteen digital input/output and six analog inputs pins.Research on prototype automatic sprinklers in Indonesia has been widely carried out, such as the design of plant irrigation systems using soil moisture sensors [2], but has not yet utilized the internet of things in their research. Internet of things (IoT) is a particular object concept that can transfer data over a network without requiring human-to-human interactions or humans to computer or smartphone devices. The prototype of the automatic sprinklers with ATmega 328based soil moisture sensor has been studied [3], but not all prototype of the automatic sprinklers can be monitored and controlled remotely.

This research focuses on plant that can be monitored and controlled anywhere and anytime without taking a lot of time using a smartphone. The smartphone installed with a special application to control or to monitor the situation surroundingthe plants. In order to have a communication between microcontrollers and smartphones,smart android application based on the internet of things (IoT)should be applied. The research aims to investigate the prototype of an automatic sprinkler in the greenhouse based on the internet of things andandroidapplication on Kale plant (*Ipomoea reptans* P.).

## 2. Materials and Methods

### 2.1. Materials

Some sensors and electronic devices were employed, such as: Arduino Uno, YL-69 for soil moisture sensor, DHT22 for temperature and humidity sensor, BH1750 for light intensity sensor, NodeMCU ESP8266 12E, relay module, water pump, light emitting diode (LED), jumper cable, breadboard, lux meter (Voltcraft, Germany), digital thermometer (Chino, India), digital humidity meter (Chino, India), soil tester (Demetra, Japan), water container, plastic tray, sprayer nozzle, a 12V adapter, and the Virtuino application. Kale seeds (*Ipomoea reptans* P.) were utilized to grow in the greenhouse prototype.

### 2.2. Methods

*2.2.1. Design of Automatic Sprinklers.* Hardware and software devices were installed consisting of YL-69 type soil moisture sensor, DHT22 type of temperature andair humidity sensor, and BH1750 light intensity sensor. Microcontroller Arduino Uno was used to control the sensor using wifi and internet connection which connected to the ThingSpeak (the internet of thingsplatform).The NodeMCUESP8266module was applied as a wifi client that is connected to the webserver (ThingSpeak). The sensor readingswill send the data via the webserver platform to the smartphones using Virtuino application (figure 1).

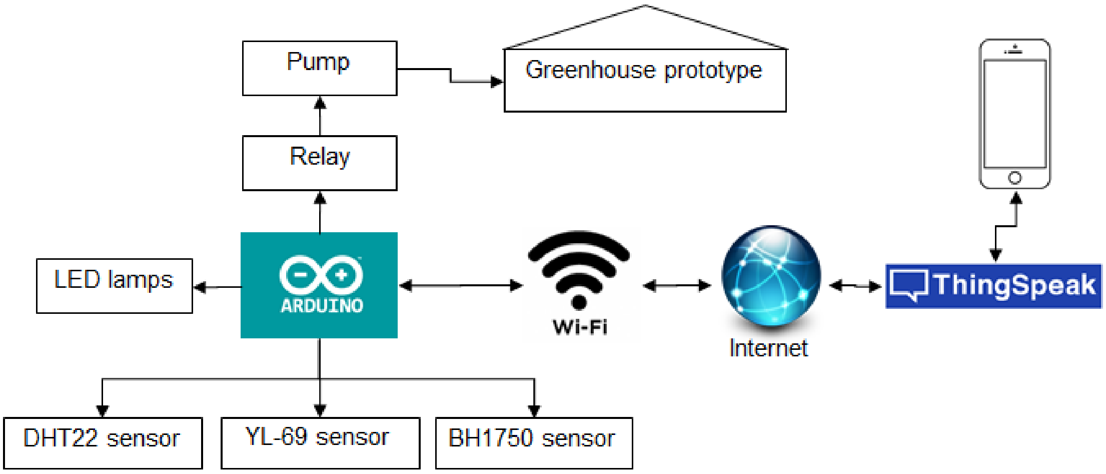



**Figure 1.** Block diagram

*2.2.2. Algorithm*. The present study used some inputs/outputs of Arduino Uno for collecting data from three sensors, such as: DHT22 sensor, YL-69 sensor, and BH1750 sensor. The algorithm for LED lamp was set according to the intensity value.If the light intensity values less than a set point value,then the LED lamp is on, otherwise the LED lamp is off. Likewise for the water pump, the output sensor of soil moisture was used to trigger the water pump based on a set point.The proposed algorithm of this study describes in figure 2. The Arduino IDE provides a simplified integrated platform which allow user to write programs using C or C++.Two data acquisition system were performed, particularly parallax data acquisition tool (PLX-DAQ) software free add-in for Microsoft Excel and sensors value via internet using ThingSpeakIoT server and Virtuinoandroid application. Both systems were compared to check the similarity results.

In order to check the successful of using theset pointon the proposed algorithm, different set points for light intensity and soil moisture values were tested. The LED lamp and water pump were tested to identifywhether the algorithm running well or not.

*2.2.3. Sensorstesting.* The sensors (i.e. DHT22, YL-69, and BH1750) were tested by comparing the accuracy of the sensor with a standard measuring instrument.The relationship between sensor and standard instrument was plotted into a linear regression in order to find the accuracy of the sensors.

*2.2.4.Observations ofkale seeds.* The proposed system then applied on kale seeds in the greenhouse prototype. The observations on kale seeds (*Ipomoea reptans* P.) were carried out for seven days by measuring visually the height, the number of leaves and the number of branches. All measurements conducted manually by operator.

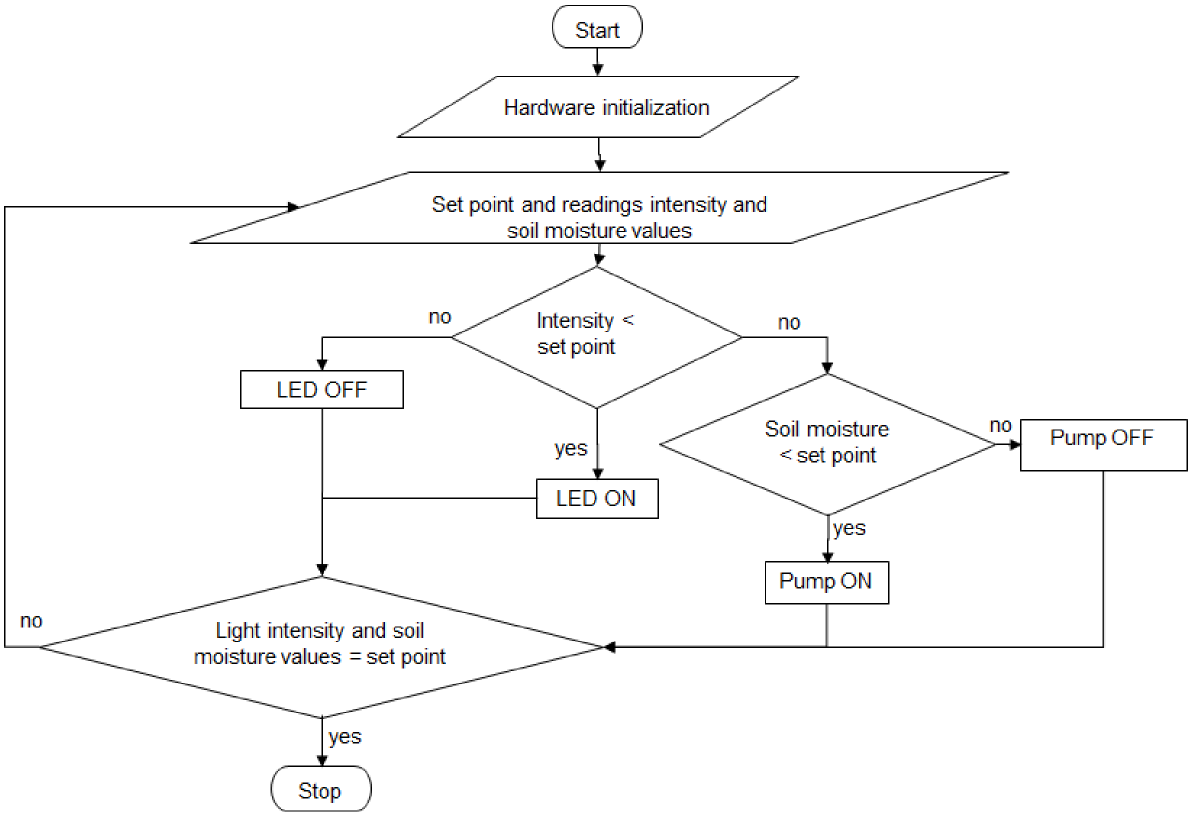



**Figure 2.** Flow chart of set point and control system

## 3. Results and Discussion

### *3.1. Implementation of Automatic Sprinklers for Greenhouse*

*3.1.1. Greenhouse Prototype*. The main construction implementation is the greenhouse prototype which is made from wooden blocks that has the dimension of 60 cm (height) × 60 cm (width) × 60 cm (length), and PVC plastic 0.5 mm in size (figure 3). The automatic sprinklers circuit is arranged on a bread board connected to the Arduino Uno board and placedin a box (figure 4).

**Figure 3.** Greenhouse prototype construction

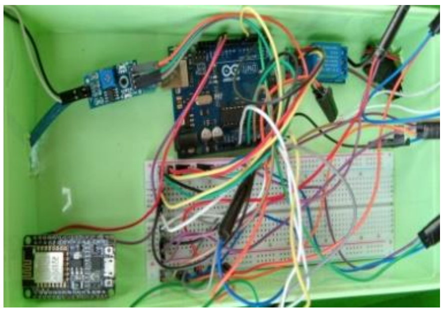


**Figure 4.** Implementation of the automatic sprinklers components

*3.1.2. Arduino Uno sketch*. Arduino Uno programming implementation in this case by entering the sketch to run the automatic sprinkler and send the sensor data to the ThingSpeak.

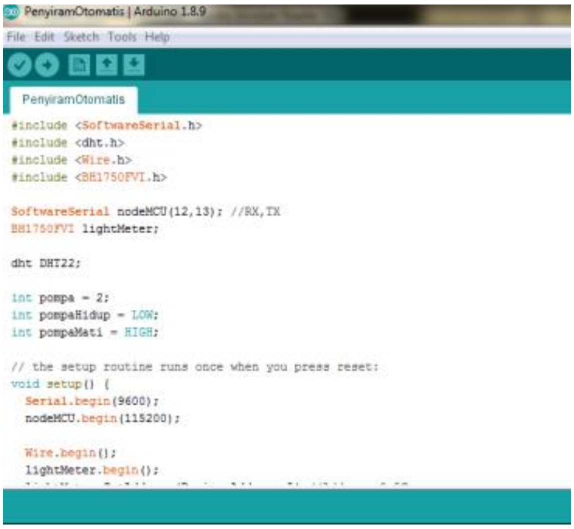



**Figure 5.** Implementation of automatic sprinklers algorithms on Arduino IDE

*3.1.3. ThingSpeak Platform*. The implementation of ThingSpeak begins by creating an account first, then proceed with creating a new channel to get the channel ID and API (Application Programming Interface)keys. Some field charts were created according to number of sensors required, in this study 4 charts are used (figure 6), such asfield 1 chart (light intensity), field 2 chart (temperature), field 3 chart (humidity), and field 4 chart (soil moisture). The charts continuously are updating the values in accordance with sensors measurement processes.

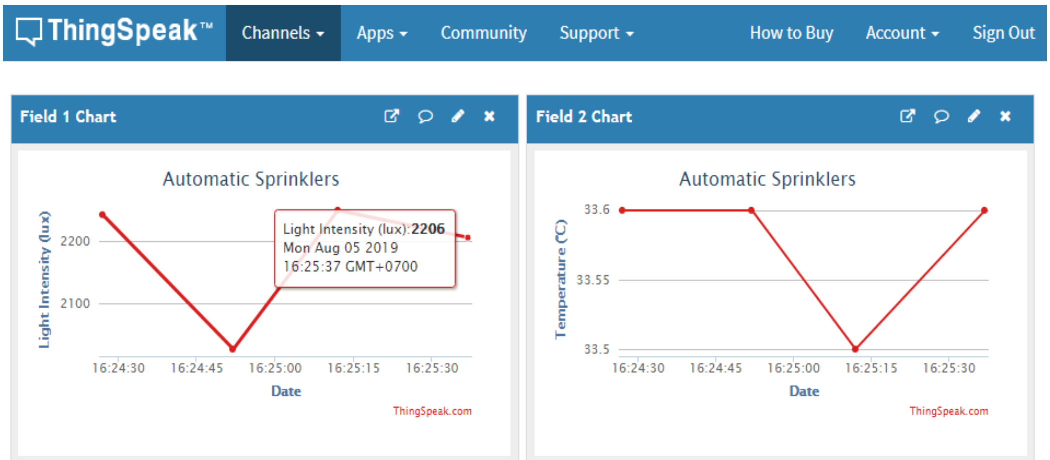



**Figure 6.**Implementation of ThingSpeak on sensors measurement in the greenhouse

*3.1.4. Implementation of Smartphones Using the Virtuino Application (app)*. Virtuino app able to monitor the conditions of the plants by using android platform. This platform stores the data which can be analyzed and generated as graphs on the webpage. The thingspeak platform also shares their data to theVirtuino App to monitor the sensor data remotely. Figure 7 shows the result of measurement between Virtuino app and standard instrument.

**Figure 7.**Measurement betweenVirtuino appand standard instrument

### *3.2. Set Point Evaluation*

Table 1 shows the condition of greenhouse when set point of light intensity is set. If the reading sensor less than set pointcause the LED lamp to turn on,otherwise the LED lamp to turn off. Table 2also describes the results of the soil moisture sensor after set point. According to the Table 1 and 2, the system has been running well according to its function.

**Table 1.** Testing of light intensity sensor

| Condition | *Set Point* Light Intensity (Lux) | Testing (Lux) | Information | Results |
|---|---|---|---|---|
| Dark Room | 30 | 27 | LED "ON" | Correct |
| | | 137 | LED"OFF" | Correct |

**Table 2.** Testing of soil moisture sensor

| Soil Conditions | Set Point of soilmoisture (%) | Testing (%) | Information | Results |
|---|---|---|---|---|
| Dry - slightly moist | 10 | 8 | Pump "ON" | Correct |
| | | 85 | Pump "OFF" | Correct |
| | 15 | 12 | Pump "ON" | Correct |
| | | 75 | Pump "OFF" | Correct |
| | 25 | 19 | Pump "ON" | Correct |
| | | 63 | Pump "OFF" | Correct |

### *3.3. Sensorstesting*

*3.3.1. Soil Moisture Sensor.* The x-axis is the output value of the YL-69 sensor and y-axis is the soil tester soil moisture value. The coefficient determination is 0.986. This value shown good correlation between the sensor and soil tester (Figure 8).

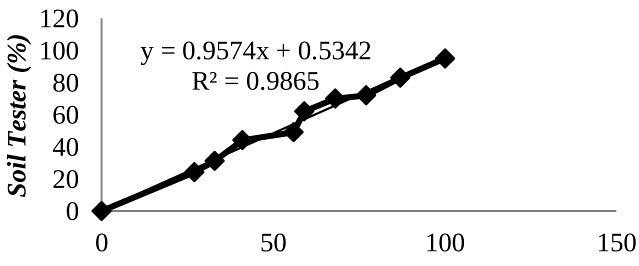



**Figure 8.** Correlation of soil moisture sensor YL-69 with soil tester

*3.3.2. Correlation of Temperature Sensor.* The x-axis is the output value of the DHT22 sensor and y-axis is the temperature value of digital thermometer. This result shows good correlation (Figure 9).

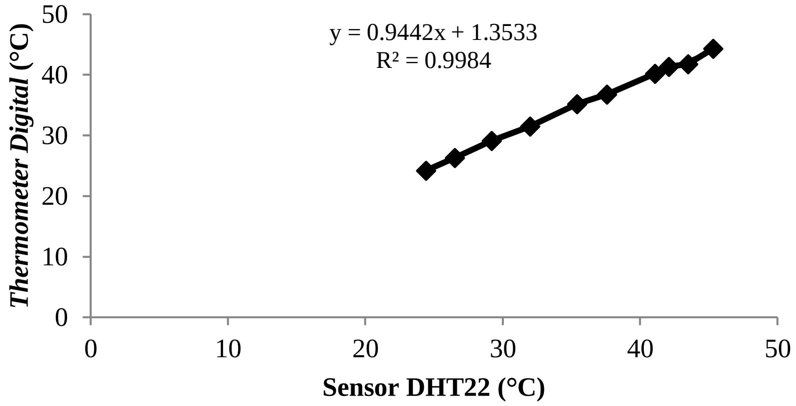



**Figure 9.** Correlation of Temperature Sensor DHT22 vs Digital Thermometer

*3.3.3. Correlation of Light Intensity Sensor.* The correlation between light intensity sensor and lux meter shows strong correlation (Figure 10).

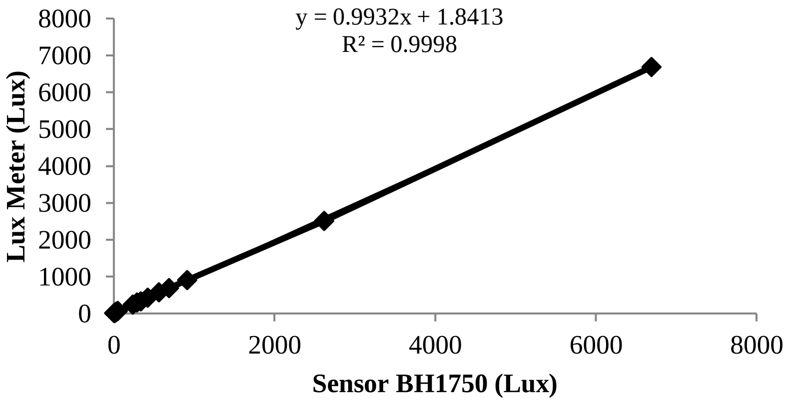



**Figure 10.** Correlation of light intensity sensors vslux meters

*3.4. Application of Automatic Sprinklers on Kale Plants*

The height of plants, number of branches, and number of leaves can be seen in Figures 11, 12 and 13. Height, number of leaves, and number of branches in kale seeds are related to water availability in plants. Lack of water is a limiting factor for plant growth. Water serve as an enzymatic reaction medium that plays a role in photosynthesis, maintaining cell turgidity, humidity, maintaining soil temperature, so plants can grow optimally [4].

Based on Figure 11, it can be explained that the seeds of kale plants can grow well. Increased of height of a plant is the result of the growth of plant stem organs [5]. The greenhouse system able to maintain the environment which affected to increase the plant height and number of leaves [6].

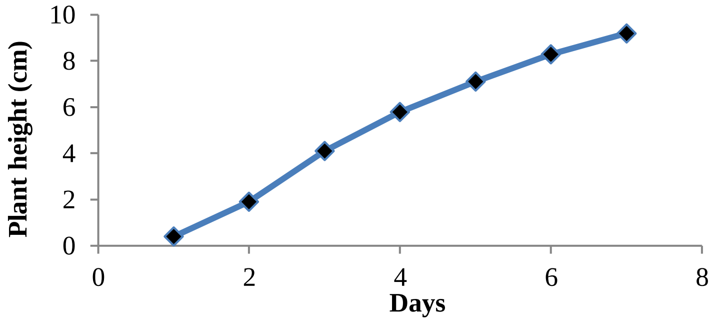



**Figure 11.** Heightof kale seedlings (*Ipomoea reptans* P.)

Based on Figure 12, it can be seen in the graph that the seeds of kale grow daily with the number of leaves that appear on the second day of observation.Figure 13 shows the seeds of kale experienced branch growth with the number of branches that appeared on the third day of observation. The number of leaves is very closely related to the number of branches, whichit increases the number of branches and leaves every days [7].

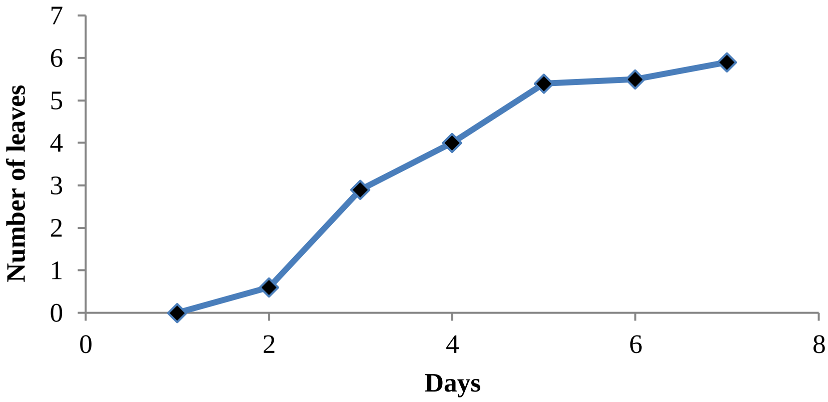



**Figure 12.** Number of leaves of kaleseedlings (*Ipomoea reptans* P.)

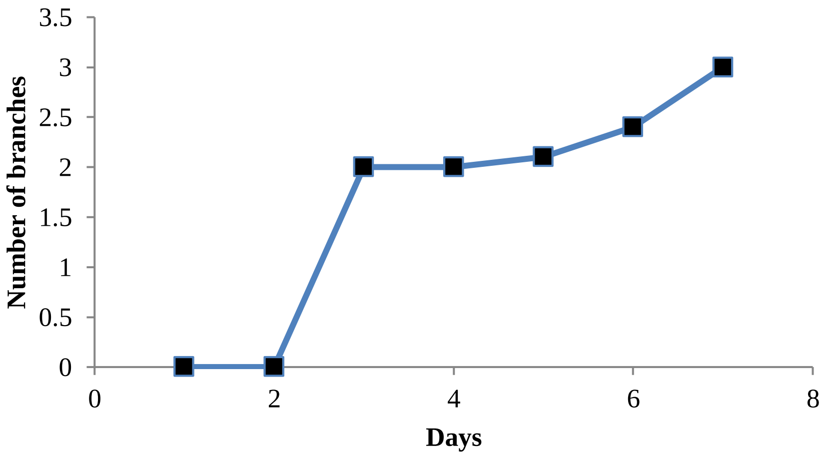



**Figure 13.** Number of branches of kale seedlings (*Ipomoea reptans* P.)

## 4. Conclusions

A system of automatic sprinklers inside the prototype greenhouse running well according to its function. The system can detect temperature, humidity, light intensity, and soil moisture and also perform watering according to the desired soil moisture level. The result of those sensors have been successfully delivered to ThingSpeak and Virtuino. The results of the kale observation in the nursery phase can grow well in the greenhouseprototype.

## References

[1] Gunawan M S 2018 *Journal of Electrical Technology* **3** 13-17
[2] Dani A and Aldila 2017 *Jurnal Teknologi Elektro* **8** 151-155
[3] Bachri A and E W Santoso 2017 *Jurnal Teknik Elektro* **2** 5-10
[4] Junaedi 2009 *Pertumbuhan dan mutu fisik bibit jabon (Anthocephalus cadamba) di polibag dan politub* (Riau: Balai Penelitian Hutan Penghasil Serat Knok)
[5] Irawati Z S 2013 *Jurnal Bioedukatika* **1** 3-14
[6] Wibowo H Y and Sitawati 2017 *Journal of Agricultural Science* **2** 148-154
[7] Yanni R 2012 Pengaruh pemberian berbagai dosis pupuk kandang ayam dan sapi terhadap pertumbuhan tanaman kangkung darat (*Ipomoea reptans* Poir) pada dua musim. Skripsi. Universitas Islam Negeri Sultan Syarif Kasim Riau. Riau.