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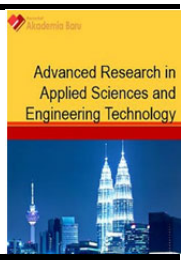


# Sensor Application for Soil Treatment and Behaviour

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**ABSTRACT**

In Malaysia, it is estimated that almost 80 percent of the world's population today used palm oil in their daily lives. Malaysia is the second country exporting palm oil, about 39 percent of world palm oil output. Besides that, Malaysia also recorded about 44 per cent of world exports, making the palm industry very important for countries other than rubber and cocoa. However, to keep the palm industry running smoothly and constantly, there are many challenges to face. One is to maintain soil fertility because the soil can affect the growth of oil palm trees. With the use of this system, it will show the condition of soil behaviour to the farmer about the treatment given. Arduino board is used in this project which it is programmed to calculate and display the level of soil condition by using temperature sensor and soil moisture sensors as an input. This sensor will detect the level of soil moisture and temperature and it is easier for farmers to monitor the soil conditions. Controlled soil conditions can improve the soil's ability to maintain the fertility of palm trees and help plant growth suit to the weather and local climate.

***Keywords:***
Moisture behaviour, temperature behaviour, peat soil, red podzolic soil



## 1. Introduction

Soil fertility plays a crucial role to keep the palm oil industry running smoothly and constantly because the soil can affect the growth of oil palm trees. The important factors to ensure soil in good condition is the level of soil moisture and temperature that required by the plant. This project is a designed system that deals with various environmental factors, using sensors like temperature sensor and soil moisture sensor the data are collected and received by an Arduino which linked to a software which show the real time values along with the standard values of different factor required by a soil. This allows user to know about the standard values which would help the farmer to grow a quality plant. Studies conducted on prototype suggested the designed system to be

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applicable which can be implemented. The major advantages of the project include avoidance from water wastage, growth plants to their maximum potential and less chances of error.

The management of oil palm plantations should consider many criteria and implemented by the farmer. This also explains that the use of information and technologies have a positive effect on the process of managing a more improved and efficient start of the selection of soil which is peat soil to harvesting [1]. Numerous research has been done in agricultural sector, yet there are a few journals and articles that have the likenesses idea and thought as the present title, however the information still in small-scale and insufficient. The method used more than two types of soil samples with one condition which is to maintain the structure of the soil, it needs control soil moisture to minimize the error [2]. The oil palm tree soil, which is red podzolic and peat soil in the range of the temperature behaviour within 18°C until 32.2°C [3]. However, both of the peat and red podzolic soil were having different value of moisture behaviour content, which is 24% to 66% [4] and 46% to 100% [5].

A good soil characteristic that suitable for agriculture and plantation soil that contain many organic elements, potential of hydrogen less than seven, soil does not harden after planting is planted, has a high moisture in the dry season and there is no overlay. The characteristics of the soil can be detected through soil temperature, texture, surface roughness and shape and features of the surface of the earth. Soil reacts and associated with harmful natural processes such as high rainfall, waste streams and landslides directly connected to soil moisture dynamics [6]. Based on previous studies, there are new ways to describe the structure of the soil, less fractal soil features can be judged more appropriately and competent [7].

Soil has the ability to store and give nutrients to plants and affect the growth of plants. The plant will absorb the nutrients through the osmotic process [8]. Nutrient commonly found in the most abundant are carbon (C), hydrogen (H), oxygen (O), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), Phosphorus (F) and nitrogen (N). For the most ideal soil condition for the plant's growing and growing is a neutral soil. However, some types of plants are still tolerant to soil with a slightly acidic pH, is the soil with a maximum pH of five [9]. The result of pH level in United State for corn, wheat, soybeans, oat, barley, alfalfa and timothy (grass). Corn, wheat, soybeans, alfalfa and timothy grass grow at their maximum potential when pH level reaches 6.8 and for the oat, barley and alfalfa the required pH values are 7.5. The study has found that, the range of pH value for alfalfa start from 6.8 to 7.5. Where alfalfa can be grown at a pH level of acid, alkaline and neutral categories [10].

The structure depends on the location or the type of the soil at the chosen land that consist with two layers of soil. For the first layer peat soil is used and for the second layer is alluvial soil or red podzolic soil. The type of soil used in the second layer is usually able to absorb moisture in high quantity and difficult to be influenced by drastic changes in weather conditions. In contrast to the first layer conditions where the moisture of the peat soil can be directly affected when the temperature increases, soil moisture will decrease [11].

## 2. Development Of System

Figure 1, shows the development of the sensor application system for soil treatment and behaviour using two types of different soil as a sample the get the data from the system. LCD displayed the data value after Arduino UNO evaluate the input that had been received from the temperature and moisture sensor from peat soil and red podzolic soil. Figure 2, showed the overall circuit connection between arduino UNO to both types of the sensor and the LCD of the real hardware construction.

**Fig. 1.** Sensor application system for soil treatment and behaviour


**Fig. 2.** Hardware construction of overall circuit connection

*2.1 Testing*

After the software and hardware part had completed, the system was tested as a trial whether it work accurately or not. The moisture and temperature was examined to verify whether it can evaluate the temperature level and moisture level correctly.

*2.1.1 Workflow of project system*

*Step 1: The temperature and moisture level was detected by sensors for signal transmitted on the Arduino UNO circuit.*
*Step 2: The soil was evaluated by Arduino UNO based on the inputs obtained from both types of sensors for two different soil types where the assessment determined whether the soil is in good condition or not.*
*Step 3: Arduino UNO displayed the results on LCD after the assessment based on the inputs obtained.*

*Step 4: The data was displayed, step 1 was repeated until step 4 on the next day continuously.*

*Step 5: Analysis was performed, based on the data obtained from the system generated over a specified period of time.*

## 3. Results and Discussion

*3.1 Analysis of Behaviour Treatment between Peat Soil and Red Podzolic Soil*

The behaviour treatment between peat soil and red podzolic soil was being analyzed through the data that had been collected in 7 days from 8.00 a.m., 12.00 p.m. and 4 p.m. The data between peat soil and red podzolic soil showed the difference behaviour for both type of the soil treatment.

*3.2. Moisture Behaviour between Peat Soil and Red Podzolic Soil*

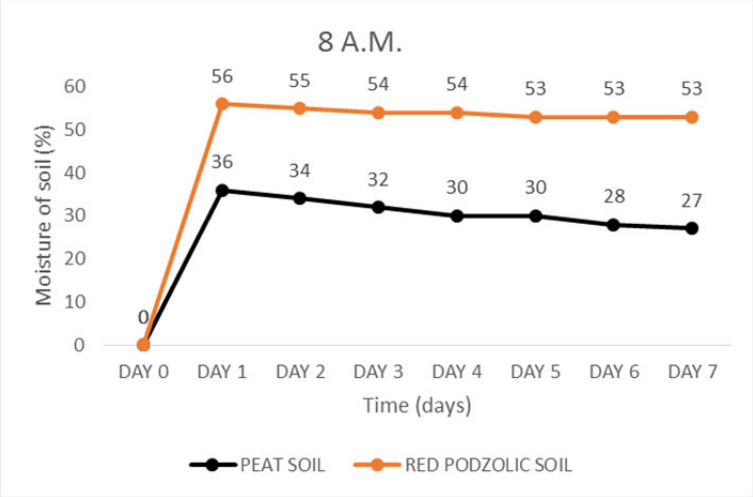


**Fig. 3.** Peat and red podzolic soil moisture level against time (days)

Based on the Figure 3 showed the moisture of peat soil at 8 a.m. decreased linearly from day 1 to day 3 by 2%, maintained at 0% on day 4 and 5, decreased by 2% from day 5 to day 6, and dropped 1% from day 6 to day 7. However, when the peat soil was not having enough water as a

treatment, the drying process occurred faster in the different level of soil behaviour that affected the growth of the plant. As for red podzolic soil, the moisture of soil dropped by 1% from day 1 to day 3, maintain at day 4 and day 5, dropped again at day 4 to day 5 and continuously maintained until day 7.

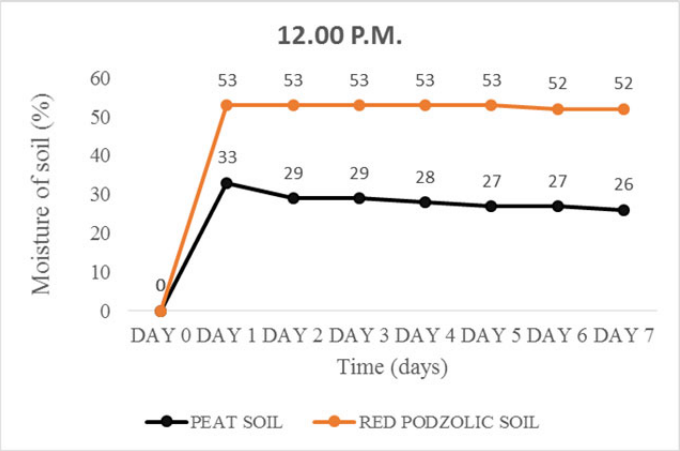


**Fig. 4.** Peat and red podzolic soil moisture level against time (days)

Based on the Figure 4 showed the moisture of peat soil at 12 p.m. decreased 4% from day 1 to day 2, continuously maintained between day 2 to 3 and day 5 to day 6, decreased by 1% from day 3 to day 5, and dropped 1% from day 6 to day 7. However, for the red podzolic soil, the result obtained for moisture of the soil stable from day 1 to day 5, dropped by 1% from day 5 to day 6, and maintained again from day 6 to 7.

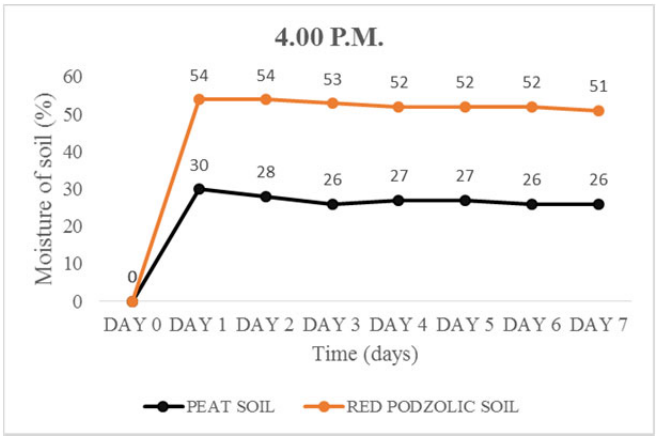


**Fig. 5.** Peat and red podzolic soil moisture level against time (days)

Based on the Figure 5 showed the moisture of peat soil at 4 p.m. decreased linearly by 2% from day 1 to day 3, increased by 1% from day 3 to day 4, and continuously maintained between day 4 to day 5 and day 6 to day 7, decreased by 1% from day 5 to day 6. For the red podzolic soil, the result obtained for moisture of soil stable from day 1 to day 2, dropped linearly from day 1 to day 4 by 1%, the same moisture content of day 4, 5 and 6. Lastly, dropped by 1% from day 6 to day 7.

The analysis of the data that had been collected found that peat soil is a type of soil that is easily affected by its environment where the absorption and drying process is fast. The quantity of

water needed by peat soil is also much higher than the red podzolic soil to maintain its moisture. In contrast to red podzolic soil, the drying process and absorption are quite slow but have high resistance to maintain it moisture. As a result, red podzolic soil is the best soil behaviour for the moisture content because of the several factor which is red pod zolic soil have a slightly faster infiltration than peat soil, ground power is good enough and have good resistance to soil erosion.

The analysis obtained through this project is same to the previous researcher which is the moisture level decreased day by day because of the degradation of the peat in engineered systems, that may cause changes in the moisture over time which affected their. These author investigated the feasibility of using wetland constructed on peat soil for the treatment of nitrate-rich agricultural effluents.

### *4.2.2 Temperature behaviour between peat soil and red podzolic soil*

In the morning, peat soil increasing the temperature linearly from day 1 today, and then dropped by 1 Celsius maintained to the next day until it rises back by 1 Celsius from day 6 to day 7. Next, for the red podzolic soil, the temperature increase slowly and constantly from day 1 to day 7. All the situation shown by figure 6.

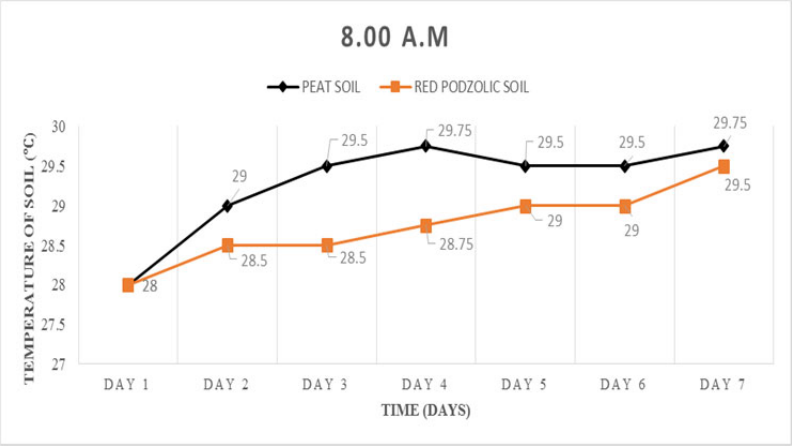


**Fig. 6.** Peat and red podzolic soil temperature level against time (days)

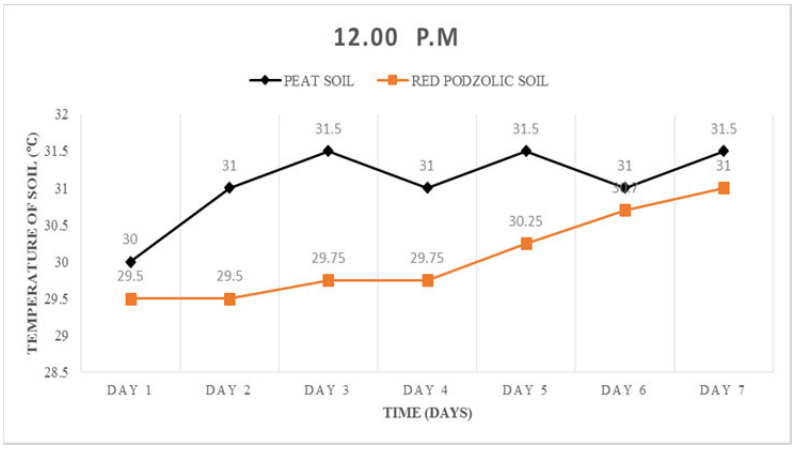


**Fig. 7**. Peat and red podzolic soil temperature level against time (days)

In the noon, the temperature of peat soil rose up by 1.5 Celsius from day 1 to day 3 as shown on figure 7. As for the day 4 to day 5 and day 6 to day 7 rose by 0.5 Celsius. Since the red podzolic soil was stable from day 1 to day 4 and increased linearly the next day until day 7.

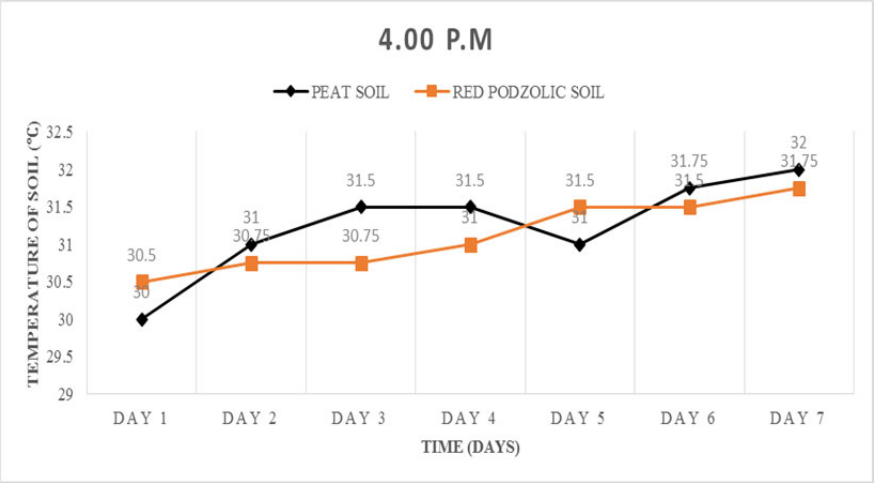


**Fig. 8.** Peat and red podzolic soil temperature level against time (days)

In the 4.00 p.m., the peat soil temperature increased by 1.5 Celsius from day 1 to day 3 and maintained at the day 3 to day 4. As for day 4 to day 5, the temperature dropped by 0.5 Celsius and increased but 1.5 Celsius from day 5 to day 7.

Figure 8 showed the peat and red podzolic soil temperature value against time (days). The temperature value from day 1 until day 7 progressions is contrast with one another which is the temperature of the peat soil directly affected by the high temperature and it's surrounding and for the red podzolic soil the temperature increase slowly not directly affected.

Based on the value of the graph, both the soil is still in the absolute range where the minimum readings for the temperature are 28 Celsius and the maximum is 33 Celsius for the palm oil tree. The graph above showed that red podzolic soil is the best soil because the behavior of the soil temperature is increase steadily compared to peat soil because peat soil is easily affected by its environmental temperature and caused it to dry quickly. This factor is influenced by the characteristics of the soil in which peat soils are composed of soil types consisting of plant materials that have undergone decomposition.

## 4. Conclusion

Based on the information and data collected from the literature review relate to sensor application for soil treatment and behavior, all the objective have been achieved. The first objective is to develop a system using sensor application which is moisture sensor and temperature sensor for red podzolic soil and peat soil and display the responses from both different types of soil using coding that have been programmed using Arduino IDE software to quicken data collection process.

The second objective of this project is to analyze moisture and temperature behavior between red podzolic soil and peat soil. The sensor application treatment and behavior system showed the moisture and temperature level of the both soil. It is important to monitor the condition of soil moisture and temperature level is within absolute range value to ensure the soil is in good condition and fertility.

Lastly, the third objective is to identify the best soil behavior between red podzolic soil and peat soil through the data collection obtained on the process of the first objective and the second objective. This objective focused more on the reactions between both of the soil according to the treatments through the data that had been collected using this system using a moisture sensor and temperature sensor as an input. Based on the experiment, the red podzolic soil is the best soil behavior because when the temperature of surrounding is high, the temperature value of the soil is still under control and the water content available to this soil still high and the drying process for the red podzolic soil is slow. This soil was chose as the best soil behavior because when the soil is easily influenced by high temperature, it reduces the moisture content in the soil and as a result the soil become hardened and reduced nutrient source from the soil where it negatively affected for root to absorb important nutrients.

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