International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 4
April 2018

Soil Nutrient Tester

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Abstract

The main aim of this project is to construct a soil nutrient tester using ArduinoUNO board and GSM module. This project gives the details regarding the amount of macro nutrients, micro nutrients present in the soil. The pH value and electrical conductivity of the soil are also measured. From the electrical conductivity we are estimating the salinity of soil and water drainage in the feild. All this information regarding the soil helps in deciding the crop that can be grown more effectively in that soil. The entire information is sent via SMS to the farmer.

Keywords:

Macro nutrients, Micro nutrients, pH value, Electrical conductivity, SMS.

1. INTRODUCTION

Proper nutrition is required for satisfactory crop growth and production. The use of soil tests can help to determine the status of soil. There are 16 elements which are essential for plant growth. They are nitrogen, phosphorous, potassium etc. They are classified as

1. Macro nutrients
2. Micro nutrients

Figure 1 has all the nutrients that are required for proper growth of plants. The deficiency of macro nutrients greatly effects the growth of the plants. Even micro nutrients play an important role in the growth of crops but, they are required in a very less amount where as macro nutrients are required in a large quantity. Apart from these nutrients pH value of the soil also plays an important role in the growth of plants. pH value is responsible for the nutrients to get absorbed by the soil.

The presence of nutrients in the soil is represented in the below listed levels. They are

- Deficient: The nutrients are at very low concentrations. The yield is reduced drastically because of lack of growth of the crops and the symptoms of the deficiency are clearly visible.
- Insufficient: This condition leads to an optimum yield and the symptoms of lack of nutrients are seldom visible.
- Sufficient: In this case the yield is high which is always desired.
- Excessive: In this case the presence of one nutrient is more than the required which makes the other nutrient deficient and thereby reducing the yield to optimum levels.
- Toxic: The surplus amount of one nutrient leads to the damage of the crop which is not desired.

Essential Plant Nutrients		
Supplied from air and water	Supplied from soil and fertilizer sources	
	Macronutrients	Micronutrients
Carbon (C)	Nitrogen (N)	Zinc (Zn)
Hydrogen (H)	Phosphorous (P)	Copper (Cu)
Oxygen (O)	Potassium (K)	Iron (Fe)
	Sulphur (S)	Manganese (Mn)
	Calcium (Ca)	Boron (B)
	Magnesium (Mg)	Chlorine (Cl)
		Molybdenum (Mo)
		Cobalt (Co)

Fig: 1 Nutrients classification

The need for soil testing arises here. Soil testing helps in knowing the nutrient content of the soil and thereby it helps us in selecting the suitable crop that can be grown in that soil. This project helps us in knowing the nutrient content of the soil and it also tells us for which crop the soil is suitable. This project helps us to find the amount of fertilizers that should be added for the crop that we want to grow. Therefore we can increase the yield and reduce the wastage of fertilizers. Figure

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2 has the details regarding the amount of nutrients required for various crops.

NAME OF THE CROP	NUTRIENT REQUIREMENT(Kg/Ha)		
	N	P	K
RICE	217	68	256
CORN	191	89	235
BRINJAL	207	45	396
POTATOES	170	22	220
ONION	155	60	132
TOMATO	136	24	192
ORANGE	135	16	110

Fig: 2 Nutrients requirement table

The pH value of the soil controls how well plants utilize the nutrients available in the soil. The general pH value of the soil is in the range of 5.5-7.

Soil Electrical Conductivity is a measure of the amount of salts in soil. Excess salts hinder plant growth by affecting the soil-water balance. Therefore by measuring the soil EC we can estimate the salinity of the soil and also the water drainage in the field.

The entire details about the soil are sent in an SMS which is easy to maintain and easy to understand. Farmers can directly buy the fertilizers that are required and they can add them to the soil in order to increase the yield.

2. WORKING

In this section, a detailed explanation of operation of the project is given.

2.1 Nutrient Sensing

Nutrients are sensed by using chemicals. All the chemicals are available in a kit so that the required chemical is used for testing the level of that particular nutrient. The sensing setup is given in figure 3. We have separate test tubes for sensing macro nutrients (N, P, and K) and pH value. The chemicals are in the form of tablets. The soil that has to be sensed is mixed with water and the respective chemical is added to the solution and the colour of the solution is changed according to the amount of nutrient present in the soil. Colour is sensed in order to know the amount of nutrient present. Colour sensor is used for sensing the colour and there by analyzing the nutrient availability.

Fig: 3 Nutrient testing kit

Colour sensing is done by using RGB LED and a LDR. The colour sensing is done by illuminating the solution by red light, blue light and green light separately. The reflected light from the solution is received by an LDR. The voltage across the LDR varies according to the amount of reflected light. It has to be noticed that a red object reflects more red light and similar for other colours also. The colour of the solution is constructed from the RGB composition of the colour of the solution.

Even the pH value of the soil is sensed in a similar way. The amount of macro nutrients and micro nutrients present in the soil can be also analysed from the pH value. Figure 4 gives the relationship between the pH value and the nutrient levels.

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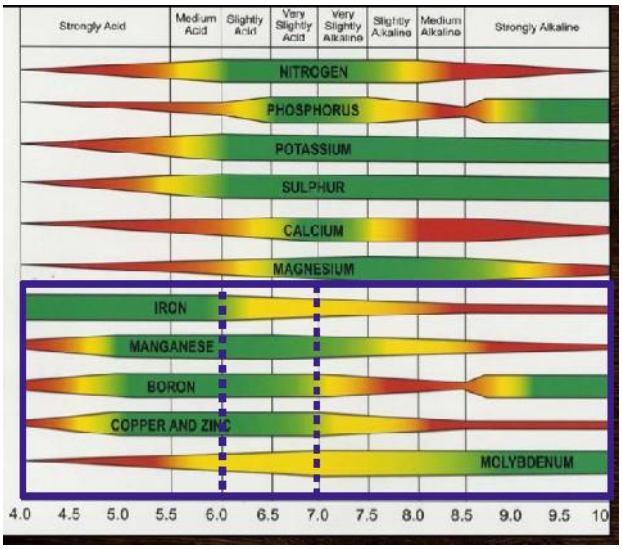

Fig: 4 Relationship between pH value and nutrient availability

2.2 Electrical conductivity measurement

Electrical conductivity (EC) is the ability of a material to transmit (conduct) an electrical current. The electrical conductivity of soils varies depending on the amount of moisture held by soil particles. As EC increases, soil microorganism activity decreases, affecting respiration, residue decomposition, nitrification and denitrification. Figure 5 shows the relationship between the soil texture and the electrical conductivity.

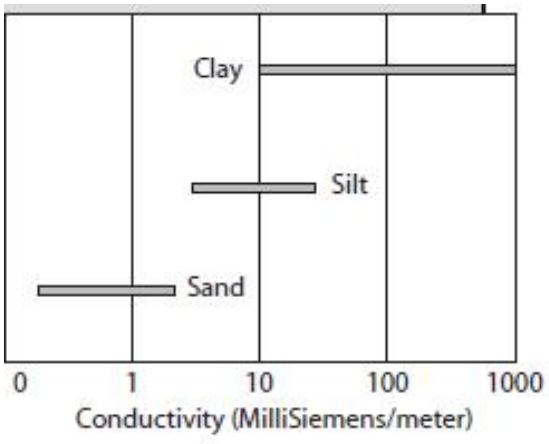

Fig: 5 Relationship between soil texture and electrical conductivity

The measurement is done by measuring the electrical current passed through the solution that is obtained by dissolving soil that has to be tested in distilled water. Figure 6 shows the electrical conductivity measurement setup.

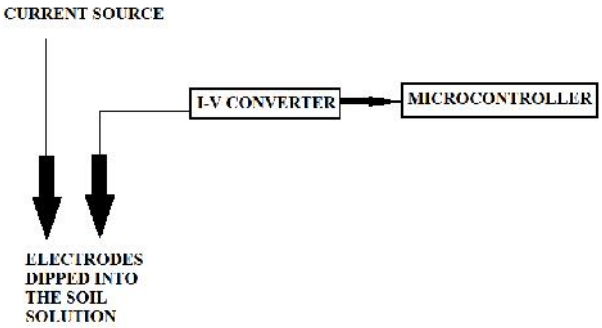

Fig: 6 Electrical conductivity measurement

2.3 Circuit diagram and explanation

Figure 7 shows the circuit diagram of the project.

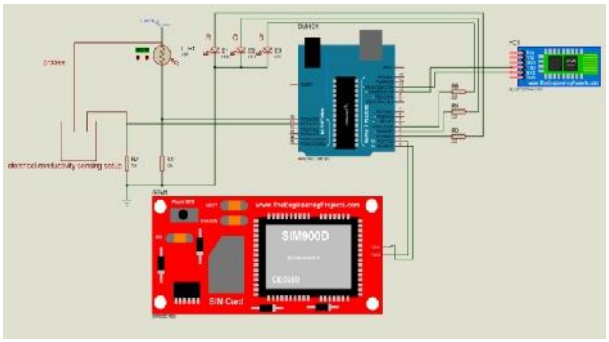

Fig: 7 Circuit diagram

In this project we are using ATMEG328p microcontroller which is fixed with ARDUINO UNO R3 board. We are connecting the serial port (that is pin 0 and 1) of the ARDUINO with the GSM module and the port is programmed to operate at 9600 baud rate. We are creating a software serial port at pin 10 and 11 in order to interface the bluetooth module. The software serial port is also programmed to operate at 9600 baud rate. We are using RGB tricolour LED and its pins are connected to pin 2, 3, and 4 respectively. We are constructing a voltage divider with an LDR and a 10KΩ resistor and the voltage across the 10KΩ resistor is read by the A0 pin of the ARDUINO. We are having a I- V converter that is formed by the probes that sense the electrical conductivity and a 10KΩ resistor. The voltage across this 10KΩ resistor is read by the A1 pin of the ARDUINO.

2.4 Bluetooth communication

We are using bluetooth module in order to make the user send the data which he has to send to the tester. This also conveys the notifications from the tester to the user. We are using Bluetooth

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Electronics android application in order to communicate with the bluetooth module that has been interfaced with the tester.

Figure 8 to figure 15 show the various messages displayed on the mobile screen when the mobile is connected with the tester.

Fig 8: Reading the details from the user.

Fig 9: Sensing the Nitrogen level.

Fig 10: Sensing the Phosphorous level.

Fig 11: Sensing the Potassium level.

Fig 12: Details of NPK levels and list of suitable crops.

Fig 13: Asking for the crop that has to be grown.

Fig 14: Electrical conductivity testing.

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Fig 15: Sending the report in the form of SMS.

The functions of various controls in the application panel are given in table 1.

Table 1: Various controls and their function

Control	Function
Keypad	For entering the name, location, and phone number.
Display	To show the messages, that are transmitted from the project.
pH	To send the colour of the water in the pH sensing test tube.
Ok	To intimate the project that the user's task has completed.

2.5 Flow chart

Figure 16 shows the sequence of operations done by the project in the form of flow chart.

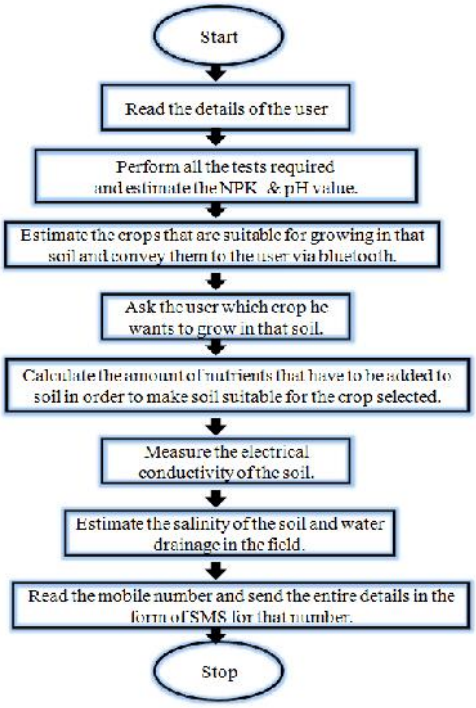

Fig 16: Flow chart

3. RESULTS AND DISCUSSION

Figure 17 is the image of the complete project with all the modules interconnected.

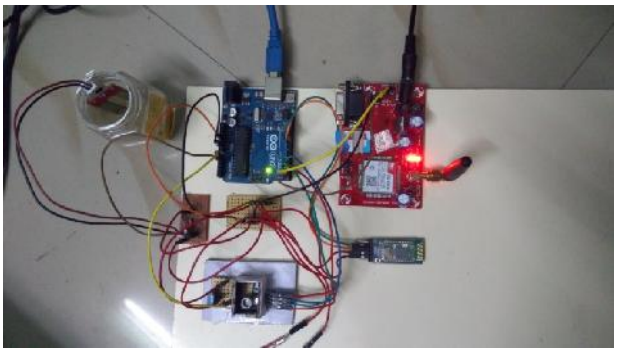

Fig 17: Complete project

The data that has been collected from the sensors is analysed and then a SMS is generated. This SMS is send to the mobile number that has been prescribed by the user. Figure 17 shows a sample SMS report.

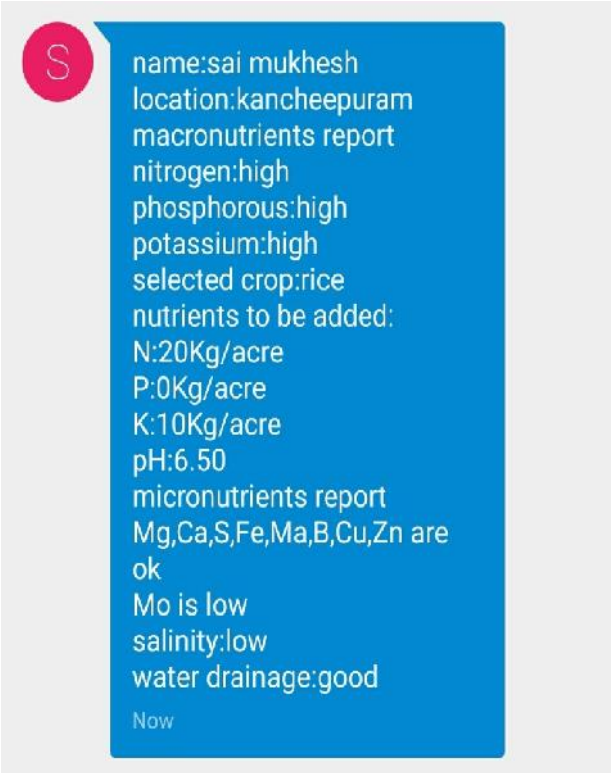

Fig 17: Sample SMS report

4. CONCLUSION

Thus from the results obtained we can conclude that we have achieved our main objective of

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generating a SMS based soil report and we have sensed various parameters like

1. NPK levels.
2. pH value of the soil.
3. Micronutrients level.
4. Electrical conductivity of soil.
5. Salinity of the soil.
6. Water drainage in the field.

From the above sensed parameters we tried to estimate the crops that are suitable to grow in that soil and we also tried to calculate the amount of nutrients that have to be added for the required crop.

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