Detection of NPK and pH components of soil

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Preface

The monograph is developed for the testing of soil electronically. The focus is on the basic issues relating theory to practice wherever possible. The effort has been made to develop a method not only in a logical and interesting manner but also to help the reader develop inside into the many facts of soil testing. The NPK and pH sensors are used to find the N, P, K and pH value of the unknown soil which is used for crops. The tested result is compare with the results of the soil which is tested in soil testing lab, which is the traditional method of testing the soil in the lab.

The proposed method can be useful to find the NPK and pH value of any soil which we think for crop. The testing result of the soil is also used for the farmer to take the decision on which crop is more suitable for the available nutrients in the soil.

It is hoped that the monograph will also be found developing the other sensors for soil testing.

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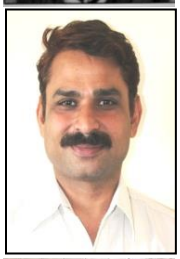

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ABSTRACT

To increase the fertility of crop it is important to determine what is the more amount of nitrogen (N), phosphorus (P) and potassium (K) required. Another important factor is to determine the soil Ph value. The concentration of H+ ions that is Ph is being used in the laboratory to know the amount of fertilizer to needed in a field. This will improve the quality of soil and yield a crop that has good quality. In this project a color sensor with fiber optic is developed for determining the NPK components of soil. To know the soil Ph we used a Ph sensor. The principle of sensor probe used for NPK detection depends on absorption of color by solution.

Keywords – Nitrogen (N) , phosphorus(P), potassium(K), potential of hydrogen(pH)

1. Introduction

1.1 Introduction

In order to complete the increasing demands of the food production over the years there is need to look upon the fertilizers that are required. The fertilizers mostly have nitrate (N), phosphate (P) and potassium (K). These fertilizers need to be used in proper proportion. If these fertilizers are used in improper quantity then they might yield crops of bad type. These crops might be bad in color, length, taste etc. Amount of NPK depend on the type of crop and on the status of growth of plant. The quantity of fertilizer that is to be used depends upon the present amount of NPK components of soil. To reduce fertilizers the researchers in agro field are also finding ways to increase crop yield. As the components vary over the cultivated field on a small scale many researchers have made an attempt to develop sensors to detect the contents of nutrients. To study the behavior of NPK integrated crop management system has been designed. Based on sensing position and information technology precision agriculture is a farm management strategy that may contribute in optimizing the soil quality. Currently analysis of components of soil is done using the chemicals which is harmful to environment, time consuming as well as costly. Along with the NPK components of soil Ph is another important factor that has great importance because of its close resemblance in biochemical processes for e.g., When the Ph level is low the growth as well as yield from farm is mostly low whereas if it is high then it is also good .If the Ph is neutral then some crops grow good. Although acidic and alkaline soils are good sometimes, Ph value decreases as the acid nature of soil increases. Soil that has Ph less than 7 are “acidic” and when pH is more than 7 then “alkaline”, for pH 7 it is “neutral”.

1.2 Objective:

The main objective of the project is to develop a cost efficient and farmer friendly unit that provide the crops with the correct quantity of fertilizer based on the macronutrient (Nitrogen, Phosphorus and Potassium) deficiency in the soil. This involves testing the Nitrogen, Phosphorous and Potassium content of the soil using a pH sensor. The pH value of 2 the soil is related to the macronutrient content and hence provides the deficient amount of macronutrients to the soil by an automated fertilization unit, thereby maintaining proper soil pH level required for maintaining the quality of soil and that of the particular crop. This process involves an In-situ soil testing technique. This also aids increasing the profitability of crop production and to reduce potentially negative environmental impacts.

2. REVIEW OF LITERATURE

2.1 Review of Literature:

We know that globally the over-fertilization is very big problem for farmers. If we do not have any particular idea about the fertilizers of crops, then due to this various environmental problems like leaching, water pollution, soil salinity, bio-magnification, contamination of ground water, poor food quality. We know that the present technique of soil testing is chemical based which is more time consuming and costly so that our electronic system can easily overcome those flause. It is very necessary and important that the system we use is fast, having low cost, and user friendly. Due to the use of poor techniques the farmers also faced the time delay issues so we should use the latest technology. The automated fertilization unit increases the profitability of crop production and reduces potentially negative environmental impacts. In present date if some person wanted to test his soil, then he has to go to the soil testing lab with his soil sample then they will test it chemically and then after 2-3 days he will get the results, so this is very time consuming process.

A key to soil testing for formulated fertilization is to find out the amount of nutrients in the soil. Among all the nutrients for growth of crop, Nitrogen, Phosphorous and Potassium are the one of the most important elements. Conventional soil NPK testing generally is carried out by three or four techniques among which few are - soil sampling, conductivity measurement, electrochemical method and optical methods. Until now, detection of soil nutrients is carried out by using electrochemical sensors for the measurement. Electrochemical methods are trustworthy, but the time consumed is more, complicated and very high cost per test. However, ISE and ISFETs are

not as vividly available and hence it leads to requirement of an alternative method and in the conductivity measurement technique two or three electrodes of similar material are immersed in soil samples. Different types of Materials can be used such as steel, silver, platinum, graphite or copper. The concentration of NPK in soil and the conductivity of electrode change. The change in the conductivity is then converted into electrical signal for other electronic control system.

Therefore, alternate methods are being used such as optical method, which are less expensive as compared to electrochemical method. The optical methods are reliable, less time-consuming, simple and very low cost per test.

3. WORK DONE

3.1 Block Diagram:

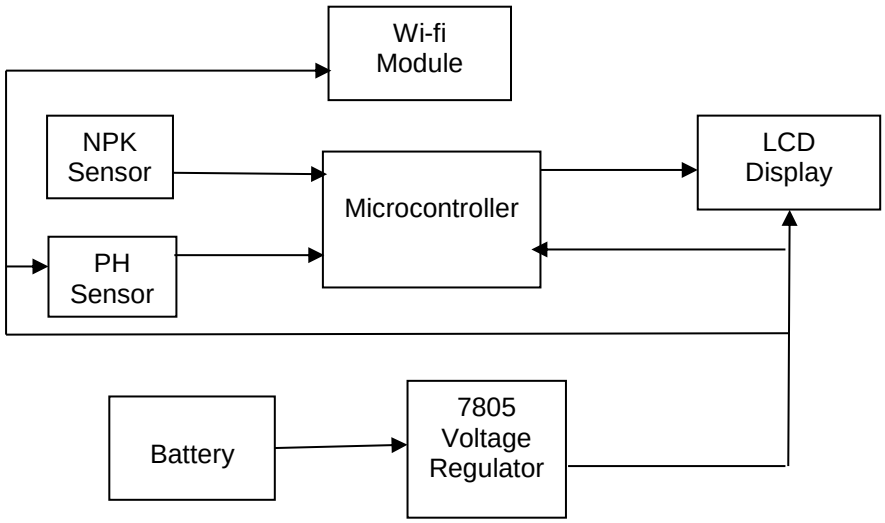


Fig 3.1 Block Diagram of System Proposed System

3.2 PCB Schematic:

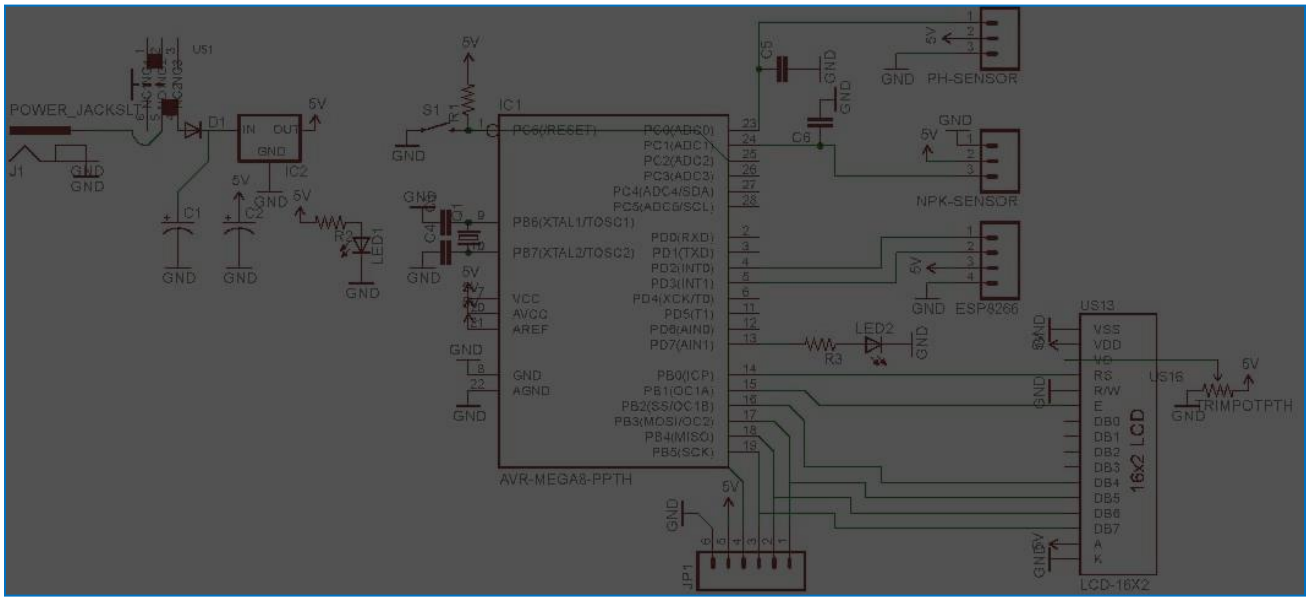


Fig 3.2 PCB Schematic

3.3 List of Components:

1. Atmega328p Microcontroller
2. Aurdino
3. pH Sensor
4. NPK Sensor
5. WiFi Module
6. 16x16 LCD
7. Resistor
8. Capacitor
9. Optical Fibre
10. LED
11. Adapter
12. Button Switch
13. Potentiometer
14. Voltage Regulator
15. Wires

3.3.1Atmega8 Microcontroller:

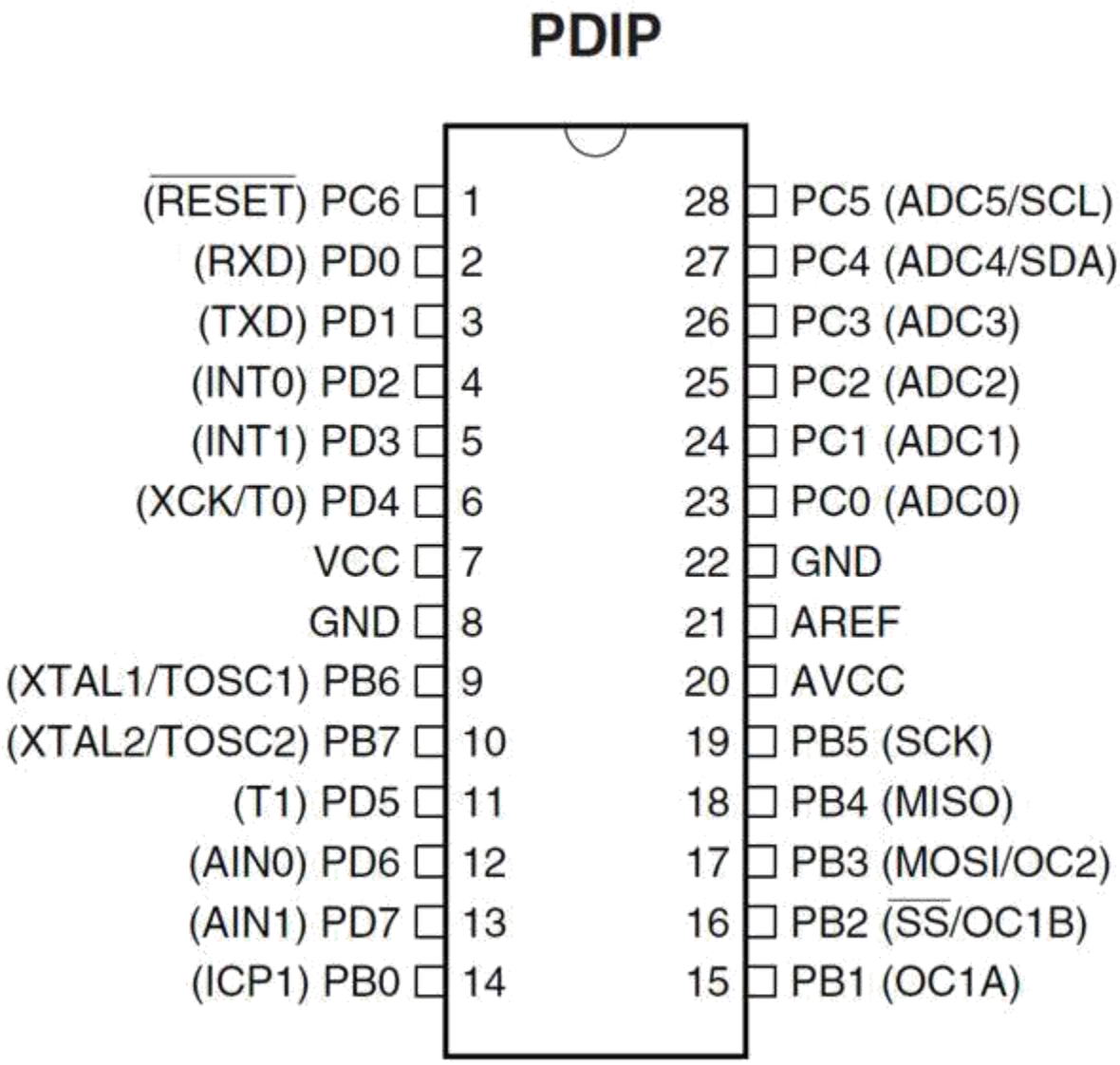


Fig 3.3 Pin Diagram OF Atmega8 Microcontroller

3.3.1.2 Pin Description:

VCC: Digital supply voltage. (Pin No.7)

GND: Ground (Pin No.8)

Port B (PB7…PB0) XTAL1/XTAL2/TOSC1/TOSC2:

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability.

Port C (PC5…PC0) (Pin No.23-28)

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability.

PC6/RESET: (Pin No.1)

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics

Port D (PD7…PD0):

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

RESET:

Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.

Are: (Pin No.21) Are the analog reference pin for the A/D Converter. ADC7-6 (TQFP and QFN/MLF Package Only) In the TQFP and QFN/MLF package, ADC7-6 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels

3.3.2 Arduino:

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Fig. 3.4 Aurdino IC

The below figure represents the block diagram of pH sensor for soil A conical shaped sensing electrode (A) interface with a reference electrode (C) through the interfacing insulator (B). The signal conditioning network (G) is connected to the electrodes (A & C).For display the pH value we have to enclose signal conditioning network in thermoplastic casting(D) and connect it to the LCD. Hence the device is now portable, simple and easy to use in pH meter for measuring the pH value. Here we used the nano particles due to which there is formation of reference electrode which will directly increase the efficiency of the pH sensor.

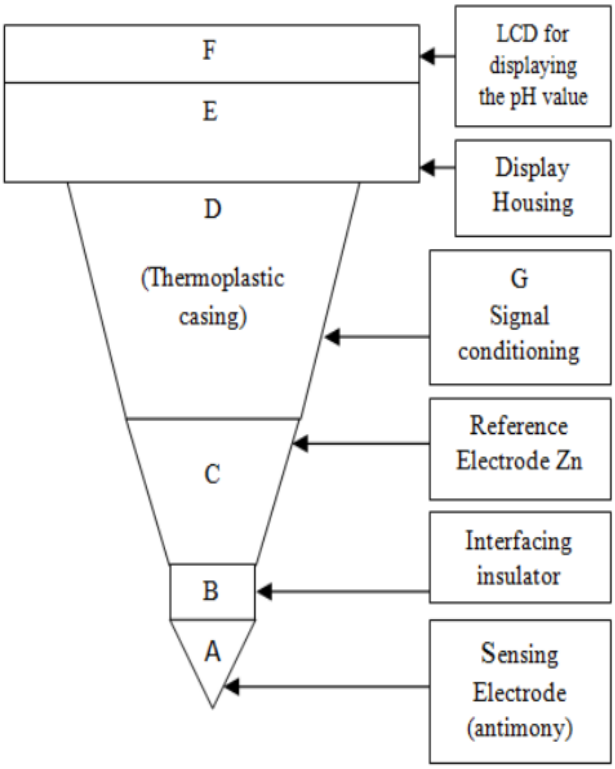


Figure 4: Block diagram of pH sensor

Here are many methods of finding pH of soil. We know that pH sensors are used for measuring semi solid soil, the best pH sensors are made up of sphere shaped glass which helps user to enter the soil devoid the help of the probe. We can also measure soil with help of chemicals using water solution. In it we mixed soil in water with 1:1 ratio in order for calibration of liquid solution using pH electrode. To fight with the salt contained with the soil we have to mix soil with great ionic power buffer solution built of calcium chloride. Here we used distilled water to give estimation of soil pH. When proper water is gathered from the bottom, the pH is found using the pH electrode.

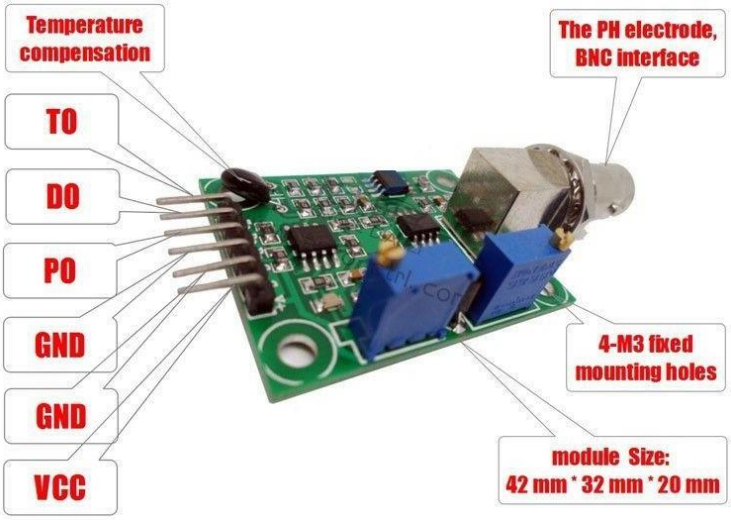


Fig.3.5 pH Sensor

3.3.3.1 Pin out:

To	Temperature
Do	Limit pH Signal
Po	Analog pH value
G	Analog GND
G	Supply GND
V+	Supply (5V)

3.3.4 NPK Sensor:

Plastic fibers and multimode are used to build NPK sensor. The design of NPK sensor is very complex procedure. Different configuration had been reported for chemical sensing .The used configuration is as shown in figure (1). Sensor probe consist of seven fibers arranged in a concentric configuration with a central fiber as a receiving fiber and the other six surrounding fibers as transmitting fibers. Every fiber is a multi mode plastic fiber of 488 um core diameter with a aperture of 0.47. The length of every fiber is 90mm.

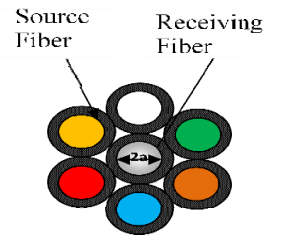


Fig3.6: NPK Sensor Probe

Zero emery paper is used to coat the tips of fiber . To avoid the damage of tip, a round shape cutted glass plate is pressed fitted to the sensing end. At the other end a circle shaped brass disc is fixed to hold six bright LED's in a circular manner with a one photodiode at the center. Colorimetric principle is used for working of developed sensor. Which deals with the measurement of the colored intensity .The color is due to absorption of light waves of particular wavelengths.

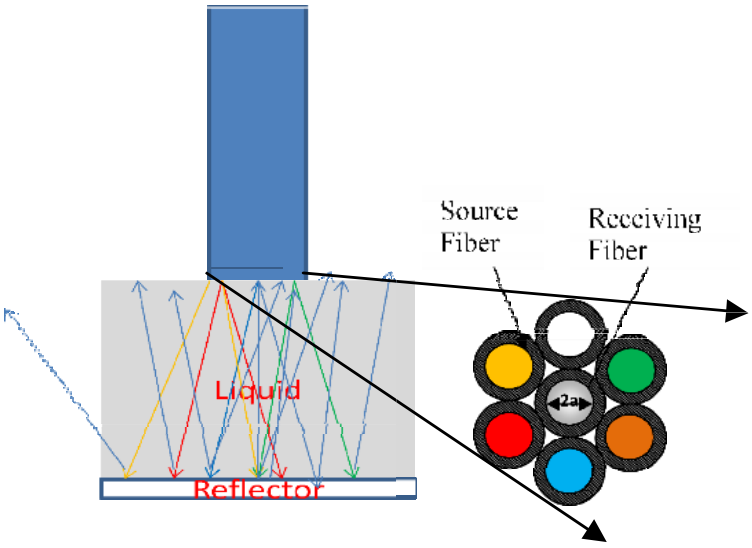


Fig. 3.7: NPK Sensor Working Principle

The NPK working is illustrated as shown in figure (2). The different colored light of different intensity is emitted by different colored LED's. The light is incident on a liquid through multimode. A reflector is placed at some optimum distance .The light travel throughout the solution starting from probe to the reflector and then back, depending on color of properties of the solution, intensities will be received. The intensities can then be plotted to obtain a simple spectrum at discrete wavelength .A simple detection mechanism can be developed from the spectrum obtained.

.3.5 WiFi Module:
3.3.5.1 Preambles

SP-01 WiFi module is developed by Ai-thinker Team. core processor ESP8266 in smaller sizes of the module encapsulates Ten silica L106 integrates industry-leading ultra-low power32-bit MCU micro, with the16-shortmode,Clock speed support 80MHz, 160MHz, supports the RTOS, integrated Wi-iMAC/BB/RF/PA/LNA, on-board antenna. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function a fast and alone application, with the lowest cost, and minimal space requirement. ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266 EX hosts the application, it boots up directly from an external flash. It has integrated cache to improve the performance of the system in such applications. Alternately, serving as a Wi-Fi.

ESP8266EX also integrate san enhanced version of Tensilica'sL106Diamondseries32-bitprocess

or, with on-chip SRAM, besides the Wi-Fi functionalities. ESP8266 EX is often integrated with external sensors and other application specific devices through its GPIOs; codes for such applications are provided in examples in the SDK. Express if Systems' Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing. For low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR,LVDS, LCD interference mitigation.

3.3.5.2. PinDescriptions

NO.	Pin Name	Function
1	GND	GND
2	GPIO2	GPIO,Internal Pull-up
3	GPIO0	GPIO,Internal Pull-up
4	RXD	UART0,data received pin RXD
5	VCC	3.3V power supply (VDD)
6	RST	**1)** External reset pin, activelow 2) Can loft or externalMCU,
7	CH_PD	Chip enable pin. Active high
8	TXD	UART0,data send pin RXD

3.3.5.3 Photos

Fig.3.8 WiFI Module

3.3.6 LCD Display 16x16:

LCD (light crystal display) is nothing but the electronic screen. Here for our purpose we used 16x2 LCD (Light crystal display) which means we can write 16 characters in 2 different lines. Each characters in this LCD (lights

crystal display) displays 5x7 matrix. This LCD (lights crystal display) contains 2 registers and 1 viz command. A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. In LCD the liquid crystal do not emits the light directly but by using the backlight property the light is emitted. LCDs are available to display arbitrary images.

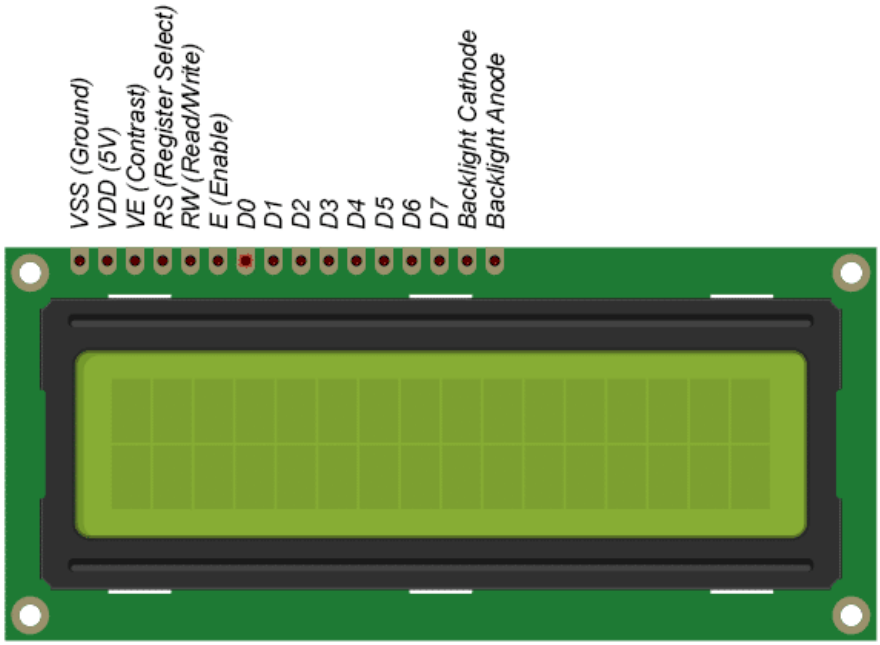


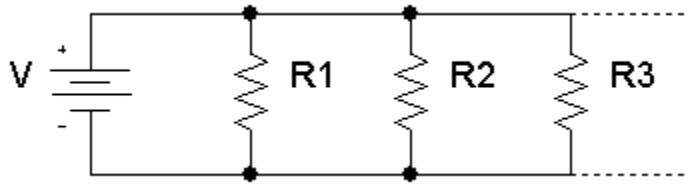
Fig 3.9 LCD Display

3.3.7 RESISTOR

3.3.7.1 What is resistor

Resistor is an electrical component that reduces the electric current.
The resistor's ability to reduce the current is called resistance and is measured in units of ohms (symbol: Ω).
If we make an analogy to water flow through pipes, the resistor is a thin pipe that reduces the water flow.

Resistors in parallel

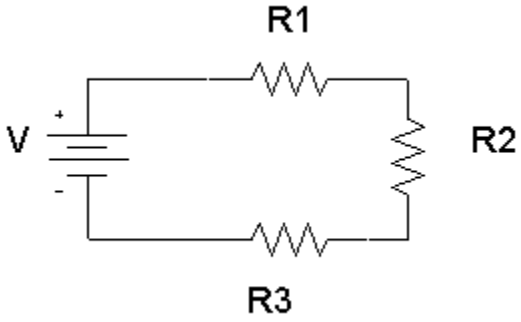


The total equivalent resistance of resistors in parallel R_{Total} is given by:

$$\frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

So when you add resistors in parallel, the total resistance is decreased.

Resistors in series



The total equivalent resistance of resistors in series R_{total} is the sum of the resistance values:
$R_{total} = R_1 + R_2 + R_3 + ...$

So when you add resistors in series, the total resistance is increased.

3.3.7.3 Dimensions and material affects
The resistance R in ohms (Ω) of a resistor is equal to the resistivity ρ in ohm-meters (Ω·m) times the resistor's length l in meters (m) divided by the resistor's cross sectional area A in square meters (m^2):

$$R = \rho \times \frac{l}{A}$$

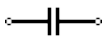
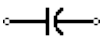
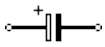
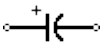
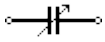
3.3.7.4 Resistors image

Fig 3.10 Resistors

3.3.8 CAPACITOR

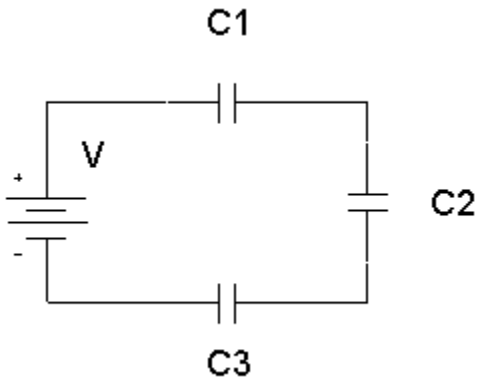
3.3.8.1 What is capacitor
Capacitor is an electronic component that stores electric charge. The capacitor is made of 2 close conductors (usually plates) that are separated by a dielectric material. The plates accumulate electric charge when connected to power source. One plate accumulates positive charge and the other plate accumulates negative charge.
The capacitance is the amount of electric charge that is stored in the capacitor at voltage of 1 Volt.
The capacitance is measured in units of Farad (F).
The capacitor disconnects current in direct current (DC) circuits and short circuit in alternating current (AC) circuits.

3.3.8.2 Capacitor symbols

Capacitor		
Polarized capacitor		
Variable capacitor		

$$C = \frac{Q}{V}$$

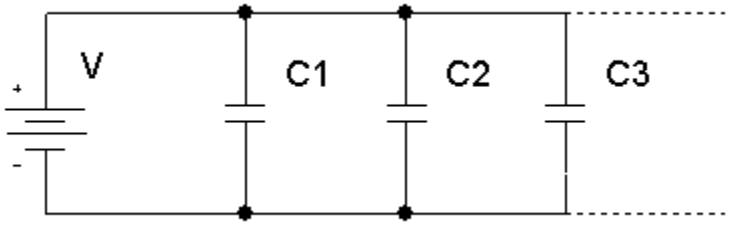
Capacitors in series



The total capacitance of capacitors in series, C1, C2, C3,.. :

$$\frac{1}{C_{Total}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$$

Capacitors in parallel



The total capacitance of capacitors in parallel, C1,C2,C3,.. :
$C_{Total} = C_1+C_2+C_3+...$

3.3.8.4 Capacitor pictures

Fig. 3.11 Capacitors

3.3.9 Optical Fiber

A flexible, transparent fiber that is made either by silica or plastic having diameter of about a human hair is called as optical fiber. In order to transmit light we use optical fiber. The light is transmitted between the two ends of the fiber. Optical fibers are used transmission over long distances and it has higher bandwidth than electrical cables. Instead of metal wires we use fibers because there are minimal losses in fiber. Apart from this fibers have immunity to electromagnetic interference. Fibers are used to carry light or images from confined space like fiberscope and they are covered with a buffer layer.. Some of them have applications as fiber optic sensor and fiber lasers.

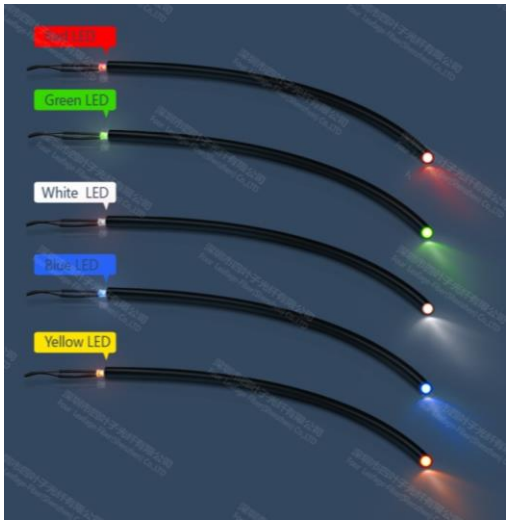


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Fig.3.12 Optical fibers

Optical fiber has a core, cladding which is transparent having a lower refractive index than core .The light passes through the core using the total internal refraction phenomenon due to which it looks like it is a waveguide. There are various modes of propagation that is single mode and multi mode. The multi mode fiber have higher diameter as compared to the single mode fiber. These further splits in step index fiber and graded index fiber each.

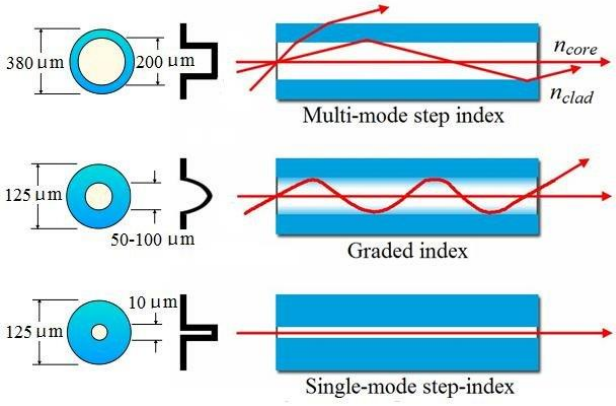


Fig.3.13 Types of optical fiber

3.3.10 LED:

A **light-emitting diode** (**LED**) is the semiconductor source of light which emit light when the current flow through it. The Electrons in semiconductor recombines with electron holes, which releases energy in form of photons. The color of the light is determined by the energy required for electrons to cross the band gap of the semiconductor. By using multiple semiconductors or a layer of light-emitting phosphor on semiconductor device white light can be obtained. Remote-control circuits uses infrared LED's, those used with a wide variety of consumer electronics. The first visible-light LEDs were of low intensity and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with high light output.
The light which is emitted from an LED is not spectrally coherent or not highly monochromatic unlike lasers. However, as its spectrum is variably narrow so that it appears to a human eye as a pure (saturated) color. Also unlike other lasers, the LED's radiation is not spatially coherent, so it cannot approach the very high brightness characteristic of lasers.

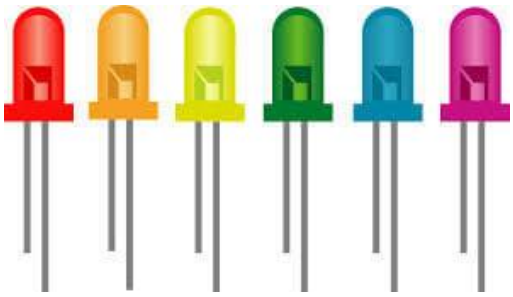


Fig 3.14 LED

A Light Emitting Diode (LED) mainly have three layers:1). p-type semiconductor2) n-type semiconductor and 3) depletion layer. Both p –type and n-type semiconductors are separated by a depletion region or depletion layer. It works only in forward bias condition. When Light Emitting Diode (LED) is forward biased, the free electrons from the n-side and the holes from the p-side moved towards the junction.
When free electrons reach the junction or depletion region, some of the free electrons recombine with the holes in the positive ions. Positive ions have very few numbers of electrons than protons. Therefore, readily accept electrons. Therefore, free electrons recombine with the holes in the depletion region. In result, more amounts of charge carriers

will cross the p-n junction. Some of the charge carriers from the p-side and the n-side will cross the p-n junction before they recombine with each other in the depletion region.
For an example, some of the free electrons from n-type semiconductor crosses the p-n junction and then recombines with the holes in p-type semiconductor. In the similar way, holes from p-type semiconductor cross the p-n junction and recombines with free electrons in the n-type semiconductor.

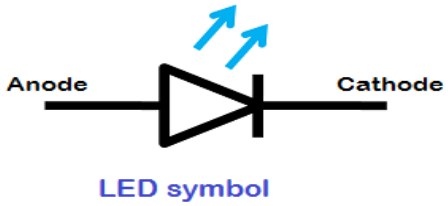


Fig 3.15 LED Symbol

3.3.11 Adapter

An **AC adapter**, or **AC/DC adapter**, or **AC/DC converter** is a type of external power supply often enclosed in a case similar to an AC plug. The other names of adapter include **plug pack**, **plug-in adapter**, **adapter block**, **domestic mains adapter**, **line power adapter**, **wall wart**, **power brick**, and **power adapter**. We can describe the adapters for battery powered equipment as **chargers** or **rechargers**. Electrical devices that require power but do not contain internal components to derive the amount of required voltage and power from mains power uses AC adapter. The internal circuitry of external power supply is very similar to the design that would be used for a built-in or internal supply.
External power supplies can be used for both with equipment with not other source of power and with the battery-powered equipment, where the supply, which when plug in, can charge the battery in addition to powering the equipment.

Fig3.16 Adapter

3.3.12 Button Switch:

Push-Buttons are normally-open **tactile switches**. Buttons which allow us to power the circuit or make any peculiar connection only when we press the button are called push buttons. Generally, it makes the circuit look connected when pressed and it breaks when released. When connecting wires between the supply and the circuit we must only connect the wires with both the stands (connections) of the Push-Button.

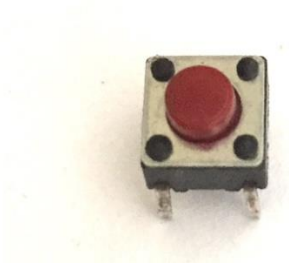


Fig 3.17.Push Button Switch

3.3.13 Potentiometer:

The potential of a device is measured by potentiometer. We know that potential is nothing but the work done (amount) by moving one charge to another. The flowing of current through the circuit is only because of the potential difference. The potential difference usually measured in volts. The device is used to measure the potential difference is nothing but the voltmeter.

Here we know that potentiometer generally does not draw any current in circuit so that using potentiometer is the best option we have. The electromotive force of a cell is also measured by using potentiometer. We can compare the electro- magnetic force of two cells with a potentiometer. The internal resistance of a cell is also measure by using potentiometer. . The internal resistance is the resistance that is provided by the electrolyte and electrodes which is present in a cell.

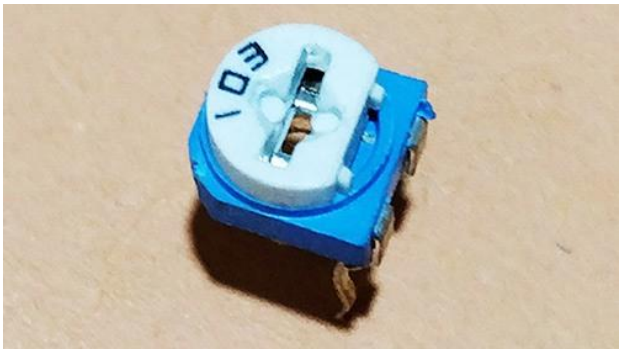


Fig 3.18 Potentiometer

3.3.14 Voltage Regulator:

A system that is designed to maintain constant level of voltage automatically is voltage regulator. A simple forward feed design is used by voltage regulator .It may have negative feedback. It may use electronic components. It is used for regulation of ac or dc voltage.

Fig 3.19 Voltage Regulator

3.3.15 Wires:

A wire is nothing but the cylindrical rod which very thin of type. The mechanical load or electrical load is bear by use of wire. When we draw the metal through whole the wire is formed or circular plates will form. There are various types of wire gauges for our daily use we used the one kind of gauge. The term 'wire' is also used more loosely to refer to a bundle of such strands, as in "multistranded wire", which is more correctly termed a wire rope in mechanics.

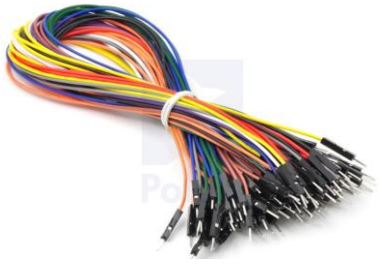
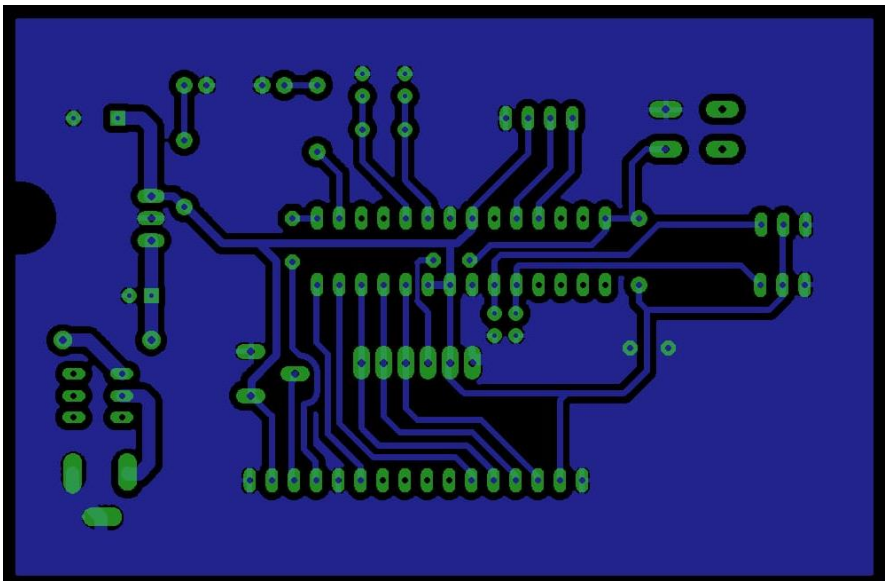


Fig 3.20 Wires

3.4 PCB Layout:

PCB Layout and Artwork:

In order to place or arrange things in a particular order on PCB is a layout. It is placing of components. The placing of components is done in such a way so that the interconnection length is optimal. It also provides easy of access for the insertion as well as testing of components. This is the basic step in architecture of the final project. There are various software to prepare a layout that is to be printed on the PCB board.



3.21 PCB Layout

4. RESULT & CONCLUSION

4.1 NPK:

The output of this system is seen in the diagram for various samples of soil. This shows that for different outputs of the soil sample, the outputs are different. The values obtained at the output are then analyzed with the values given in the microcontroller's table. The table consists of the threshold levels of nitrogen, phosphorus and potassium. Table 1 indicates the three levels for amount of NPK in the sample

Component	**Low**	**Medium**	**High**
Nitrogen	$x \leq 15$	$15 < x \leq 20$	$20 < x \leq 25$
Phosphorus	$16 < x \leq 20$	$20 < x \leq 35$	$35 < x \leq 50$
Potassium	$20 < x \leq 25$	$25 < x \leq 40$	$40 < x \leq 60$

When a soil sample with ph=7 was tested with this sensor, the following results were obtained-

1) Nitrogen test- Value found in the sample was x=14. This indicates that the sample is low in nitrogen and needs appropriate nitrogen fertilizers in it.

2) Phosphorus test- Value found in the sample was x=33. This indicates that the amount of phosphorus in the soil sample is sufficient in the soil.

3) Potassium test- Value found in the sample was x=55. This indicates that the amount of potassium in the sample is very high and there is no need of additional fertilizers for the soil.

4.2 PH:

The output of the sensor is as shown in the figure for various samples of soil. It shows that for different outputs of the soil sample, the outputs are different.

Nature	**Values**
Acidic	**Less than 7**
Neutral	**7**
Basic	**Greater than 7**

Cloud computing is a model which is used as network of severs which is hosted on the internet to manage, store, and process the data. It is not the local server or a PC. We have used this model in order to help the farmers. The output of the soil samples that will be tested with the sensors will be uploaded on the cloud. The farmers will be able to use this data from wherever they want to.

The following are the results which we get on the site with the help of cloud computing:-

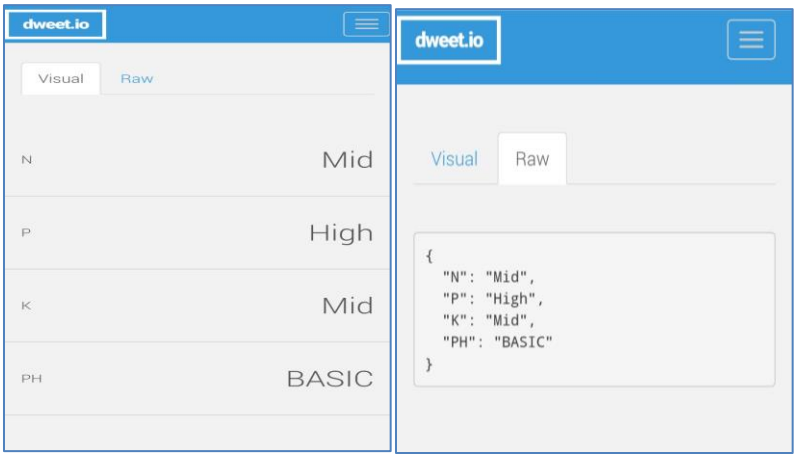


Fig 4.1 Results

4.3 Lab Results:

The pH and NPK results which were tested in Soil Testing Lab Maharaj bagh, Nagpur with chemical method are given below. These were compared with our results which came out to be approximately same.

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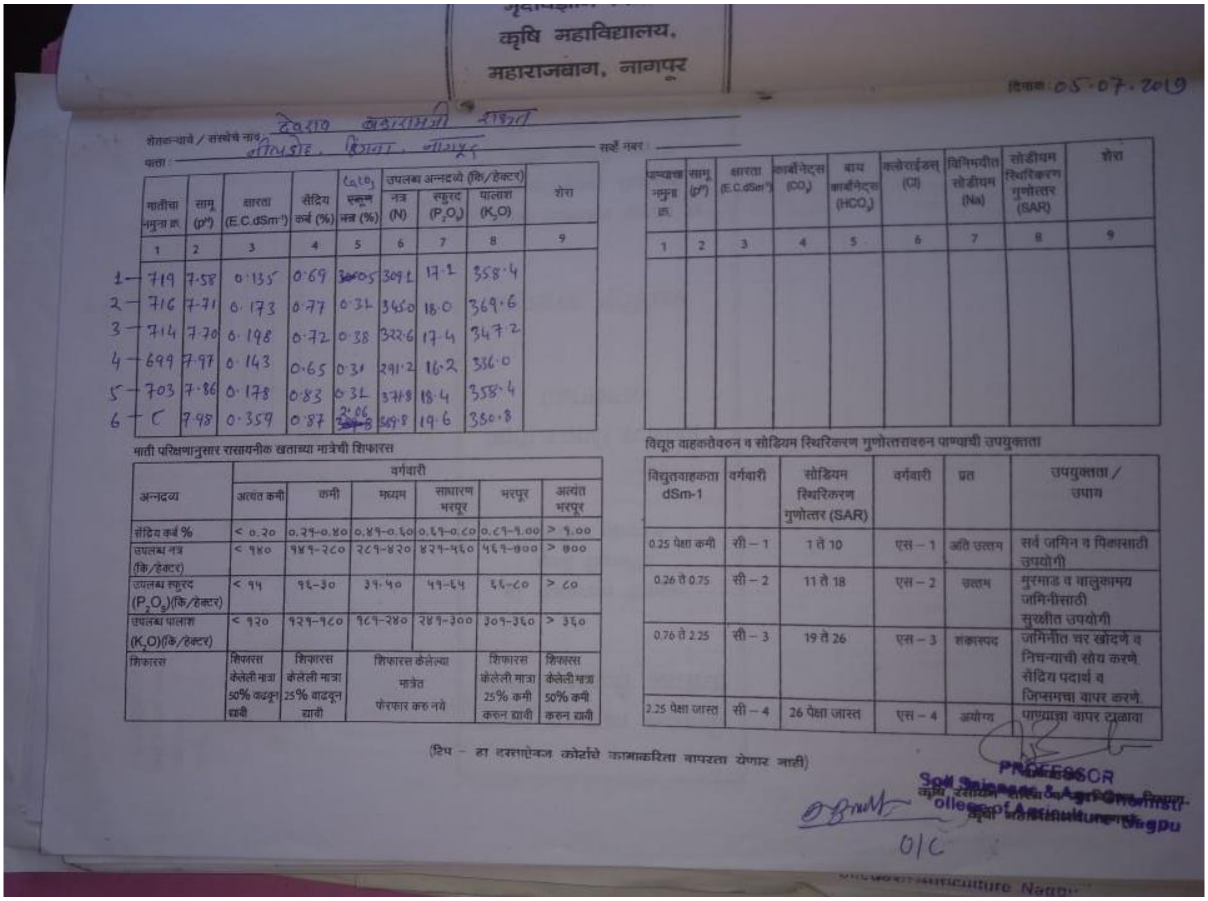


कृषि महाविद्यालय, महाराजबाग, नागपूर

दिनांक: 05-07-2019

शेतकऱ्याचे / संस्थेचे नाव: [illegible]

पत्ता: [illegible]

सर्वे नंबर:

मातीचा नमुना क्र.	सामू (pH)	क्षारता (E.C.dSm-1)	सेंद्रिय कर्ब (%)	$CaCO_3$ चूनखडी तत्त्व (%)	उपलब्ध अन्नद्रव्ये (कि/हेक्टर) नत्र (N)	स्फुरद (P_2O_5)	पालाश (K_2O)	शेरा
1	2	3	4	5	6	7	8	9
1 – 719	7.58	0.135	0.69	0.5	309.2	17.2	358.4	
2 – 716	7.71	0.173	0.77	0.32	345.0	18.0	369.6	
3 – 714	7.70	0.198	0.72	0.38	322.6	17.4	347.2	
4 – 699	7.97	0.143	0.65	0.31	291.2	16.2	336.0	
5 – 703	7.86	0.178	0.83	0.32	371.8	18.4	358.4	
6 – C	7.98	0.359	0.87	2.06	349.8	19.6	380.8	

माती परिक्षणानुसार रासायनीक खताच्या मात्रेची शिफारस

अन्नद्रव्य	वर्गवारी: अत्यंत कमी	कमी	मध्यम	साधारण भरपूर	भरपूर	अत्यंत भरपूर
सेंद्रिय कर्ब %	< ०.२०	०.२१-०.४०	०.४१-०.६०	०.६१-०.८०	०.८१-१.००	> १.००
उपलब्ध नत्र (कि/हेक्टर)	< १४०	१४१-२८०	२८१-४२०	४२१-५६०	५६१-७००	> ७००
उपलब्ध स्फुरद (P_2O_5)(कि/हेक्टर)	< १५	१६-३०	३१-५०	५१-६५	६६-८०	> ८०
उपलब्ध पालाश (K_2O)(कि/हेक्टर)	< १२०	१२१-१८०	१८१-२४०	२४१-३००	३०१-३६०	> ३६०
शिफारस	शिफारस केलेली मात्रा 50% वाढवून द्यावी	शिफारस केलेली मात्रा 25% वाढवून द्यावी	शिफारस केलेल्या मात्रेत फेरफार करु नये		शिफारस केलेली मात्रा 25% कमी करुन द्यावी	शिफारस केलेली मात्रा 50% कमी करुन द्यावी

पाण्याचा नमुना क्र.	सामू (pH)	क्षारता (E.C.dSm-1)	कार्बोनेट्स (CO_3)	बाय कार्बोनेट्स (HCO_3)	क्लोराईड्स (Cl)	विनिमयीत सोडीयम (Na)	सोडीयम स्थिरिकरण गुणोत्तर (SAR)	शेरा
1	2	3	4	5	6	7	8	9

विद्युत वाहकतेवरुन व सोडियम स्थिरिकरण गुणोत्तरावरुन पाण्याची उपयुक्तता

विद्युतवाहकता dSm-1	वर्गवारी	सोडियम स्थिरिकरण गुणोत्तर (SAR)	वर्गवारी	प्रत	उपयुक्तता / उपाय
0.25 पेक्षा कमी	सी – 1	1 ते 10	एस – 1	अति उत्तम	सर्व जमिन व पिकासाठी उपयोगी
0.26 ते 0.75	सी – 2	11 ते 18	एस – 2	उत्तम	मुरमाड व वालुकामय जमिनीसाठी सुरक्षीत उपयोगी
0.76 ते 2.25	सी – 3	19 ते 26	एस – 3	शंकास्पद	जमिनीत चर खोदणे व निचऱ्याची सोय करणे. सेंद्रिय पदार्थ व जिप्समचा वापर करणे.
2.25 पेक्षा जास्त	सी – 4	26 पेक्षा जास्त	एस – 4	अयोग्य	पाण्याचा वापर टाळावा

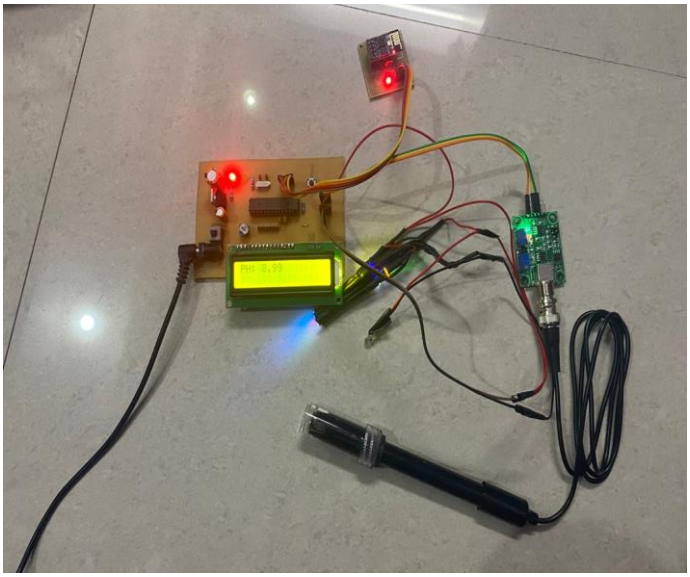
(टिप – हा दस्तऐवज कोर्टाचे कामाकरिता वापरता येणार नाही)

PROFESSOR
Soil Science & Agril. Chemistry
College of Agriculture, Nagpur

O/C

4.4 Conclusion:

The fiber optics NPK sensor is successfully made to detect the amount of nutrients such as Nitrogen, Phosphorus and Potassium in the soil. It is based on aligned arrangement of optical fibers. The principle on which it works is colorimetric principle in which the abstraction of light by the solution outcomes the difference in the result of the sensor. A soil sample solution is prepared which is tested and calibrated using the microcontroller. Hence the sensors are very beneficial for the farmers as they can select the appropriate fertilizers to improve the amount of components that are not up to the mark in the soil and the sensors also reduce the excess use of fertilizers. Therefore in agriculture industries, the fiber optics can be widely used in different applications.



5 FUTURE SCOPE

5.1 Future Scope:

The automated fertilization unit is found to be a crucial factor in the field of precision agriculture. Though it is successful in its operation, more development can be achieved in the field of precision. The main scope of the project is its utilization on a larger scale, on large agricultural fields apart from small farm lands. It can also be implemented for various varieties of soils and its respective crops. Changes with respect to climatic factors, such as temperature and moisture content can also be incorporated within the system which will result in better precision of the soil characteristics that are obtained.

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