Measuring the Nutrient Level In Agriculture Soil: A Review

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Abstract- *This paper introduces Internet of Things, which connects a real world to virtual world. It is also an interconnection of physical devices such as sensors, actuators and other embedded devices. Also used in medical, industries, agriculture etc.…. This paper explains about nutrient detection in agriculture soil using Internet of Things. It conducts a survey on the technologies used in determining the level of nutrients for smart agriculture. Due to this the usage amount of fertilizer can be reduced. Here nitrogen, phosphorus, potassium are mainly monitored since they are the essential nutrients for plant growth and are monitored using various techniques along with sensors, microcontrollers and other embedded devices.*

Keywords- nutrients, fiber optic sensor, spectroscopy, electrochemical sensing

I. INTRODUCTION

Day by day the population increases, hence the demand of food growth increases. In order to produce more increase in food growth the soil must be rich in nutrients. Here fertilizers are being used to increase the crop yield. Nutrients are classified into macro nutrients and micro nutrients. Nitrogen (N), potassium (K), phosphorus (P) are the main essential nutrients for plant growth and are termed are macro nutrients. Along with that the secondary nutrients essential for plant growth are calcium, magnesium and sulphur. The micro nutrients are boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn). They are supplied by air and water containing carbon (C), hydrogen (H) and oxygen (O). In today's world usage of fertilizers have been increased which has led to low quality of agricultural products. Due to this there is an improper balance of nutrients in plant growth which leads to consummation of more chemicals in human growth. Hence nutrition deficiency is low in living organisms. To avoid the consummation of more fertilizer soil has to be tested for efficient plant growth. Based on the value of nutrient level in soil the usage amount of fertilizer can be reduced. Level of nutrients must be continuously monitored in order to produce efficient crop productivity. Along with the nutrients level in soil, the temperature, humidity and soil moisture is also important for efficient productivity of crops. By this we can decide the type of crop productivity. In early decade people had longer healthy life due to efficient productivity of crops without the use of fertilizers. Now a day's lack of understanding leads the farmers to mismanagement of water, more use of fertilizers which leads to more crop productivity but is of low quality. Production of more crops along with efficient quality is a major challenge in present decade.

Typical concentrations sufficient for plant growth [1]:

Element	symbol	Mg/kg	percent	Relative no of atoms
Nitrogen	N	15,000	1.5	1,000,000
Potassium	K	10,000	1.0	250,000
Phosphorus	P	2,000	0.2	60,000
Calcium	Ca	5,000	0.5	125,000
Magnesium	Mg	2,000	0.2	80,000
Sulphur	S	1,000	0.1	30,000
Chlorine	Cl	100	-	
Iron	Fe	100	-	
Boron	B	20	-	
Manganese	Mn	50	-	
Zinc	Zn	20	-	
Copper	Cu	6	-	
Molybdenum	Mo	0.1	-	
Nickel	Ni	0.1	-	

II. LITERATURE SURVEY

Here the study deals with detection of actual values of nutrients of soil using various analyses. Initially NPK nutrient values are tested and analysed as they are important for sufficient plant growth. The study deals with the various methods of detecting and monitoring the nutrient values in agriculture soil.

NUTRIENT ANALYASIS OF SOIL SAMPLES FROM VARIOUS PLACES:

The study explains about the experimental method of determining nutrients such as nitrogen, phosphorus, potassium, calcium and magnesium. Each content is determined by using various methods. The soil samples are taken at a depth of 10cm from four positions in each plot and are mixed together. Here nitrogen content is determined by Kjeldhal method. Phosphorus can be determined by using either Bray's method or Olsen's method. Bray's method is done for acidic soils whereas Olsen's method is done for neutral and alkaline soils [2]. Potassium is determined by flame photometric method and calcium and magnesium content is determined by either EDTA titration method or by atomic absorption spectrophotometer. In this the soil samples are collected from lake sides, mountain, horticulture spot and from agriculture area.

NUTRIENT DETECTION IN SOIL: REVIEW PAPER:

This paper explains about determining the values of macro nutrients and micro nutrients in agriculture soil. It explains about the pH detection techniques. pH plays an important role for crop productivity. The parameters are sensed by using optical diffuse reflectance sensing, electrochemical sensing and electro conductivity sensing. Optical sensing [3] is done by using infrared rays and is visible. For spectroscopy near infrared wavelength [4] is used for quantifying crop productivity. The method is based on the interaction between incident light and soil surface. Physical and chemical properties of soil are determined by emitting the light. Characteristics of incident light vary due to physical and chemical properties of soil. Other than infrared rays, UV rays can also be widely used. These methods are reliable and are time consuming. But only limited amount of samples can be taken as it is done based on experimental purpose. **Electrochemical sensing:**It is classified into ion selective electrode (ISE) and ion selective field effect transistor (ISFET). An ion selective electrode monitors the macro nutrients such as nitrogen, potassium and phosphorus. An ion selective field effect transistor monitors macro nutrients and micro nutrients such as chlorine, iron, zinc etc. . . . Both ISE and ISFET [3]consist of ion selective membranes with reference electrodes. Nutrients are determined due to the reaction with reference electrodes and the values are converted as signal. An ion selective membrane also senses the nutrients such as magnesium, calcium, chlorine etc.

N, P, K DETECTION AND CONTROL FOR AGRICULTURE APPLICATIONS USING PIC CONTROLLER: A REVIEW:

This paper explains about the detection of nitrogen, potassium and phosphorus in agriculture soil. They are tested using chemical analysis methods such as conductivity measurement technique, electrochemical method, and optical method. The other ways are soil sampling and sample pre-treatment. **Conductivity Measurement Technique:** In this two or three electrodes are immersed soil samples. The electrodes must be same and can be of steel, silver, platinum, graphite or copper. Here the electrodes are connected to multimeter to measure the values that are being changed and one electrode is connected to AC voltage. Neutralization of ions can be avoided by applying A.C. voltage. When current varies conductivity also varies. Also when concentration increases electrical conductivity increases. **Electrochemical Method:**electrochemical sensors are used and consist of ion selective electrode (ISE) and ion selective field effect transistor (ISFET). ISE/ISFET has different membranes, chemical solutions and are coated with wire field effect transistor. The other type of electrochemical sensor is the CW/FET [3, 5] which has a platinum wire coated with PVC. This acts as membrane matrix and has cationic glass electrode (CGE) which is used for detecting the nutrients. **Optical Method:** this is the last type of sensing the nutrient in agriculture soil. Due to the incident light physical and chemical properties of soil varies. Along with this other technique such as laser induced florescence spectroscopy (LIFS) [3, 4, 5] can be done. This method absorbs the radiation to a certain wavelength and analysis the molecules. The last technique is the NIR spectrophotometric method where electromagnetic radiations are absorbed at a particular wavelength of range 780 – 2500nm.

OPTICAL SENSING METHODS FOR ASSESSMENT OF SOIL MACRO NUTRIENTS AND OTHER PROPERTIES FOR APPLICATION IN PRECISION AGRICULTURE: A REVIEW:

This paper explains about sensing methods and other spectroscopic methods for sensing soil properties. For sensing soil quality assessment two technologies are used. First one is the optical sensing where the level of energy absorbed/reflected by soil nutrients are detected using reflectance spectroscopy. The other technology is that electrochemical sensing where ion selective electrodes are used which in turn generates as a output voltage or output current. For sensing the soil properties the methods that can be done are near infrared spectroscopy, attenuated total reflectance spectroscopy(ATRS),Raman spectroscopy. In Near

infrared spectroscopy [4, 5, 6] the basic principle is the simple harmonic oscillator where photons are diffused and are interfered by polychromatic source of optimal radiation based on the range of infrared rays. In this the frequencies are similar to vibrational frequencies when absorbed and others will be reflected back. It also indicates the intensity of light due to the wavelength when diffused through the sample. If the intensity is less, it indicates the absorption and the presence of molecular bonds in the sample. VIS – NIR spectroscopy methodmainly determines the nitrogen content in soil. UV – VIS – NIR spectroscopy method senses the concentration of phosphorus content in soil and also absorbance spectra of soil. **Attenuated Total Reflectance Spectroscopy:** This method is similar to near infrared spectroscopy but the infrared is directed into crystal which is in direct contact with the sample and also has higher refractive index [5]. Here the principle is based on total internal reflection. The rays entering the crystal get totally reflected and the angle of incidence between the sample and the crystal must be greater than the critical angle. When radiations are absorbed this means that when soil is close to reflecting surface, the beam losses its energy. The attenuated radiations are measured and plotted by spectrophotometer. The crystal used to perform the principle is made up of zinc selenide, germanium and thallium iodide. Here nitrogen content, soil moisture content and organic content of soil are estimated. **Raman Spectroscopy:**This technique is based on the inelastic scattering of monochromatic light which is emitted from laser source. Inelastic scattering is defined as the diffusion of photons providing a change upon interacting with the sample. These photons are absorbed by the sample and can also be reemitted. The reemitted photons frequency can be shifted up or down which is compared to monochromatic frequency. This is known as Raman Effect [5]. It can also provide information based on vibrational transition of irradiated molecules and provides better result for phosphorus detection. The soil samples are analysed using laser beam. The laser beam are reflected and collected through Raman probe and fiber optic cable by spectrometer. The wave number range of Raman spectrum can be of about 350 to 3640 cm. The obtained data which is generated by the spectrometer is then communicated to processor for calculation of phosphorus concentration in the soil sample.

DETECTION OF NPK NUTRIENTS OF SOIL USING FIBER OPTIC SENSOR:

This paper explains about the detection of macro nutrients – nitrogen, phosphorus and potassium in agriculture soil using fiber optic sensor. Here the soil samples are taken at a proper depth (which is of 15 – 20 cm below ground level). To determine the macro nutrients, the sensor is built using multimode and plastic optical fibers. For chemical sensing there are various configurations and the design of optical fiber is critical. The fiber configuration is done by sensor probe which consists of seven fibers arranged in concentric configuration. Here the central fiber acts as a receiving fiber and the other fibers act as a transmitting fiber. The core diameter of each fiber is 448 µm [6] and is made of multimode plastic fiber. They are enclosed in a brass cylinder and works on colorimetry principle which deals with the colored intensity measurement. Sensor works on the colorimetric principle which deals with the intensity of colored light. The light waves are absorbed at certain wavelengths and results in excitation of electrons in its molecule. LED are used in order to emit light of same intensity. In this the light travels through the sensor and are reflected back. Different intensities are produced based on the color of absorption of solution. Those intensities are plotted against certain wavelength to obtain the spectrum at discrete wavelengths. Each time the distance varies between the sensor and reflector and output is noted at each intervals.

III.CONCLUSION

Monitoring the nutrients for essential crop growth is necessary as the amount of using fertilizers increases. Various technologies and techniques are used in determining the soil nutrients. Farmers can increase efficient crop productivity based on the overall pH value of soil and this leads to healthy life of living organisms. Further handy electronic sensor can be used which is less complex, time consuming and determines accurate pH value of soil.

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