

ON THE GO SOIL NUTRIENT IDENTIFICATION AND AUTOMATED FERTIGATION SYSTEM

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Abstract: Continuous cropping without any proper measurement and provisioning of soil nutrient may affect the life of the crop. Soil nutrient measurement is greatly required for proper plant growth and effective fertilisation. Moisture content present in the soil must be checked properly. Today manually turning ON and OFF of the motor pumps lead to wastage of water and insufficient supply of fertilizers. The objective of this proposed work is to provide an automated system for fertigation based upon the soil testing using pH sensor and interfaced with the Arduino. With the help of pH value the macronutrients such as nitrogen, phosphorous and potassium are determined in the soil. This automated system would minimize the time and human intervention to irrigate and fertilize crops. Initially NPK is measured from soil and sent the sensed signals to controller to fix ratio of fertilizers. The amount of fertilisers need to be supported to soil is sprinkled by the automated fertigation system. The farmer also gets a feedback from display about the status of the farm.

Index Terms: NPK measurement, soil moisture, water level, Arduino, fertiliser, fertigation.

1. Introduction

Indian economy is based on agriculture and the climatic conditions are isotropic and are not able to meet the needs of agricultural resources. The main reason is the lack of rains and sanctity of land reservoir water and overused of fertilizers so these parameters are to be monitored and controlled. This saves the farmers time, money and it cuts out intermediators who tend to buy low from farmers and sell high to end consumers. The status of a soil is said with respect to its ability to supply elements essential for plant growth without a toxic concentration of any element. Thus, soil fertility focuses on an adequate and balanced supply of elements or nutrients to satisfy the needs of plants. A soil test is a process by which elements (phosphorus, potassium, calcium, magnesium, sodium, sulphur, manganese, copper and zinc) are chemically removed from the soil and measured for their "plant available" content within the sample. The quantity of available nutrients in the sample determines the amount of

fertilizer that is recommended. Farmer does not test his land before feeding fertilisers. The automated fertilization unit increases the profitability of crop production and reduces potentially negative environmental impacts. Potential advantages of fertigation are higher yield, improved quality of produce, improved efficiency of fertilizer recovery, minimal fertilizer losses due to leaching, control of nutrient concentration in soil solution and flexibility in timing of fertilizer application in relation to crop demand based on development and physiological stage of crops. Scheduling fertilizer applications on the basis of needs reduces nutrient element losses associated with conventional application methods that depend on the soil as a reservoir for nutrients. In addition, fertigation reduces fluctuations of soil solution salinity due to fertilizers, thereby improving soil solution conditions particularly for salt sensitive crops. In general, with fertigation protection of soil and water from fertilizers on a sustainable basis can be achieved. Eventual disadvantages of fertigation include unequal chemical distribution when irrigation system design or operation is inadequate, over-fertilization in case that irrigation is not based on actual water requirements and chemical reactions in the irrigation system leading to corrosion, precipitation of chemical materials, and/or clogging of outlets. Most of these problems have been extensively studied [1] and solutions are available. Soil test based fertilizer prescription necessitates to avoid over use or under use of fertilizers for crop requirement. Quantity of NPK decides crop type and plant growth status and decides about the quantity of fertilizer to be used is further dependent on present contents of NPK nutrients in the soil.

A. Existing System

The existing system deals only about automatic irrigation, manual fertiliser spraying without testing of soil. Soil testing is not done by farmers. So farmers feed the fertilizers as it is in the field without any proper knowledge [2][3][4][5]. Mostly fertilizers are feed in agriculture land manually by the farmers. [6][7][8][9] The main drawbacks are feeding fertilizers manually will spoil the crops. If the fertilizers level is

high then the crop will be damaged and make a loss to the farmers. [10][11] After feeding of fertilisers the water should be supplied to the agriculture land. Manual intervention while operating motor is a major drawback.

B. Proposed System

This proposed work will help the farmer to put fertilizers in correct ratio and in correct time. This will be automatically done by mixing the fertilizers in the water tank and spraying it evenly so that incorrect mixing of fertilizers will be avoided. The main advantage is it requires proper amount of fertilizers and maintaining the value of pH. So that the fertilizers will be evenly distributed in agriculture land. The damage due to fertilizers will be reduced by using this proposed system. The overall process will be controlled by the Arduino and Humidity sensors. This system helps to improve productivity of crop by getting quick result of soil quality and recommending proper fertilizer.

2. Hardware Description

A. Block diagram

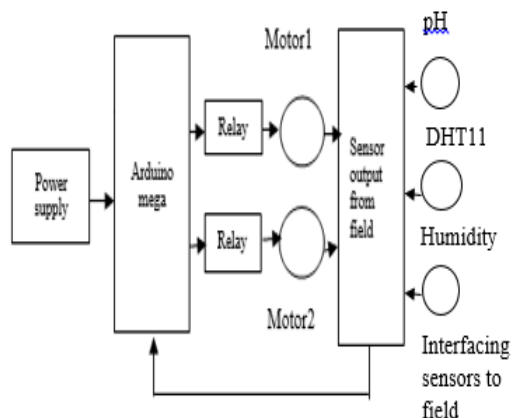


Figure 2.1 Block diagram

B. Description

- Arduino controller: Arduino mega is used as the decision making in the proposed system.
- pH sensor: A smart sensor that takes direct measurements of soil pH and send these data to controller.
- Pump motor: Water is fed throughout the farm using pump motor. It forms as a irrigation unit.
- BC547: To ON a motor BC547 is used. Based on the clock pulse generated in the microcontroller the transistor will on the relay and the relay circuit will on the motor.
- Relays: To start the motor relays are used. If the

controller gives an signal then the normally open will be converted into an closed loop and NC will be normally closed if there is no trigger signal from the micro controller then the circuit will be in the closed loop and if the controller signal is triggered then the relay changed its position to normally open and then the circuit will be in the open state and there will not be any current flow in the circuit.

- DHT11: The temperature of the field for irrigation purpose is measured by using DHT11.

- Humidity Sensor: Irrigation techniques like drip irrigation need accurate moisture content for plants. So moisture level must be monitored at frequent intervals and this could be achieved by using humidity sensor.

3. Methodology

The aim of this proposed system is to develop an on-the-go soil nutrient identification and automated fertigation system. To achieve this purpose, the development was divided into four stages when combined together they form a whole measuring electrical system. These stages are as follows

- Testing of soil
- Designing using Arduino controller and interfacing with the sensors
- Implementation in the field
- Prompting to farmer

This proposed system consists of temperature sensor, humidity sensor, and a pH sensor. This is correlated with the NPK measurement. Mainly pH level in the soil determines the NPK status of the soil. The relationship with the pH and NPK is as follows

Table 3.1 NPK relation to pH[7]

pH Value	Nitrogen Content	Phosphorous Content	Potassium Content
4.5(extremely acidic)	30%	23%	33%
5(very strong acid)	53%	34%	52%
5.5(Strong acid)	77%	48%	77%
6(Medium acid)	89%	52%	100%
7(Neutral)	100%	100%	100%

A. Testing of soil

Soil pH is an indicator of soil acidity and basicity. Most soils have a pH in the range of 4 to 10. The pH of a particular soil, such as 5 or 8, reflects a certain chemical and mineralogical environment in that soil, and thus the pH is of great importance to plant roots and microbial activity. Within the pH range of 4 to 10, the primary effect of soil pH on plant growth does not

depends on hydroxyl ions and hydrogen ions but associated with chemical environments. In general, the major influence of pH is on ion activities that affect the toxicity of elements like Al and Mn or on nutrient. Nitrogen availability is maximum between pH 6 and 8 because the mineralization of N is maximum in this range. The availability of P in acid soil is reduced by precipitation and adsorption by Fe and Al. For these reasons soil pH is one of the most important factors affecting soil fertility and so is commonly managed to increase crop yields. Based on pH status the plant type which must be grown on the particular soil is decided. This serves as an awareness to farmer. The above details are further listed in the table 3.2.

Table 3.2 Plant growth with pH level

Soil pH	Plant growth
>8.3	Too alkaline for most plants
7.5	Iron availability becomes problem
7.2	Acceptable for most plants
7.0	Near neutral
6.8	
6.0	
5.5	Reduced microbial activity
<4.6	Too acid for most plants

Table 3.3 Solubility of fertilizers in water
(kg fertilizer/m³)

Type of fertilizer	Solubility (kg/100 litres)
Ammonium sulphate	71
Ammonium nitrate	119
Urea	110
Monoammonium phosphate	23
Potassium sulphate	7
Potassium nitrate	32

When choosing the P fertilizer for fertigation, besides solubility, care must be taken to avoid P-Ca and P-Mg precipitation in the tubes and emitters. From this standpoint, acid P fertilizers (e.g., phosphoric acid, urea phosphate or monoammonium phosphate) are recommended. Different sources of fertilizers, including P fertilizers, have different effects on irrigation water and soil pH. High pH values (>7.5) in the irrigation water are undesirable. Calcium and Mg carbonate and orthophosphate precipitations may occur in the tubes and the drippers. In addition, high pH may reduce Zn, Fe and P availability to plants. The desired pH is below 7 and the range favoured by most

cultivated crops is 5.5-6.5. The pH of the irrigation water could be reduced or controlled by using P acid or acid based fertilizers like urea phosphate and monoammonium phosphate.

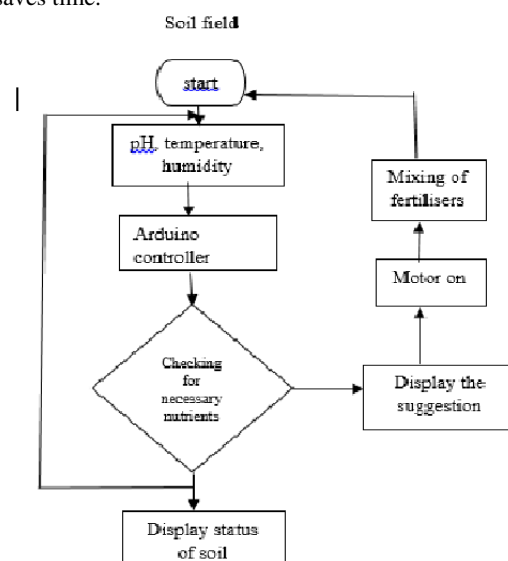
The use of acid fertilizers in drip systems may be beneficial in many ways other than the direct benefit from the added P, such as increased solubility of soil native P minerals, increased availability of other nutrients and micronutrients and prevention of chemical clogging of the fertigation system.

B. Prompting to farmer

After testing a suggestion will be generated which tells information to farmers, what contents is are present in soil and how much amount of fertilizers is needed as per the requirement of soil. An irrigation system uses a microcontroller, where the water is supplied only when the moisture in soil goes below a pre-set threshold value. The irrigating tank has water and fertilizers mixed in the correct proportion. The automated fertilization system assures spraying of fertilizers through sprinkler system. Further, the fertilizers will be sprayed through water pipes and sprinkler system after receiving signals.. This will enable the user to supply appropriate fertilizers in the field which ultimately results in high yield.

4. Results

An automated system for fertigation is based upon the soil testing. The macronutrients such as nitrogen, phosphorous and potassium are determined from soil as a relation to pH. Based on the pH value the farmer is suggested with the suitable fertiliser for the field. This enhances the usage of fertiliser in a proper way and saves time.



For fertigation two motors are turned ON. One motor is from the well and another motor is from the fertilizer mixed tank and mixed together and fed to the land. After the water reaches its maximum level both the motors will be turned OFF automatically.

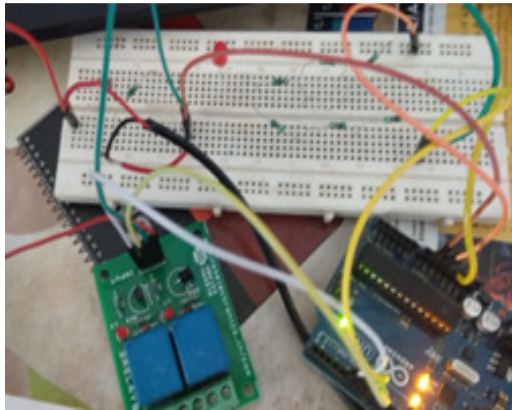


Figure 4.1 Output indication to turn off the motor

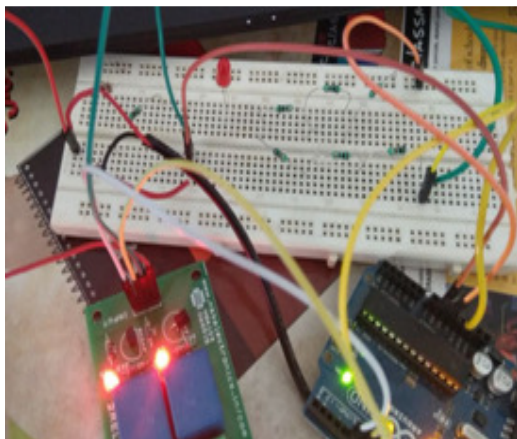


Figure 4.2 Output indication to turn off the motor

This process can be controlled by the Arduino micro controller and humidity sensor which is already fixed with agriculture land. The humidity sensors are connected with the Arduino micro controller and will be used to turn off the motor. To turn ON the motors automatically the micro controllers are used and to turn off motor humidity sensor is used. If the humidity sensor is high due to the water in the agriculture land then the motor will be turned off automatically by the motor.

Both the normal and fertilizer mixed water are fed in the agriculture land. This is one of the easiest way to feed fertilizer to the agriculture land. And the effect due to the fertilizer is reduced by using this proposed work.

5. Conclusion

This proposed system suggested the fertilizer details to farmer in a way that farmer could feed the land in an even manner and without any deficiency to crops. The farmer could get all the proper information about the details of the soil including pH and nitrogen, phosphorus and potassium levels. This avoids over dosage of fertilisers and it is user-friendly to farmers. This proposed system could be further enhanced by using advanced measurement techniques and this could be monitored by using LabVIEW. This could be further improvised with intelligent techniques and smart sensors.

References

- [1] Viscarra Rossel, R.A.V.; Gilbertson, M.; Thylen, L.; Hansen, O.; McVey, S.; McBratney, A.B. —Field measurements of soil pH and lime requirement using an on-the-go soil pH and lime requirement measurement system”Quality of runoff from fescue plots treated with poultry litter and inorganic fertilizer. J. Env. . 23:579-584.
- [2] Bundy, L.G., T.W. Andraski and J.M. Powell.”ASAE. 2005. Manure Production and Characteristics “Publication D384.3
- [3] Raghavendra,R. M.UttaraKumar,S. A.Hariprasad, “Implementation of Simulated Water Level Controller”, International Journal of Advanced Research in Computer Science and Software engineering.
- [4] Edwards, D.R., and T.C. Daniel”Management practices effects on phosphorus losses in runoff in corn production systems” J. of Environ. Qual. 30: 1822-1828.1994.
- [5] F J Veihmeyer, and A H Hendrickson, "Soil Moisture in Relation to Plant Growth," Annual Review of Plant Physiology, Vol. 1, 1950, pp. 285-304
- [6] Raghavendra,R.M.UttaraKumar,S.A.Hariprasad, “Implementation of Simulated Water Level Controller”, International Journal of Advanced Research in Computer Science and Software engineering pp(328-329).
- [7] Santhi, R, S. Maragatham, K.M. Sellamuthu, R. Natesan, V.P.Duraisami, Pradip Dey and A.Subba Rao.2012. Soil Test and Yield target based Fertiliser prescriptions (Tamil), AICRPSTCR, TNAU, Coimbatorel

- [8] F J Veihmeyer, and A H Hendrickson, "Soil Moisture in Relation to Plant Growth," Annual Review of Plant Physiology, Vol. 1, 1950, pp. 285-304,
- [9] A Survey on Soil Testing, <http://www.vegetablegardener.com/item/2374/soil-testing-savvy>, Accessed on 15th May 2015.
- [10] Singh, D., Chhonkar, P.K. and Pandey, R.N. 1999. Soil plant water analysis – a methods manual. New Delhi, IARI.
- [11] T.Sivaranjani.,J.Indirapriyadharshini,“Virtual Instrumentation Based Continuous Monitoring and Control of Drip Irrigation System in Agricultural” Automation and Autonomous System, vol 9(6),pp105-107
- [12] S.V.Manikanthan and T.Padmapriya “Recent Trends In M2m Communications In 4g Networks And Evolution Towards 5g”, International Journal of Pure and Applied Mathematics, ISSN NO:1314-3395, Vol-115, Issue -8, Sep 2017.
- [13] T. Padmapriya, V.Saminadan, “Performance Improvement in long term Evolution-advanced network using multiple input multiple output technique”, Journal of Advanced Research in Dynamical and Control Systems, Vol. 9, Sp-6, pp: 990-1010, 2017.

