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# Precision Data Acquisition and Analysis for Nutrient Management of Tomatoes

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***Abstract* - Agriculture is the soul of every nation, where it considers some factors such as uneven rainfall, changing climate and weather conditions, monsoon for soil and nutrient during the crop growth. Agriculture is predominantly essential and the main source of our livelihood. Nutrient management is a major thirst area and to be the focus in the field of agriculture. Due to the paucity of nutrients in plants, the human is forced to face many challenges in day-to-day life. Restoration of nutrient is crucial, in this view there is need to espouse the precision agriculture system which alters crop related plan and policies. The main aim of this research is to collect some of the factors influencing nutrients in plant growth and analyze them. The data collection is done by both manual and precision methods. The plant chosen for the analysis is Tomato - a horticulture crop. This is an attempt towards developing an expert system based on precision data.**
***Keywords:* Expert System, Precision Agriculture, Nutrient Management, Sensors**

## I. INTRODUCTION

The major challenge in the field of agriculture is to increase the yield in such a way to feed the growing population and to minimize the pressure on the utilization of land resources. Fertilizers are used to improve crop production in terms of water user efficiency (WUE) [10] and nutrient use efficiency (NUE) [9]. In order to maintain a steady supply of food, it is not sensible to diminish or eradicate the usage of fertilizers. The only possibility is to use the fertilizers in such a way that the nutrients in the soil regained or regenerated. Crop rotation is a remedy for that. Global climate change has a greater impact over agricultural production. The increase in the world population is starting to put forth the million dollar question regarding the availability of fresh water and the quantity of water available for crop production [8] in the future .

Agriculture demands for proper management of agriculture resources that satisfy augmented demand for food. To consume a safe and healthy life there comes the need for precision agriculture which implements advanced technologies like the Internet of things [1].

With the advent of new technologies such as Geographic positioning systems (GPS), Geographic Information System (GIS), sensors, advanced software etc Precision agriculture is made possible. It is targeted to modify the production parameters such as fertilizer, irrigation, pH value, temperature, humidity etc. This paper implements the precision data acquisition and analysis for nutrient management of tomatoes in the terrace garden.

## II. BACKGROUND STUDY

Dholu, M., & Ghodinde, K.A., have presented about the Internet of Things (IoT) for Precision Agriculture Application [1]. In this paper, an electronics system has been proposed that includes a sensor node along with the IoT application in the domain of agriculture. The proposed system is capable of sensing data and controlling the parameter locally. Simultaneously it sends data to the Thing speak cloud which is further accessed by the user through a mobile phone. In the future scope of this work may be to improve the usage of a mobile app like adding alarms, if a particular parameter is not controlled properly. In the proposed system, the set point for relative humidity, soil moisture, and surrounding temperature are obtained during coding of the MCU. To make this prototype more practical this control of setting the set point can be given to the mobile app itself.

Bharate, A.A., & Shirdhonkar, M.S., have presented a review of plant disease detection using image processing [2]. In this paper, the researchers reviewed the technical implementations in the research area of plant disease detection using image processing techniques. From the observations of the authors, it is understood, that the color, texture and morphological features are most suitable to identify and classify the diseases in plants. Most commonly used classification techniques for classifying plant diseases are artificial neural networks and support vector machine. Automatic detection of plant diseases would solve the problem of an expensive domain expert. Detection of plant diseases in early stage would help farmers to improve the crop yield, which in turn improves Indian gross domestic product (GDP).

Tian *et al.*, have presented about the Detection system for Greenhouse Tomato disease degree based on Android Platform [3]. M.A. Mirhosseini, Y. Fathipour, M. Soufbaf and G.V.P. Reddy, have presented their research works on Implications of using two natural enemies of Tuta absoluta (Lepidoptera: Gelechiidae) toward tomato yield enhancement [4] for Tomato leaf miner (TLM). Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae) is the most common and popular destructive pest of tomato crop worldwide. The authors tested the measure and quality of tomato fruits after simultaneous use of two biological control agents, the predatory mirid bug Nesidiocoris tenuis (Reuter) and the egg parasitoid against TLM.

The highest number of fruits per cage, the percentage of undamaged fruits, total yield weight, and undamaged yield weight were all obtained with predator-in first treatments, with or without parasitoid releases. Furthermore, measures of fruit quality were also highest in predator-in-first treatments, including, highest percentage of water, greatest proportional fresh weight of carbohydrates, most lycopene, most β-carotene, most flavonoids, and highest total chlorophyll. Thus, the researcher's findings support a predator-in-first augmentation approach for management of TLM.

Verma, S., Chug, A., & Singh, A.P, have presented about Prediction models for identification and diagnosis of Tomato Plant Diseases [5]. In this paper, the researcher presented a survey on detection and prediction models for tomato plant diseases, based on Image processing and IoT sensors and summarizes the studied approaches and methodologies. The main goal of this paper was to find the computational and biological aspects of disease identification. They intend to combine and carry out IoT sensors and Imaging techniques exhaustively as well as study implications of both coalesced.

Gupta, P.M., Salpekar, M., & Tejan, P.K., have presented about Agricultural practices and improvement using IoT enabled SMART sensors [6] which describes IoT, Cloud and Data Analytics. This can positively influence modern agricultural practices by enabling traditional farmers or end users with the latest tools to give precise assisted support to take intelligent actions.

## III. METHODS AND MATERIALS

Solanum Lycopersicum - Tomato is a horticulture crop grown throughout the world. It is an annual vegetable crop and ranked as second next to potato due to its importance. Because of its medicinal value and highly nutritive, Tomato is the widely cultivated vegetable in India. It is one of the most important commercial vegetable crops. The yield of tomato depends on a number of parameters like climatic conditions, nutrients, irrigation, soil, time of sowing, the population of the plant, pests etc. Nutrient management is the basic and most crucial parameter that influences the growth, quality, and yield. In the world, India is one among top three nations of huge production tomato and produces 18.7 Million tons of tomato, but the quality, as well as productivity, declined due to various diseases, pest attacks, nutrient deficiency, and uneven climatic conditions. Existing agricultural practices usually lacks in proper soil testing, watering, and water testing, fertilizer calculation, proper pest management, data collection of micro-organisms [5]. All this needs a more human resource. These are a tedious and difficult process for a farmer to take open eye reading for the entire crop in the field.

The horticultural crop tomato is chosen for precision data acquisition and analysis in this research work. A terrace garden is set up for experimental study. The growth of the crop is monitored from the pre-seedling stage until the fruiting stage. Overall data is collected from ten sets of samples placed in the terrace garden (s1 to s10) for a period of 12 weeks. The following figures.1-4, represent the stages of growth of tomato from the pre-seedling stage to the fruiting stage. The duration of crop growth is recorded for the period of 84 days which is approximately 3 months.

Fig.1 Pre-seedling and Germination Stage

Fig.2 Vegitative Stage

Fig.3 Flowering Stage

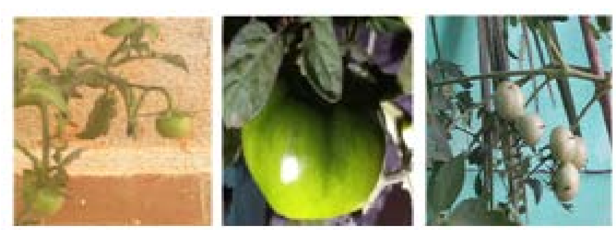

Fig.4 Fruiting Stage

Fig. 5 Terrace Garden

The three mandatory parameters of every crop are soil Moisture, light intensity and pH value are considered for this preliminary level of experimentation. Temperature and light intensity affect the fruit-set, color and nutritive value of the fruit. The data collected from Manual Testing of Soil Fertility(pH) using Universal Indicator paper compared with the data collected from the Three-way meter.

Being the preliminary level of data acquisition, the data collected from the sensor are manually entered into the analysis framework.


Fig. 6 Manual Testing of soil Fertility (pH) using Universal Indicator pape

Fig. 6 shows the manual pH soil test using Universal Indicator Paper which is sensitive to pH, before the test it appeared like yellow in shade and after testing it appeared like the olive green in shade, which indicates the pH range between 7.0 to 9.0, proper soil testing is more important. The paper indicator test is taken every week for the ten set of samples and the values recorded.

Fig. 7 Three way Meter

Fig. 7 shows the manual soil testing using a three-way meter which consists of the parameters such as soil moisture, light intensity, and pH range.

The way of taking readings by the three way meter is represented in figure 8. The readings of Moisture ranges between 1 to 10 (1-Dry: 10-Wet), the readings of light intensity ranges between 0 to 2000 (0-Dark: 2000-Light), the readings of pH ranges from 3 to 8 (3-Acidic: Alkaline-8).
The readings recorded for all the ten samples every day and the data is analyzed.

Fig. 8 Three way Meter reading

## IV. DATA ACQUISITION AND ANALYSIS

The data collected using the manual paper test method and the sensor based three-way meter collected from the terrace garden for all the ten set of samples. The paper test has conducted on a weekly basis. The exact values could not be measured using the paper test. It did not show major differences. It usually showed a color between 7 and 9 reference values.

But the three-way meter readings used to collect values both in the morning and afternoon. Even though the scope of this paper is to compare the pH value collected through both the methods, the soil moisture, and light intensity values stored and recorded for future analysis. The average value of the soil moisture, light intensity and soil pH values collected for each sample is given in the following table.

TABLE I AVERAGE READINGS FOR TEN SAMPLES

| Samples | Soil Moisture | Light Intensity | Soil pH value |
|---|---|---|---|
| S1 | 7.667 | 955.556 | 7.664 |
| S2 | 7.333 | 588.889 | 7.657 |
| S3 | 6.333 | 861.111 | 7.657 |
| S4 | 7.667 | 555.556 | 7.657 |
| S5 | 7.000 | 761.111 | 7.693 |
| S6 | 7.000 | 511.111 | 7.768 |
| S7 | 8.111 | 855.556 | 7.850 |
| S8 | 7.667 | 533.333 | 7.710 |
| S9 | 6.556 | 844.444 | 7.657 |
| S10 | 7.778 | 533.333 | 7.768 |

The pH value depends on the soil moisture as well as the manure provided to the samples. The samples S1 to S3 are given vermicompost, S4 to S6 are given organic manure, S7 without any kind of manure or fertilizer and S8 to S10 with chemical fertilizers. Depending upon the weekly average the manure is given every month. The pH value changes recorded and it started reducing from alkaline with value 8 to desirable 6.0 to 7.5 for tomatoes.

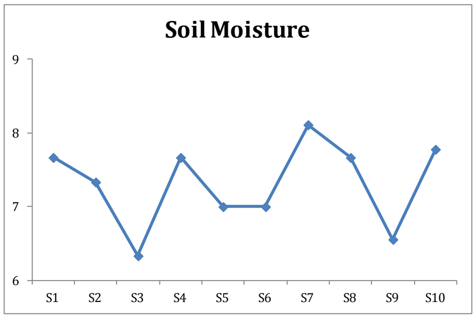


Fig. 9 Average Soil Moisture for ten samples

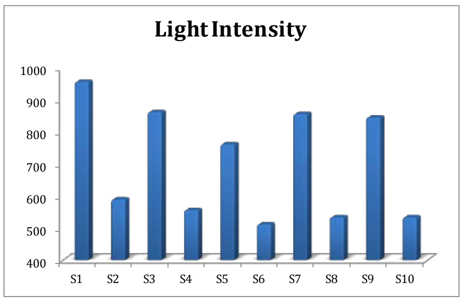


Fig. 10 Average Light Intensity for ten samples

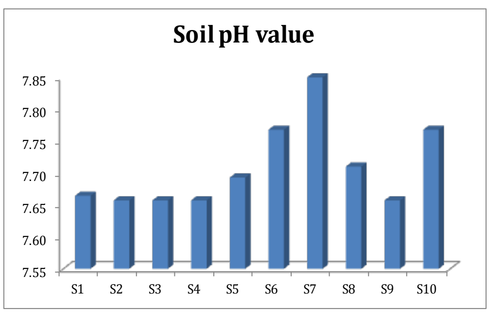


Fig. 11 Average Soil pH value for ten samples

## V. CONCLUSION

The data collected from ten samples have analyzed in this paper. The suitability and challenges associated with precision data acquisition and analysis are also studied during this period. The Future work will be based on Precision Agriculture that provides a user friendly cost effective background with high-precision nutrient management for crops, pest, and disease free crop [6] to the farmers, The tedious manual data collection will be overcome by automated data collection and also to relieve the burden of the farmers and make comfortable with automated farming techniques.

## ACKNOWLEDGMENT

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