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WSN based Soil Moisture Stress Monitoring and identifying its association on Other Parameters on plants growth using hadoop Framework

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***Abstract*—** Nowadays farmers are facing huge difficulties in their cultivation and don't get expected yields due to several diseases caused by many factors such as unpredictable changes in weather and soil parameters. This problem leads to research in the area of agriculture towards precision agriculture with an intention of improving the crop yield. The lots of research works are underway on precision agriculture. In this regard, this paper present research work of study on how soil moisture affects the growth of tomato plant and its association among other soil parameters such as temperature, pH etc.,

***Keywords*—** precision agriculture, wireless sensor network, soil temperature, soil ph, classification tree

I. INTRODUCTION *(HEADING 1)*

Agriculture is the most important factor and it plays a vital role in human life. Precision Agriculture is the latest advancement in the farming of modern agriculture [1],[2]. In precision agriculture, modern technologies are used for agriculture to improve the crop yield and predict the possible disease and take necessary actions well in advance. The technologies like sensors are used to build Wireless Senor Network to collect the soil and other weather parameters, which are the essential parameters for growth of plants. The variation on those parameters and its effects on growth of the plants are identified through proper analysis of sensor data using modern technology such as Hadoop Framework using Cloud Computing Technology. The sensor based collected data forms the training data set for the classification tree induction. The classification tree will be generated for predicting the possible diseases & its various disease stages. The Decision Support system comprised of repository of parameters effects and its correspondence towards diseases are stored. The soil and different weather parameters required for plants growth are associated with each other. Proposed Paper carries the work towards identifying the association among soil and environmental parameters on plant growth and predicting the possible diseases.

Wireless Sensor Network is key area of research in computer science. Nowadays WSN is been used in many applications, which is indication of its popularity. Even though being used in many areas, WSN expecting enhancement in some of areas such as energy efficient routing, since WSN nodes are battery/energy constrained devices. In this regard, many people around the world doing their research for enhancing the WSN technology. In this paper, WSN is being used for collecting soil and weather parameters and exposes a pores for further research for increasing the performance of WSN for better data collection and prediction of diseases.

The classification tree generation becomes a difficult task, when training data sets are large. Hadoop is the well-known and most popular tool of the era for huge data processing. Hadoop works based on map-reduce programming paradigm. In this paper, hadoop framework is used for building a classification tree [3]. The efficient map-reduce program are written in java to identify the association among the environmental parameters and obtain the threshold on each factors.

II. LITERATURE SURVEY

A. Soil Moisture Effects on Plants Growth

The moisture content on the soil is the key nutrient for proper growth of the plant. The moisture stress on plants leads to certain diseases [4]. Some of the deceases symptoms of moisture stress include stem discoloration, vascular discoloration, leaf blighting, raised spot on unripe fruits [5],[6]. The moisture stress effects the tomato plants during different stages such as flowering stages, fruit ripening stages [7]. Moistures stress leads to the reduction in vitamin c in fruit and TSS and acidic contents on fruits and reduction in flowering [8].

B. Association Rule Mining

In association rule mining, the associations among the data items are analyzed and end up with a rule apriori algorithm [9]. In this paper association between temperature, soil moisture and other parameters are considered to identify the association among them. The association is used for creating classification tree to predict the possible disease and identifying the each parameter threshold values

III. METHODOLOGY

The architectural diagram for the proposed WSN based precession agriculture is shown in figure 1. The experiments were carried out on the in-house Experimental setup, which builds a Wireless Sensor Network test bed for monitoring 3 tomato plants as shown in figure 2 & figure 3. Soil moisture, soil temperature and pH sensor are plugged to each plant. The uniform quality seedling were chosen and planted on three plastic jars. Plastic Jars had a proper drainage for excess water outflow. The excess water outflow are collected in container and analyzed for Ph Level. The following experiment was done by inducing a different level of moisture stress on each plant. As the moisture stress induced, correspondingly the values of temperature, soil moisture, and Ph level at that level of moisture stress are collected from each plant. The corresponding temperature, soil moisture, salinity and pH levels are collected and framed the training data set and undergo analysis for identifying the association among them. The training data set is given hadoop map-reduce framework for classification tree generation. The classification tree will be utilized for latter data to put into specific class of diseases prediction. The rules generated by classification tree will used for identifying the proper association among them provides a better and deeper understanding of their association and effects on plants growth and predicting the possible disease.

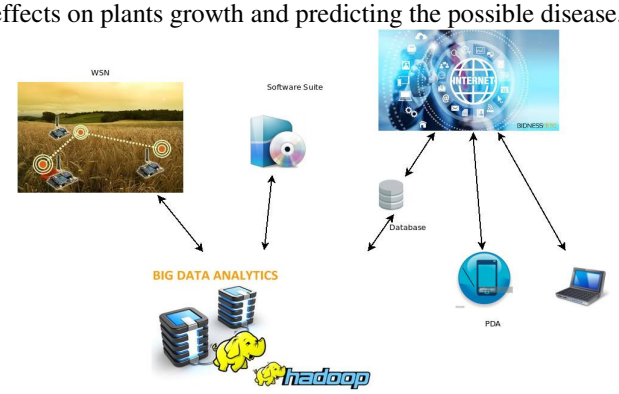

Figure 1 Architectural Diagram

The following figure 2 shows the actual setup of the in-house covered chamber for plant monitoring

Figure 2 Experimental Indoor Setup

Chamber is prepared for 3 plants to maintaining the same humidity level. The external co 2 generator is provided for co2 consumption by plants as shown below. The experiment data are exported to the file for analysis; hadoop framework is used for analysis and identifying the threshold on temperature and other parameter for noted diseases. Initial water capacity of the pot is measured and the 20 % Pot capacity, 40 % pot capacity and 60 % pot capacity water is given to plant 1, 2, and 3 respectively.

A. Experimental test Setup

The steps taken for experimental test setup are as follows,

1. the plastic jar of size 26cm(W),48cm(L) are used for planting, three jar's are taken (one for each plant)
2. Inserting temperature, moisture, salinity sensor, and pH sensor on plant 1,Plant2 & plant 3
3. Increasing moisture stress
    a. Every Day: Putting 20% Pot Capacity of water to 1st plant
    b. Putting 40 %Pot Capacity of water to 2nd plant
    c. Putting 60 %Pot Capacity of water to 3rd plant

The soil moisture level, Temperature, Ph Levers are started collecting since first day of plant seeding. Tomato plants are grown in controlled environment and provided with a required nutrients [10].Every day values are collected for twice, first one is before watering and second time after watering . The following Table 1 shows the snapshot of values taken after 14 days vegetative period on 15th and 20th day.

Day	Plant	Temperature	Water	Moisture	Ph	Diseases Identified
Before Watering						
Day 15	Plant 1	25.036	Initial	11.8645	6.5	Dried leaf
	Plant 2	24.670 ºC	Initial	13.416	6.2	Burn leaf
	Plant 3	24.843 ºC	Initial	11.648	6.6	Bend in Stem, died leaf
After Watering						
	Plant 1	24.987 ºC	40%PC	25.143	6.4	Dried leaf
	Plant 2	24.297 ºC	20%PC	28.3545	6.2	Burn leaf
	Plant 3	25.107 ºC	60%PC	20.8492	6.7	Bend in stem, Died leaf
Before Watering						
Day 20	Plant 1	24.0971	Initial	14.8954	6.1	Dried leaf
	Plant 2	24.1957	Initial	14.4264	6.3	Burn leaf
	Plant 3	24.3856	Initial	15.1841	6.5	Bend in stem, Died leaf
After Watering						
	Plant 1	24.3789	40%PC	24.0245	6.5	Reduction in Dried leafs
	Plant	24.269	20%P	27.4163	6.3	Reduced Burn

	2	1	C			leafs
	Plant 3	24.6351	60%PC	19.5502	6.8	Bend in stem, Died leaf

Table 1Experimental Dataset

B. Steps taken during Experiments

- Exported the everyday collected to excel sheet analyzed for association among parameters.
- If disease is identified, accordingly noted down the corresponding parameters values and considered as threshold.
- Selecting records of disease identified and considered as training data set for classification Tree [11].
- Rules are generated as per the classification tree, for predicting diseases.

The experiment carried out for 30 days since seedling and graph shows the effects of temperature and moisture. The training dataset for classification tree generation is shown in Table 2. The figure 3 shows the classification tree generated corresponding to the training dataset.

Prediction Attributes			Class/Diseases affected – Y/N
Temp	Moisture	Ph	
>28	<11	Increases Rapidly	Yes - Reduction in growth and damping off stem
<28	11> & <20	Increase slowly	Initial Stage - Dried leafs and reduction in growth, intial stage of affection
<28	>20	Low effects on salinity	No – Ideal with respect to temperature and moisture diseases

Table 2 Training Dataset for Classification Tree

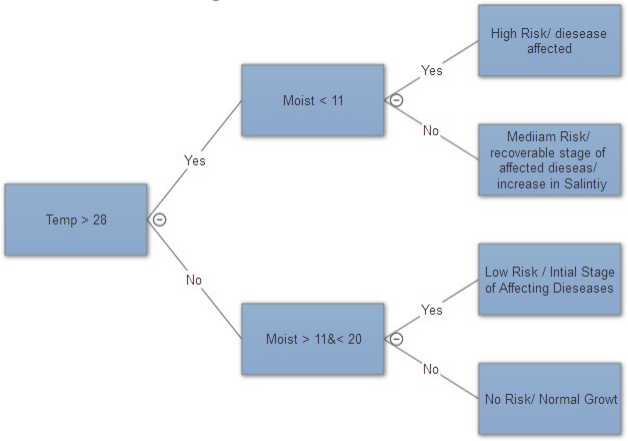

Figure 3 Classification Tree

IV. RESULTS & CONCLUSION

The experiment shows how temperature varies with respect to moisture stress. If moisture stress reaches the threshold of less than 11, plant reaches the wilting point and temperature increases to 27°C above indicates the moisture stress and burn or dryness on leafs and plant wilting. Hence if soil temperature increases above 27 °C it may due to the moisture stress. The moisture stress decreases the pH level to 6 to 6.4 ~ and make pH of the soil in alkaline condition. The current work provides a scope of identifying the salinity stress under moisture stress.

Figure 4 Burn on Leaf, Initial Stage

Figure 5 Dried Leaf

Figure 6 Dry Leaf Affected Stage

Figure 7 Stem Bend , High Risk, Disease infected

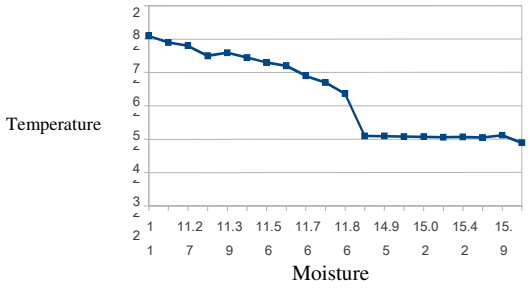

Figure 8 Moisture Stress Vs Soil Temperature

The results shows the images of defected plant due to moisture stress, plant 1 with moisture stress of 20% pc with corresponding disease, plant 2 with moisture stress of 40% pc and corresponding disease, plant 3 with moisture stress of 60% pc and corresponding disease.

There would be an increase in temperature, when moisture stress increases. Plant leaf area plays key role in photosynthesis process. Moisture stress affects the plant leaf in different stages, initially starts with a burn spot on leaf as shown in fig 4. If moisture stress untreated, then effects moves onto convert the leaf to dried leaf as shown in fig 5 & 6. Continuation of moisture stress on plant leads to severe damage of stem wilting point as shown in fig 7. Experiment shows that stem wilting point and burn spot in leaf area occurs, when moisture level goes less than 11. The soil temperature, when moisture stress reaches 11 is 27° as shown in fig 8. Hence association among the temperature and moisture stress is identified and temperature threshold of 28°C is the indication of moisture stress for plant wilting point. The graph in Figure 8 shows the association among the temperature and moisture stress level.

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