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A Survey on Disease and Nutrient Deficiency Detection in Cotton Plant

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***Abstract*—** Cotton is most important fibre crop which plays very important role in economic and social affairs of people, especially in India, but if disease like Alternaria Leaf Spot and deficiency of some major nutrients goes undetected in early stage then it can reduce as much as 25% of total production. In this paper, Various methods and algorithm has been discussed and compared for the detection of above. Since thousands of years, farmers have been detecting these defects in cotton. Number of methods has been proposed by various researchers which vary largely in technology. Earlier visual symptoms were the main source for defect detection in every plant, but then researchers have come with technologies like Image Processing, Optical Sensor, and Spectroscopic Determination etc. Ultimate goal of our research is to detect disease and nutrient deficiency in cotton plant. These techniques and methodologies have been studied thoroughly and then compared to get a single view in this paper.

Keywords: Cotton, Leaf, Image Processing, Disease, Detection, Nutrient Deficiency, Optical Sensor

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I. INTRODUCTION

This survey paper is basically aimed to review all the technologies and algorithm by which one can detect Alternaria Leaf Spot (A major disease found in cotton crops in India), Anthracnose, Bacterial blight, Boll rot, Fusarium wilt, boll worm and deficiency of major nutrients like Nitrogen, Phosphorous, Potassium, Zinc, Boron, Sulphur and Iron.

Indian people started producing and using cotton since Indus Valley Civilization. India thus enjoys a position being earliest country in the world to domesticate cotton and utilize its fiber to manufacture fabric. According to government records, India's 64% people are related with agriculture. Cotton is major crop produced in India. India is 2nd largest producer of cotton after China. And most of this cotton is utilised in India only. This shows importance of cotton in Indian society. Current conditions show that India is among the largest cotton exporter countries. Annual survey shows that as much as 25% of cotton production is reduced due to numerous diseases and deficiency of essential nutrients. Alternaria Leaf Spot is major disease seen in Indian cotton.

In this survey paper, all the techniques and methodologies proposed by researchers have been discussed. Not only techniques but their performance, limitations, accuracy everything has been analysed and discussed in this paper.

II. REVIEW OF PRIORLY USED TECHNIQUES

Numerous techniques and methodologies used in this area is reviewed and briefly described here.

Various papers had been published regarding disease detection in cotton crop. Nutrient deficiency detection is not among the topics much spoken of. Large number of researches in this area is focused on disease detection rather than deficiency of major nutrients. Instead of mixing all different techniques at once, we have classified the methods according to techniques the researchers have used in their research.

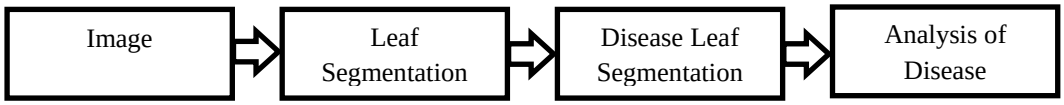

Figure 1.Cotton Leaf Diagnosis System

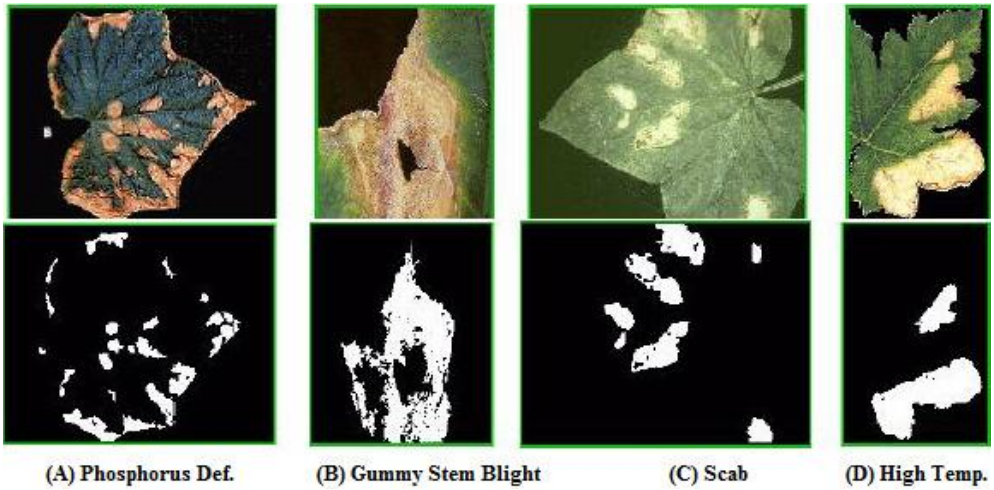

Figure 2. Features of Diseased Cotton Image

A. Visual Analysis

Analyzing the plant visually is oldest method to detect disease and nutrient deficiency in plants. And so this is no different in case of cotton plant. As describe earlier, cotton plant is one of the oldest crop grown by people. So farmers were known to facts about how leaves change their shape and colour when some defect occurs. We have methods to identify deficiency of nutrients in cotton plant.

In their paper of IOWA State University [1], author has suggested various visible methods to detect nutrient deficiency in plants. The properties are given for corn plant, but these symptoms are generally common in each plant. For example, Nitrogen deficiency causes pale, yellowish-green plants with spindly stalks. Symptoms appear on leaves as a v-shaped yellowing, starting at the tip and progressing down the midrib toward the leaf base. Like Nitrogen, deficiency of other nutrients like Phosphorous, Potassium, Calcium, Iron, Boron, Molybdenum etc. can be detected too.

In their module of Montana State University [2], they also have given visual ways to detect deficiency of nutrients mentioned above. This is techniques doesn't vary largely. Additionally, they have given ways to diagnose these deficiencies.

There is specific time period until which this analysis should have been made. And there may be a chance where our prediction may get wrong which can be very harmful. We need deep technical knowledge to detect nutrient deficiency and also that there are limited time during which detection is possible. As a diagnostic tool, visual observation can be limited by various factors, including hidden hunger and pseudo deficiencies, and soil or plant testing will be required to verify nutrient stress. There is not much scope of research in this method. "What s there is there for permanently" is a way visually analysis works.

Nonetheless, the evaluation of visual symptoms in the field is an inexpensive and quick method for detecting potential nutrient deficiencies or toxicities in crops

So we need a reliable and easy method for this.

B. Image Processing

Image Processing is a noble technology for defect detection in cotton crop. There has been large research going on this issue. Number of researchers has used various techniques of Image Processing for this. The main source for the disease is the leaf of the cotton plant. About 80 to 90 % of disease on the cotton plant is on its leaves. So for that their study of interest is the leaf of the cotton tree rather than whole cotton plant the cotton leaf is mainly suffered from diseases like fungus, Foliar leaf spot of cotton, Alternaria leaf spot of cotton. Image Processing uses this leaves for processing.

Figure 3. Proposed Workflow [5]

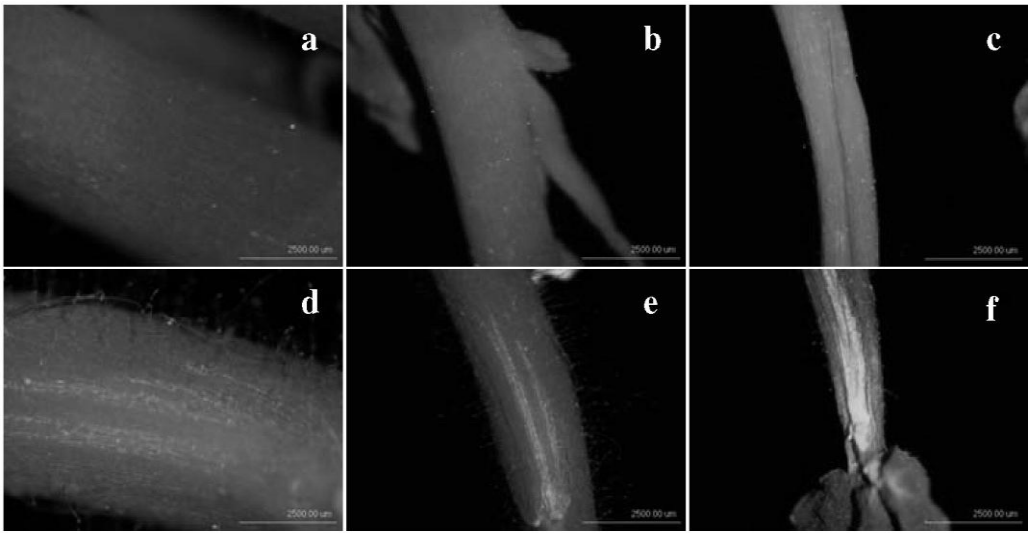

Figure 4. Microscopic Images of Plant

In one of these methods, [3] image database is used to compare with input image after extracting features and then diseases has been classified as four categories wiz. Bacterial Diseases, Viral Diseases, Fungal Diseases and Diseases occurred due to insects. Colour image segmentation has been used as shown in fig.1 and fig.2 given above. Using this technique it becomes easy to extract the various features of diseased leaf of cotton image.

Working diagram is shown in fig. 3.This method provides 85 to 91% exact disease detection depending upon the quality of image provided by the portable scanner and the training. More train network leads to a very efficient diagnosis of the diseases on the cotton leaf.

In another work, [4] computational system developed is developed to identify from images the existence, or not, of pathogens in a given plantation. Based on these studies, three diseases has been detected wiz. Ramularia (RA), Bacterial Blight (BA), and Ascochyta Blight (AS). RGB colour model is used to read the image from data bank. DWT is used at third level to each colour channels. The wavelet energy for each sub-band is computed after applying DWT to the third level. The resulting values are inserted into the corresponding feature vector. For feature classification, the method presented in this work uses an Artificial Intelligence technique largely employed in binary classification, known as Support Vector Machine (SVM). Results show that from a total of 105 images, 101 images were properly classified as belonging to healthy class (92.6%).

In a related work, [5] damaged paddy leaf has been detected using Image Processing. Though we are concerned with cotton crop, this work is of much use as the method followed by them is very similar to cotton plant. Work flow used is shown in fig. 3. Defects have been detected with 90% accuracy.

From analysis, we can conclude that Image Processing gives very high accuracy in defect detection. Above mentioned results shows that Image Processing gives accuracy of around 90% over all, but practically IP is used in negligent manner in farms as this is very complex method and very expensive too. It is very hard to get high quality image from all around the farm. Much expertise is required to use this method. There is a lot of scope for researchers in Image Processing. Day by day, a new way for detection is getting a way into this world so large number of aspirants is trying to use Image Processing to enhance defect detection performance.

C. Optical Sensor Method

One another very efficient and reliable method for defect detection in cotton crop is Optical Sensor Method. Researchers use chemical properties of nutrients to sense their presence in the plant.

In one of the such methods, [6] Rather than just detecting any disease or deficiency, researchers have focused on measuring or monitoring nitrogen content in cotton plant in various conditions. They aimed to Evaluate, under field conditions, the effect of variation in levels of nitrogen

fertilization on the detection of nitrogen content in cotton leaves using reflectance properties registered by an active optical sensor. After experimenting, they have concluded that the values of the vegetation index (NDVI) and chlorophyll content showed increasing trend over the period and the readings were significantly affected by N rates applied from 45 days after emergence (DAE), indicating greater N utilization by plants during the stages of higher vegetative growth. As mentioned, above method doesn't really detect disease or nutrient deficiency of nutrients other than Nitrogen. So it can't be applied to others nutrients.

In another such research, [7] two novel fiber-optic sensor systems for non-destructive plant

Biotechnology monitoring applications have been developed. The first is a nutrient stress analyser. This exploits the spatial signatures that are unique to specific elemental deficiencies in plants to identify nutrient deficiency. The second device is a green fluorescent protein (GFP) analyzer4 that serves as a fluorescent protein marker-cum-optical system for identifying genetically-modified plants. Fig. 4 shows microscopic images.

Optical Sensor method gives desirable accuracy, but it is very expensive method as it includes some very expensive instruments and sensors. This too is a method that involves very deep knowledge about plant, not only physical but one should be aware of plant's chemical properties in order to use this method. Lot of researchers is using this technique to enhance the detecting methodology. So this method has a great scope in future.

III. TABULATED COMPARISON

Table given below shows comparison of techniques described above.

Table 1. Comparison of Techniques

		Methods		
		Visual Analysis	Image Processing	Optical Sensor
Properties	Complexity	Very Low	Average	Very High
	Cost	Very Low	High	Very High
	Accuracy	Average	Very High	High
	Scope of Research	Very Low	Very High	High
	Timing Constraints	Very High	Low	Average
	Components Required	Not Required	Camera, Network Equipments	Nutrient Analyzer, Sensors
	Software Required	Not Required	Visual Analytics	Related Software

IV. CONCLUSION

After reviewing above mentioned techniques and methods we can conclude that there are number of ways by which we can detect disease and nutrient deficiency of cotton plant. Each method has some pros as well as limitations. On one hand, visual analysis is least expensive and simple method, it is not as efficient and reliable as others are. Image Processing is a technique most spoken of. Very high accuracy and least time are major advantages offered, but it backs away when implementing practically. It will come with alternate ways in future as lot of research is going on in this area. Use of optical sensors is probably not too much useful as far as detection is concerned; it is of lot use in monitoring the plant. Still lot of research is going on today in this matter so we would see more and more useful methods.

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