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Cotton plant disease detection

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ABSTRACT

Agriculture is one of the major sectors of the Indian economy and food security. Agriculture needs to find new ways to improve efficiency, production and yields. Approximately 30-35% of the yield gets affected by pests and diseases. The reason it happens is because these diseases are detected at a late stage which gets difficult to control. Hence, advancement in image processing technology and automated learning plays an important role in plant disease detection especially image processing and machine learning. On the other hand, manually detecting diseases in plants needs a tremendous amount of work, expertise and is very expensive because of the involvement of an expert or a plant pathologist. This paper majorly focuses on the need for a solution for early detection of cotton plant diseases, the diseases of cotton and their characteristics, different challenges farmers face while cultivating cotton and while identifying diseases in them, and the step by step technical approaches being used for the detection of cotton plant diseases. There is a lot scope in the advancement of technologies to improve the production by detecting and providing solutions to the farmers on an urgent basis.

Keywords: *Cotton diseases, Image Pre-Processing, Feature Extraction, Image Segmentation, Classification*

1. INTRODUCTION

India whose major part of the economy is dependent on its agriculture, the textile industry plays an important role in the economy of the country and coming to cotton amongst agriculture in India, plays a significant part in sustaining the livelihoods of around 40-50 million people who are engaged in activities related to cotton farming, trading and processing. India has the largest area under cultivation of cotton in the world with 126 lakh hectares. Cotton is a Kharif crop and requires a high temperature of around 25-30 degrees Celsius and is best suited to grow in tropical and subtropical regions of the world and it contributes to 29.8 per cent of India's agricultural gross domestic production [1]. Considering the situation of Shirpur in the state of Maharashtra having the huge textile hub, has 24 Industries with Modern Technologies. Textile Park of Shirpur has 800 shuttle less looms weaving 1.5 lakh meters of cotton fabrics per day. This group is getting its cotton from nearly 3 lakh farmers and has improved the productivity by adopting various measures like rainwater harvesting and the use of cash crops. But there are many causes which lead to the stunted growth of the cotton crop which include excessive rainfall, temperature changes, deficiency diseases, bacterial and fungal diseases, pest attacks and overuse of fertilizers. Out of these pest attacks and diseases lead to huge economic losses because they can occur throughout the year. Poor management of these pest attacks by overusing chemicals and fertilizers has led to resistance to the insecticides. In a developing country, 80% of the agriculture is generated by small scale farmers and more than half of the loss in yield is generated because of pest attacks on the crops [2]. Thus it is found that early detection of diseases can prove helpful for further treatment. There has been a tremendous amount of research going on about computer vision, image processing and deep learning for its application in detection of plant diseases.

2. COTTON DISEASES

Jassid attack: Jassid (Leafhopper) is a sucking pest that hampers cotton throughout its growing period in all zones. This pest injects toxins into leaves while feeding which results in abnormal changes in leaves - marginal chlorosis and reddening. Marginal chlorosis is the yellowing of leaf margins which when left untreated results in the reddening of those areas. As a matter of heavy doses of insecticides usage against it the leafhopper has revealed resistance against insecticides [3].

Fig. 1a: Jassid Attack effect on cotton

Fig. 1b: Cotton Jassid

Magnesium deficiency: This deficiency of Mg causes interveinal chlorosis. With Mg deficiency the green leaf veins are well defined. Symptoms occur in mature leaves first. Severely affected leaves also show some whitish to light brown patches on the leaf blade and for plants grown in the fields, they may show some reddish interveinal discoloration.

Fig .2: Magnesium Deficiency

Potassium deficiency: This deficiency occurs very frequently in cotton among other agronomic crops [4]. This deficiency occurs because of the lack of Potassium in the soil typically because of early maturity, high production and high yields than what the plant root system is capable of [5]. Typical K deficiency symptoms consisting of yellowish-white irregular patching of the leaves that changes to brown spots at the leaf tips, around margins and between veins. The leaf tip curls downwards as the tissue breakdown continues. Finally, the whole leaf becomes rust colored, brittle and drops prematurely which results in immature fruit.

Fig. 3a: Potassium Deficiency

Fig. 3b: Early stage of Potassium Deficiency

Mealybug attack: Mealybugs are unarmored scale insects found in moist, warm habitats. Mealy bugs attack leaves and shoots of cotton or suck the sap from the leaves and shoots. The major infestation signs are white powdery substance on leaves, shoots and stems, wrinkled leaves, sometimes growth stunting, chlorosis and unopened flowers. Mealybugs are most likely to be affected by treatment in the larval stage which might produce radical success **[6].**

The major signs of cotton Mealybug infestations are wrinkled leaves and shoots, distorted and bushy branches, white powdery substance on leaves, shoots and stem, presence of honey dew, less number of bolls, unopened flowers, chlorosis, stunting, deformation and death of plants.

Fig. 4a: Mealybug Attack

Fig. 4b: Mealybug Attack on shoot

Adult Aphid attack and Aphid attack: Aphid is an insect which feeds by sucking sap from plants. Aphids reproduce rapidly, and which is why they can cause extensive damage to plants. The cotton aphid (*Aphis gossypii*) causes viral disease and acts as a vector agent which thereby spreads rapidly. These insects extract nutrients from the plant and disturb the balance of growth hormones. As a result, the plant's growth is retarded giving rise to deformed leaves or, if the infestation occurs early enough in the season, the death of young plants. Aphids are slow moving soft-bodied yellow coloured pests [7].

It is pear shaped small, soft-bodied and slow moving yellow or dark green in colour. It ranges from 0.5-7 mm in length (Minks et al., 1986). Whereas the adult cotton aphid varies in colour from light to dark green and has dark siphunculi (Slosser et al., 2001) at low temperatures.

Fig. 5a: Leaf Curl due to Aphids

Fig. 5b: Aphids on Cotton leaf

Alternaria Leaf Spot: The symptoms are caused by Alternaria macrospora. This fungus resides on cotton residues and spreads through air and water splash on healthy plants. Early infections lead to small, circular, brown spots with purple margins. As these grow, their center might get dry and sometimes they may come together and produce irregular dead areas in the middle of the leaf blade. The seeds may get infected and carry the infection [8].

Fig. 6: Alternaria on the cotton leaf

Cercospora Leaf Spot: This disease is caused by the fungus Cercospora and mainly affects older leaves of mature plants. Reddish-black lesions appear in early stages and as the disease progresses, the lesions enlarge and turn greyish-white at the center with a purplish bordering [9]. This is more prevalent in cotton plants that have nutrient deficiency (possibly Potassium).

Fig. 7a: Cercospora Leaf Spot along with the start of Potassium Deficiency

Fig. 7b: Cercospora lesions on Cotton leaf

Bacterial Blight: This disease is caused by the Bacteria "Xanthomonas Campestris pv. Malvacearum". It starts out with some angular red to brown leaf spots. As this progresses, these lesions turn into brown, necrotic areas and spread to the stems which results in black cankers. High humidity, rainfall and warm temperatures promote the growth of the bacterium which survives on crop debris or seeds [10].

Fig. 8a: Bacterial blight

Fig. 8b: Bacterial blight lesions on leaf and backleg symptoms on the petiole

Nitrogen Deficiency: Growth of the leaf is enhanced by the presence of Nitrogen as it helps in photosynthesis. Hence the reduction in N content causes the stunted growth of the leaves, it also leads to the discoloration of the leaves-pale green, light red petioles and veins. The Nitrogen deficiency first appears on older leaves and negatively affects the growth of the crops [11].

Fig. 9a: Nitrogen Deficiency

1. Challenge faced by Farmers

A variety of challenges are faced by farmers cultivating cotton. Considering the case of Shirpur in Dhule district, many small scale farmers who own a small piece of land to cultivate cotton, mostly use chemical fertilizers and pesticides which help in yielding high productivity in short periods of time [12]. This causes soil degradation and also causes reduction in water and nutrient retention capacities. Pests that attack cotton develop resistance to the continuous use of these pesticides and lead to the introduction of secondary pests which are difficult to identify.

2. Solution to reduce issue of Cotton disease detection

A variety of solutions are available to handle the issue of diseases in cotton. Expert help is one solution where they go to the farm for disease inspection or farmers send the images of diseased leaves to plant pathologists or disease experts and then they guide them with the medication and further treatment. This solution is not viable to detect diseases as early as possible as sometimes the experts might not be available at the required time which can cause delays and also this is not for farmers with poor financial background as this help may not be for free. Early detection of the diseases is the best possible solution which is why image processing with Machine learning algorithms can be used to monitor diseases in plants before they turn extensive and too hard to cure them. The researchers intend to develop a machine learning model that will detect the type of cotton disease and the various phases of development that are used in image processing are discussed in this section [13].

3. Flow of Disease Detection

- **Image Acquisition:** This is the step where different images of the cotton leave with the diseases are to be collected and labelled manually for training the model in the future. This dataset has to be segregated into training and testing images wherein 80% is for training and the rest 20% is for testing.
- **Pre-processing:** This involves removing noisy data from the images, or increasing the contrast and decreasing the pixels of the images. Some various candidates that need correction include [14]:

i) Sensor Correction: Include dead pixel correction and vignetting

ii) Lighting corrections: Lighting can cause the problem to obstruct the texture of the leaf and structure because of uneven lighting or deep shadows.

iii) Colour corrections: It can prove to be helpful to redistribute colour saturation in the intensity channel.

- **Image Segmentation:** It is dividing a digital image into different parts and then recognizing the objects and extract only the required information from the image.
- **Feature Extraction:** This process derives a set of values that define the image called features which provides information that will help in identification of the disease. Some of the most important features in cotton leaves are their colour and texture. Colour features are the primary source to extract features using a colour histogram or a colour co-occurrence matrix. Pattern matching is the next step after extracting the features where the matching algorithm compares the features with the index features of the images.
- **Classification:** This part is where the actual disease detection is done using either an unsupervised or supervised algorithm. It is the process where the observed pattern in a particular image is categorised. Different classification techniques are used to identify the diseases such as CNN's, Support vector machines, k- nearest neighbours etc.

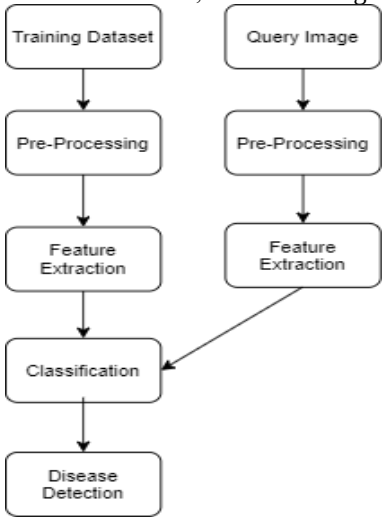

Fig. 10: Flow of Disease Detection

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