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Prediction of Crop Fertilizer Consumption

based on Nitrogen Deficiency

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***Abstract*— Agriculture is the major factor contributing to Indian Economy. According to the statistics its GDP sector composition is 17.9%. India is the second larger producer of agricultural products. In order to produce more agricultural products without any wastage, technical advancements are required in this domain. In research of identification of nitrogen deficiency and prediction of fertilizers consumption by chilly, the images of chilly was captured at two stages. Leaf part of plant is prime factor in identification of nitrogen deficiency. During identification of deficiency various features like texture feature, area of the leaf etc of leaf image are extracted. Feature Extraction is the main key for the identification of deficiency of nitrogen. The farmers usually have little control over the usage of fertilizers. There is need for proper guidance for optimal usage of these fertilizers and is required by farmers in order to get more yields and prevent wastage. Research works carried out so far only identify the nutrient deficiency and disease detection. The proposed work identifies the nitrogen deficiency in chilly, determines the area of region of deficient region and predicts the amount of fertilizer consumption by these deficient plants. Thus the identification of nutrient deficiency is helpful to farmer for proper monitoring of crop growth and optimum usage of fertilizers.**

Keywords*— Nitrogen deficiency, Fertilizer consumption, Chilly, Histogram, Leaf, Factors affecting fertilizer consumption.

I. INTRODUCTION

Agriculture is the backbone of Indian Economy. Plants require nutrients in order to grow and give more yields. Nutrients to the plants are provided through soil, manure and the fertilizers. There are 16 essential nutrients that are required for the plant growth viz., carbon, hydrogen, oxygen, nitrogen, phosphorous, potassium, sulphur, calcium, magnesium, boron, iron, manganese, molybdenum, zinc, chlorine and copper. These are either provided through soil or water in the form of micronutrients and macronutrients. The deficiency of these nutrients can be found out by using soil testing mechanism. There have been advancements in Science and Technology in India from past few decades. But the productivity of farming is declining and there are several reasons behind it: fragmented land holding illiteracy of farmer, lack of decision making in choosing good seed, manure and fertilizer [1]. Several studies show that farmers have little knowledge over usage of optimum level of fertilizer for optimal crop yield. The plants require fertilizer when they are deficient of nutrients. Also the usage of fertilizer more than the requisite level produces crops with increased fertilizer content which upon consumption leads to several harmful diseases [2]. When fertilizers are added to the soil it decreases the microbial activity of soil. The factors affecting the fertilizer consumption are: extent of available land, cultivated land, rainfall, cropping pattern, soil characteristics.

India ranks first largest producer of Chilly in the world. Andhra Pradesh contributes to about 26%, Maharashtra contributes to about 15%, and Karnataka contribute to about 15% to the total area under chilly. Nutrient mobility is key factor in diagnosing nutrient deficiency. There are three kinds of nutrient deficiency i.e. mobile nutrients, intermediate mobility and non-mobile deficiency. Mobile nutrient deficiency is shown in older leaves, whereas in case of intermediate mobility deficiency is shown in old and middle growth stage of plants and in case of non mobile nutrients deficiency is seen in new growth.

Out of all the nutrients that are provided to the plants nitrogen plays a vital role as it is responsible for generation of chlorophyll and amino acids and is necessary for enzymatic reactions in plants. Thus the nitrogen deficiency can have serious impact on chilly growth. As nitrogen is the mobile nutrient, the deficiency is usually seen in older leaves. Some of the nitrogen deficiency symptoms that are seen are general yellowing of older leaves at the bottom of the plant, rest of the plant is light green in colour, plant development gradually slows down, general drying, beginning at margins, of the area between the lower leaf veins. The petioles bend and hang downwards, parallel to stem. The plant develops flowers and

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fruit setting would be poor. The fruit receptacle would be thin and ovary would also be small. Sometimes there would be no fruit development at all, and on those plants that bear fruits, the fruit would be deformed [12] . The various nitrogen fertilizers that are supplied to plant, when it is deficient are ammonium nitrate, urea, ammonium sulphate, and annyhydrous ammonia.

The proposed system identifies the nutrient deficiency and determines amount of fertilizers consumption by the deficient plants. The identification of deficiency is key step in determining the amount of fertilizer consumption. The system plots histogram for images of chilly plant and on the basis of characteristic of histogram plotted the plants are classified into healthy and nitrogen deficient plants. Area of affected region is calculated in order to determine fertilizer consumption. Prediction of fertilizer consumption can prevent the toxicity and deficiency in plants to certain extent and this can help farmers to get proper yield without much wastage.

II. Related Work

Various techniques have been used for the identification of nutrient deficiency detection. Large numbers of papers have been published on disease detection rather than the deficiency detection and amount of fertilizer consumption.

Ashish Meyatra et al [3] carried out a comparative study of various technologies that can be used for identification of nutrient deficiencies and disease detection such as visual analysis, image processing and optical sensor in terms of complexity, cost, and accuracy, scope of research, timing constraints, and software and hardware requirements. They developed a model for detection of disease and identification of nutrient deficiency in cotton plants. They have developed a methodology for detection of diseases in plants using the technique of template matching. The algorithm for template matching was used for detection of alternaria leaf spots; a training matrix was calculated using database of image. The images captured from the farm were compared with database to detect the altenaria leaf spots. They have also identified the nutrient deficiency of nitrogen, phosphorous, potassium, calcium, sulphur etc., using the colour histogram technique. This technique uses different colour models during calculation. This system is accurate, precise and practically feasible when compared to similar existing systems as the model is developed for the real images captured from the farm M Anita et al [4] lists out the symptoms of nutrient deficiency of nitrogen, phosphorous, potassium, zinc, sulphur etc.They have developed a model for identification of nutrient deficiency using the technique of artificial neural network and svm for the characterization of images. They isolated the image into many sub-images; each of these sub-images was categorized into classes using artificial neural network. Support Vector Machine was accumulated to characterize the aftereffect of ANN. Their algorithm followed following steps:

1. input image,
2. separation of RGB channel,
3. opening operation,
4. median filtering,
5. Gaussian image
6. homogenized image,
7. background homogenized image,
8. detection of deficiency,
9. histogram of an equalized image.

The preciseness of the results of this implementation is 90%.

Swapnil.S.Ayane et. al. [5] have identified the nitrogen deficiency in cotton plants. They have used histogram analysis technique for identification of nitrogen deficient and healthy leaves. Further, they have calculated the area of nitrogen deficient region in order to get area of infected region. The limitation of this model is amount of fertilizers required by the deficient plants is not determined. S. Jeyalakshmi et. al. [6] have listed out a diagnosis components for identification of nutrient deficiency in plants i.e. Leaf area measurement, Segmentation of edge and veins of leaf, Determining the shape of leaf, Classification of deficient mineral, Determining the age of leaf, Extraction of colour features of leaf and also discusses about the various methodologies being used in these diagnosis components by various researcher. For leaf area measurement, methodologies used are: Image Histogram, Binarization, RGBthresholding, area projection.For segmentation of edge and veins of leaf, methodologies used are adaptive thresholding, Otsu method, multiple threshold edge detection, ring projection. For colour segmentation, the methodologies used are masking green pixels, colour-coocurrence method, iterative segmentation method, statistical pattern recognition method, histogram threshold method, thresholding hue values. Methodologies used for feature extraction are: mathematical morphology, template matching colour histogram, regression model. For classification methodologies used are back propogation, SVM, supervised neural methods, histogram. There have been many research work in identification of macronutrient when compared to micronutrients. Dulari Bosamiya et al [7] reviews and surveys priorly used techniques for identification of disease and nutrient deficiency detection in cotton plants. They have discussed about the survey the carried out on methodologies like visual analysis, image processing and optical sensor method. They observed that visual analysis is least expensive but not efficient and accurate, whereas image processing is more efficient.

The studies carried out so far are more about disease detection rather than deficiency identification and prediction of amount of fertilizer. There has been a comparative study of various technologies used for identification of deficiency. The techniques used for the identification of nutritional deficiency are visual analysis, image processing and optical sensor approach. According to their studies, image processing is the best approach, as it is cost affective and accurate[3]. The proposed system determines the amount of fertilizers consumption on the basis of nutritional deficiency using image

processing approach. Statistical measure such as histogram analysis is used for identification of nitrogen nutrient deficiency; amount of fertilizer consumed is determined based on the area of affected region and threshold values of amount of fertilizers required.

III. Proposed Approach

In this section, we discuss about our approach for identification of nitrogen deficiency and prediction of amount of fertilizer consumption by plants. This system consists of phases such as: Image acquisition, converting of input image to gray scale image, plotting of histogram, segregating plants into healthy and nitrogen deficient plants determining the affected region and fertilizer consumption. Workflow of these phases is shown in Figure 1.

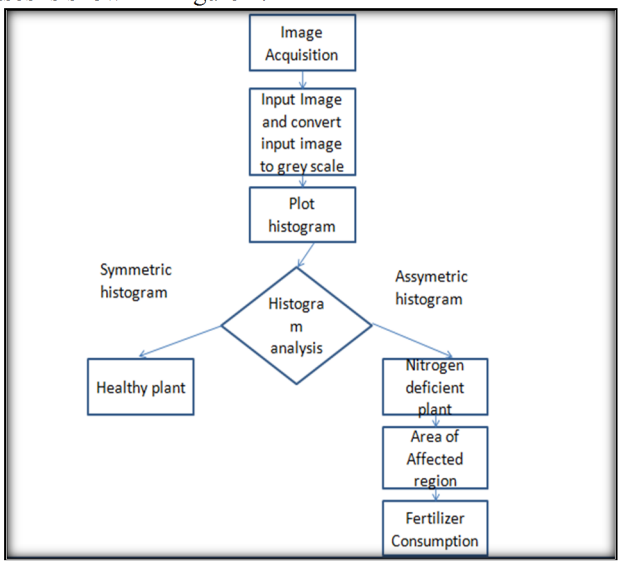

Figure 1-Block diagram of the system

A. Image Acquisition

This is first stage of image processing. The Chilly plant images are captured using Motorola XT1562 Camera. Nearly around 200 photographs of two stages of chilly plant where captured from University of Agricultural Science Dharwad. The images are taken consisting of healthy and non-healthy chilly plants. The image of chilly acquired at stage 1 is shown in Figure 2 and image of chilly acquired at stage 2 is shown in figure 3. The images captured were resized to the dimensions of 300*400 for easier processing of the images.

Figure 2-stage 1 of chilly plant

Figure 3-stage 2 of chilly plant

B. Histogram Analysis

The histogram of an image is a graphical representation of tonal distribution of an image. In an image processing context it is a histogram of pixel values. The histogram construction of an image is done as follows: initially the image is scanned, then the number of pixel value at intensity value is measured and histogram is constructed. Using histogram analysis nitrogen deficiency is identified. For deficiency identification, following algorithm is used. The input image was converted to a gray scale image and histogram was plotted for it. On the basis of histogram obtained, the plant was categorized into healthy and unhealthy. If the histogram obtained was normal curve then it was categorized as healthy. If the histogram obtained was either positively skewed or negatively skewed then it was categorized as nitrogen deficient. The pseudocode of algorithm used is as follows.

The steps of above algorithm were followed for all the images collected. The set of acquired images were segregated into two stages based on the growth of plant. The different set of images of these two different stages of plant is given as input to algorithm. Further these images are converted to gray scale images. For these grey scale images histogram is plotted. Based on the nature of histogram obtained for this gray scale images. If the histogram obtained is symmetric then it is a healthy plant. If the histogram

obtained is asymmetric then is nitrogen deficient plant. The below figures shows the output of histogram analysis of image of chilly plant of stage1 .

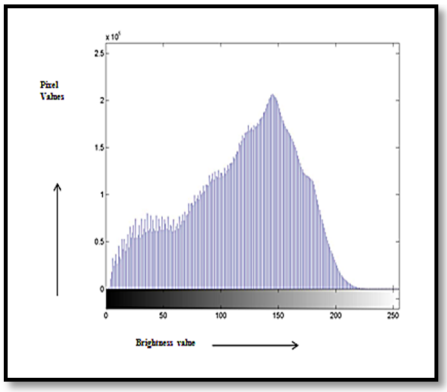

Figure 4-Histrogram for a healthy leaves

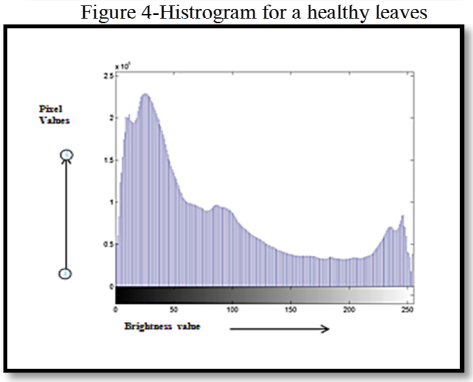

Figure 5 –Histogram for a nitrogen deficient leaves

From Figure 4, it is observed that pixel values are symmetrically concentrated with respect peak gray scale value and thus it is classified as healthy plant. From figure 5, it is observed that pixel value rapidly decreases after peak value of gray scale is obtained and thus it is classified as nitrogen deficient plant. For the nitrogen deficient plants, area of deficient region is calculated and amount of fertilizer consumption is predicted.

C. Area of deficient region Calculation.

The area calculation is required for prediction of amount of fertilizer consumption. Area of deficient region was calculated for the plants which were nitrogen deficient, obtained as a result of histogram analysis. For estimation of area of deficient region following steps were followed. The original image was converted to binary scale image and the area was obtained as the scalar which is weighted as sum of the pixels of those images. This total weighted sum of pixels at each stage was calculated. The area of deficient region was calculated for two stages of plant growth. The estimated area of nitrogen deficient region is shown in Table 1.

Table1.Area of affected region.

Stage	Affected region(square centimeter)
1	21418751
2	21418752

IV. Experimental Results

Amount of fertilizers consumption is calculated on the basis of the area of the deficient region for nitrogen deficient plant. It was observed that nitrogen deficiency was seen at early stage of plant growth when compared to later stages.

A. Amount of fertilizer consumption

There are various nitrogen fertilizers like Ammonium Nitrate, Urea, Ammonium Sulphate, Ammonium Chloride, Ammonium phosphate. Our study is limited for the prediction of amount of fertilizer such as Ammonium Nitrate, Urea, and Ammonium Sulphate. For the prediction of amount of fertilizer consumption, area occupied at each stage was calculated. Using the threshold of certain types of nitrogenous fertilizers, amount of fertilizer consumed at each stage was calculated for area of nitrogen deficient and thus amount of fertilizer consumption is predicted [8]. The estimated amount nitrogenous fertilizers consumption such as urea, ammonium nitrate and ammonium sulphate is shown in Table2.

Table 2.Prediction of amount of fertilizer consumption

Stage	Ammonium Nitrate(in kgs)	Urea (in kgs)	Ammonium Sulphate (in kgs)
1	23.414	117.072	117.072
2	20.7972	103.989	103.9861

On prediction of amount fertilizer consumption, it was observed that less amount of fertilizer is required at stage 2 when compared to stage 1 as nitrogen is a mobile nutrient.

V. Conclusion

The study identifies the nutrient deficiency, predicts the amount of fertilizer consumption by chilly plants and factors affecting fertilizer consumption. The study uses histogram analysis in the identification of nitrogen deficiency and predicts the amount of nitrogen fertilizer consumption at two stages. Further this proposed work can be extended to indentify various nutrient deficiencies and predict the amount of fertilizer consumption by support vector machine along with histogram analysis.

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