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ScienceDirect

Procedia Computer Science 85 (2016) 286 – 292

Procedia Computer Science

International Conference on Computational Modeling and Security (CMS 2016)

An Analysis of Leaf Chlorophyll Measurement Method using Chlorophyll Meter and Image Processing Technique

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Abstract

A regular and periodic monitoring of crop health is essential in any cultivation. An important parameter which act as indices of crop health is the leaf chlorophyll measurement. In the Asian part of the world, Betel vine (*Piper betle* L., family Piperaceae) ranks second to coffee and tea in terms of daily consumption. Therefore, these important and highly productive crash crop is selected for the purpose of study. The experiment was conducted in an established pan betel vine crop field (Pan boroj). A small review of the popular method of leaf chlorophyll measurement is done and some of the drawbacks of the existing methods are reported. The review point out a need for fast and precise leaf chlorophyll measurement technique. Thus an image processing technique based on trichromatic colors i.e., red green and blue (RGB) model is proposed. For the purpose of analysis of the proposed model, the model outcome was compared with atLEAF+ chlorophyll meter reading. And a regression analysis was performed the result of regression analysis proof that there is a strong correlation between proposed image processing technique and chlorophyll meter reading. Thus, it appears that the proposed image processing technique of leaf chlorophyll measurement will be a good alternative for measuring leaf chlorophyll rapidly and with ease.

Peer-review under responsibility of the Organizing Committee of CMS 2016

Keywords: Betel vine; chlorophyll; chlorophyll meter; image processing; coefficients of determination (R^2) ;

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Peer-review under responsibility of the Organizing Committee of CMS 2016
doi:10.1016/j.procs.2016.05.235

1. Introduction

Food production is of primary concern for any country. Agriculture and forestry have a significant role in GDP growth and India ranks second worldwide in farm output. Among all other crops in India Betel leaf is one of the most propitious commercial crops. It is also known as Pan in India. It is cultivated in 55,000 hector with annual production worth Rs. 9000 million[1].The quality and productivity of crop are directly related to the green pigment visible in the leaves which is due to the presence of Chlorophyll. Leaf chlorophyll is mostly used as an index to diagnose diseases and getting the nutrient and nitrogen status in the plants.

Various invasive and noninvasive methods have been proposed earlier to measure the leaf chlorophyll. The conventional method of chlorophyll measurement such as spectrophotometry extracts the pigment from the leaf tissue and precludes the results[2,3].The invasive approach of chlorophyll measurement, also needs the leaf to be destructed so the sample can't be retained after the experiment. These methods are slow, too laborious, instruments are bulky and leaf sample can't be retained for further measurements[4]. As a noninvasive approach SPAD-502 and atLEAF+ meters have given an advantage of rapid measurement, but suffer from the drawback that they are costly methods and also the results are not much accurate in low light intensity[5,6]. So a rapid image processing method has been proposed to get the better results.

To avoid the complexities with the invasive methods and compensating the cost factor of chlorophyll meters, a new image processing technique for chlorophyll measurement is proposed. The proposed method deals with one of the great real world application such as Agriculture. This method requires a scanner to scan the leaf in order to get images and a windows xp base PC or laptop with Matlab installed to process those images. That means this is very easy, portable, less time consuming, cost effective and provides accurate results. In the past two decades, many image processing techniques have been developed to monitor plant health and chlorophyll concentration using the RGB (Red Green Blue) color. In almost all studies, digital technique that measures foliar chlorophyll concentration cameras were used to acquire leaf images, then analyzed to examine the relationship between the R, G and B values with the chlorophyll content that directly indicates the amount of nitrogen present in plants but such methods suffer from a disadvantage of light intensity while taking pictures using digital camera[7].

The proposed image processing method also deals with trichromatic colors i.e. RGB. The chlorophyll content is estimated by having the histogram of leaf image; the corresponding values of R, G and B are obtained and compared to the values by atLEAF meter. Also the sample leaves were scanned to get images that avoid the problem of light intensity as stated earlier. The relationships between R, G and B with atLEAF values were found to be linear over the range and resulted in high accuracy with strong correlation.

2. Materials and methods

2.1 *Study site*

The experiments were carried out in Dhara, a village under Rajnandgaon district of Chhattisgarh state India, located between 210 15' N and 800 50' E. Fortnightly data were recorded from an established Betel vine cultivation field in local language called as Pan Boroj starting from 12 January 2015 and continued till 14 January 2015.

Deep black soil type was found in the study site. The proposed site has a subtropical climate characterized by hot summer and monsoon rainfall followed by dry and cold winter season. The normal average rainfall is 1273.4 mm. The annual temperature varies from 46.2 % (summer) to 11°c (winter). The relative humidity varies from 87% (rainy season) to 35% (winter)[8]. A pictorial view of the above mentioned study site is shown in Fig.1. below.

Fifteen Betel vine (Piper betle L.) leafs of Bangla Desi variety were chosen on random basis. The chlorophyll content of the leaf was measured and recorded using atLEAF+ chlorophyll meter. And the same leaf was scanned as shown in Fig.3. for estimation of chlorophyll using image processing algorithm, using CanoScan LiDE 110 (Canon scanner), with 300 pixels per inch (ppi) resolution and 24 bit color depth. Above procedure was repeated for all the selected samples. The scanned images were stored in .jpg format in windows xp base laptop. As the measuring area of atLEAF+ meter is (9mm × 9mm), a fixed number of pixels (12 × 12) were selected from the scanned image of leafs. In a consequence histogram of leaf image was obtained using MATLAB 2010a.