A Low-cost Sensor for Measuring and Mapping Chlorophyll Content in Cassava Leaves

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ABSTRACT

A crop health monitoring system associated with field positioning is required for site-specific nutrient management. The amount of chlorophyll in a plant leaf, as quantified by leaf greenness index, reflects a plant's health. The present study is aimed at developing a low-cost sensor (LCS) for assisting cassava farmers to estimate and map the chlorophyll content in cassava leaves. The device consists of a color sensor that gives frequency responses to red (R), green (G), and blue (B) chromatics. The color sensor was calibrated to convert the frequency outputs to R, G, and B values. We evaluated the accuracy of color measurement by comparing the three chromatic values with those obtained from a commercial color analyzer. The sensor was further calibrated for chlorophyll measurement by correlating the greenness index of cassava leaf samples with values measured by a standard chlorophyll meter SPAD-502. The sensor was validated by comparing leaf greenness with the readings of the SPAD-502 using a different set of leaf samples. A GPS receiver was installed in the device for simultaneous recording of field position. The results showed that the sensor accurately measured the actual R, G, and B. The color difference expressed in terms of Euclidean distance ranged from 1.61 to 63.31, with an average of 17.62, which is acceptable. Analysis of linear correlation for R, G, and B resulted in coefficients of determination (R^2) of 0.9493, 0.9704, and 0.9849, respectively. Evaluation of leaf greenness with the SPAD-502 meter yielded a root mean square error (RMSE) of 0.9688 and an R^2 of 0.97, suggesting satisfactory accuracy. The developed low-cost sensor effectively showed the spatial variation of chlorophyll content in cassava plants across a planting area.

Keywords: Cassava, Chlorophyll, Color sensor, SPAD-502, GPS positioning

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is an important food and energy crop in Thailand, used in a broad range of industries. Site-specific management of cassava production can help reduce inputs, enhance yield, and conserve agro-ecosystems. This requires an effective crop monitoring system that can observe plant health status, as well as its spatial variations across a field.