Name(s)	Project Number
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Project Title

Predicting Broccoli Yield Utilizing a Remote Sensing Low Altitude Multispectral Camera: A Two-Season Trial

Abstract

Objectives
Constructing statistical models to predict crop yield involves difficult calculations and measurements to arrive at an accurate yield prediction. Measuring chlorophyll content using a SPAD meter is tedious and can spread disease. This study was done to assess the efficacy of vegetation indices obtained through multispectral imaging in predicting the chlorophyll content and yield in broccoli over two seasons.

Methods
A field experiment on different N-fertilizer rates on broccoli was used. A small unmanned aircraft system (UAS), or drone with a GPS-enabled multispectral camera was built and flown autonomously at an altitude of 100 feet. More than 100,000,000 light reflectance values were collected to calculate the vegetation indices, GNDVI and NDVI. Chlorophyll content was measured on the same day. The vegetation indices were compared to the head yield and SPAD measurements using regression analysis.

Results
The regression analysis for two seasons showed very strong positive linear relationships between NDVI and GNDVI, and the head yield. The coefficient of determination for the NDVI regression lines in seasons 2018 and 2019 showed R^2 values of 0.93 and 0.92 respectively. GNDVI and head yield also showed a relatively high correlation for seasons 2018 and 2019 with R^2 values of 0.8 and 0.81 respectively.
The chlorophyll content and the vegetation indices for both seasons were highly correlated with each other. GNDVI consistently demonstrated the highest correlation for 2018 and 2019, with R^2 values of 0.92 and 0.93 respectively, compared to NDVI which had R^2 values of 0.74 and 0.83 respectively.

Conclusions
Based on my 2 year data, I showed that vegetation indices NDVI and GNDVI obtained from a high-resolution multispectral camera can reliably estimate the head yield and chlorophyll content in broccoli plants. NDVI is a more precise index to use in predicting head yield in broccoli while GNDVI is better in estimating the chlorophyll content in broccoli.
This method of estimating head yield in broccoli can easily and quickly obtain measurements over vast areas. It does not require complex calculations to develop a statistical crop yield model. By estimating the chlorophyll content and predicting the yield, farmers can judiciously apply fertilizer and save money as well as protect our environment by avoiding ground water contamination.

Summary Statement

This study showed that the vegetation indices NDVI and GNDVI obtained through a high-resolution multispectral camera mounted on a drone can reliably and accurately estimate the head yield and chlorophyll content in broccoli plants.

Help Received

The California State University - Fresno Agricultural Field was accessed in this study. I conceptualized, planned, conducted, and analyzed the project myself. I did not receive any mentorship from any faculty or staff from the university.