# Unmanned Aerial Systems for Precision Agriculture – A Case Study in Disease Risk Modeling

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White mold, caused by the fungus *Sclerotinia sclerotiorum*, is an important disease of snap bean that causes a reduction in the number of pods due to premature pod abscission. Snap bean fields are typically treated with prophylactic fungicide applications to control white mold, once 10% of the plants have at least one flower to prevent ascosporic infection. The primary goal of this research is to develop spatially-explicit white mold risk models, based on inputs from remote sensing systems aboard unmanned aerial systems (UAS). The objectives of this study are to i) identify spectral signatures for the onset of flowering to optimally time fungicides, ii) investigate spectral characteristics prior to white mold onset in snap beans, and iii) link the location of white mold with biophysical (spectral and structural) metrics. These metrics will then be used to develop the spatially-explicit probabilistic risk model for the appearance of white mold in snap bean fields. This talk concentrates on research findings to achieve the first objective. A DJI Matrice-600 UAS, boasting a Headwall Photonics Nano-imaging spectrometer (272 bands; 400 to1,000 nm) was utilized to collect the hyperspectral imagery (HSI). High frequency flights were flown at Cornell AgriTech at The New York State Agricultural Experiment Station, Cornell University, Geneva, New York, around days when portions of the snap bean fields were flowering. The HSI data then were converted into reflectance using the empirical line method, based on in-field black/white calibration panels. Samples of flowering and non-flowering snap bean spectra were selected from the HSI data for the July 2018 time period using spectral band ratios and thresholding (RaT), followed by selective panchromatic illumination thresholding (sPIT) to select high signal-to-noise vegetation signals. Single feature logistic regression then was used to determine which spectral ratio indices (RI), normalized difference indices (NDI), and wavelengths were critical for discriminating between flowering and non-flowering plants. Single wavelengths in the green, red, and near infrared separated the classes with average accuracies ranging between 85 to90%. RI and NDI separated the data with accuracies of 93% using spectral features that are correlated with plant stress and chlorophyll b. Next, the features with the highest c-index were used to train logistic regression (LR), support vector machine (SVM), and perceptron models to investigate deep learning approaches. The SVM had the highest average accuracy (>93%) with a single NDI feature. When the model was applied to flowering and non-flowering test data from July 2017, the average plant pixel probabilities were 86.3% and 41.1%, respectively. This finding suggests high accuracy and promise for our ability to develop UAS-based white mold risk models, since we can identify flowering plants, and furthermore, the spectral bands are located primarily in the cheaper, more operational silicon (Si) detector range.
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