AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2019 – 2021

TITLE: Limiting yield loss and grower risk with hyperspectral camera technology for early season virus detection in wheat fields.

RESEARCH LEADER: Christina H. Hagerty

COOPERATORS: Marja Haagsma (PhD Candicate), John S. Selker, OPEnS Lab

EXECUTIVE SUMMARY: Hyperspectral imaging allow rapid, non-destructive, and objective crop health assessments, especially in diseases know for generating patterned visual symptoms. We identify wavelength regions that can be exploited to identify Soilborne mosaic virus (SBWMV) infected wheat. Leaf samples were scanned in a lab environment to investigate the spectral differences between healthy and diseased leaf (incl. non-symptomatic and symptomatic pixels within the diseased leaf). These spectral differences were used to identify the most informative wavelengths by using a data driven analysis. Moreover, the potential of 84 commonly used vegetation indices was investigated. A machine learning approach was used to create a classification model to automatically separate pixels into symptomatic, non-symptomatic healthy classes. The success rate on the leaf samples was 69.7% using the full spectrum. It was very encouraging that using a subset of 4 broad bands, to mimic a data set from a much simpler and less costly multispectral camera, the accuracy increased to 71.3%. The classification models were validated on field data. Classification of hyperspectral data from two nurseries were used to assess the outcome for varieties with known susceptibility levels. Here we compared a resistant variety to two susceptible varieties in a diseased and healthy nursery. The ratio of pixels assigned to each class was used as a response metric. Moreover, the classification outcomes for field transects, in the form of a thematic map, were compared to visual assessments of experts. We successfully classified for infection in the field using classifiers trained on the entire spectrum of the hyperspectral data acquired in a lab setting.

OBJECTIVES: Utilize narrowband hyperspectral camera technology for early season Soilborne wheat mosaic virus detection.

PROCEDURES: PhD candidate, Marja Haagsma, collected data with a hyperspectral camera in commercial winter wheat fields infected with SBWMV in spring 2019. Data collected was used to identify wavelength signatures of diseased plants. Data from the hyperspectral camera was vetted in spring 2020 by scanning individual wheat leaves both with, and without SBWMV.

SIGNIFICANT ACCOMPLISHMENTS TO DATE: Project was highly successful and wavelength signatues of diseased plants were identified. This ARF funded project is a chapter of Haagsma's PhD thesis (defense expected spring 2021). A manuscript titled "Detection of Soilborne wheat mosaic virus in wheat using hyperspectral imaging; from lab to field scans, and from hyperspectral to multispectral data" is in final preparation for *Precison Agriculture Journal.*

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: n/a

FUTURE FUNDING POSSIBILITIES: WSARE or NIFA Precison Ag.