BIOAg Project Report

Report Type: Progress

Title: Integrating Drones into Weed Management on the Palouse

Principal Investigator(s) and Cooperator(s):

Alexander K Fremier (Principal Investigator)
Daniel Auerbach (Additional Investigator)
Ian Burke (Additional Investigator)

Abstract:
Farmers on the Palouse are increasingly spending more resources to manage weeds. Weed management, in part, requires fine scale knowledge of weed populations. Mapping weeds with drones is promising but requires knowledge of environmental variation and weed phenology. Application of drones in weed management is growing globally but local applications on the Palouse are limited. We will develop drone and multispectral image analysis protocols for mapping common weeds and work with multiple farms to understand the best timing of flights to create weed maps across fields with different crops and solar aspects. We hypothesize that a multispectral imagery and field scouting approach will improve weed mapping efficiency in large extent, rain-fed cropping systems such as the Palouse. Consistent mapping of weeds will open more opportunities for targeted application of biologically-intensive approaches to weed management and improved management outcome assessments.

Project Description:
The overarching goal of this project is to determine the feasibility of integrating drones into weed management on the Palouse. To do this we had three primary objectives:

1) Develop multispectral image classification procedures for common weed species across a range of weed-crop combinations, growth stages, and topographic complexities using drone-based multispectral imaging.
2) Field test the procedure on a single large contiguous area to begin to understand how to rapidly integrate spatial data into on-farm weed control measures
3) Prepare peer-reviewed manuscript(s), online training videos and presentations for farmers, and begin developing a multi-year proposal to USDA for development and assessment of drone-based weed mapping and on-farm weed management procedures in Palouse cropping systems.

Outputs:
Overview of Work Completed and in Progress
We completed a total 75 drone flights across three crop types and four sensor types between April and July 2023 (description in methods below). We successfully post processed and stitched all images sets from August through October. We were able to successfully align images across

locations and sensor types for analysis. As part of the analysis, we also complete in-situ measurements of weed and crop locations - 50 at each site, (25 known crop locations and 25 known weed locations).

We are currently analyzing the data. We are working on completing the protocols to successfully extract the spectral signatures of crops and weeds after verifying the GPS location is accurate. We are using the LiDAR data sets to measure growth rate of the different crop types.

Methods and Results
We selected two plots for three different crop types (wheat, barley, and garbanzo beans). We selected the different plots based off differing slope angles to determine how these may impact our ability to detect weeds within the crops. After determining the locations of the plots, we designed flight paths which overlapped with known weed locations from previous years and based off the expert opinion of the landowner (Ian Clark).

Flights were conducted using four different sensor types: RGB, multispectral, thermal, and LiDAR. Flights were conducted based off growing degree days to try and capture weeds at varying growth stages. All sensors were used each time a plot was surveyed. We flew a total of 75 missions across the different crop types and sensors. Final imagery was cataloged and stitched to create an orthomosaic which can be manipulated to determine spectral signatures.

As part of the final surveys, we conducted a ground validation where an observer walked each of the plots and manually identified weeds and captured a point at each location using a survey grade GPS. A total of 50 points were taken in each plot (25 of crops and 25 of weeds). These points will be used to determine the accuracy of aerial methods to detect weeds using spectral signatures.

We are using a combination of ImageJ and QGIS, both open-source software, to isolate image layers to obtain spectral signatures. First, the RGB imagery is split to isolate the red, green and blue layers. The multispectral camera only contains the green, red, red-edge and near infrared bands and blue may help differentiate spectral signatures. We will then use the points taken from the ground measurements to take reflectance values of each of the layers which we can plot to obtain the spectral signature. If successful we can use the spectral signature to isolate weeds from the spectral signature of the crop.

Impacts

- Short-Term: Create a protocol using various drone-based sensors to capture spectral signatures of crops and weeds. Catalog spectral signatures for known crops and weeds on Palouse farms.
- Intermediate-Term: Use the data to isolate weeds at larger scales on Palouse farms.
- Long-Term: None

Additional funding applied for/secured:
NA

Graduate students funded:

Daniel Auerbach, Ph.D., School of the Environment

Recommendations for future research: