Grant Code: New

Title: An objective assessment of economic loss due to wireworm damage in Idaho wheat

Personnel: Arash Rashed, Associate Professor of Entomology; Sanaz Shafian, Assistant Professor of Precision Agriculture; Patrick Hatzenbuehler, Assistant Professor and Extension Specialist – Crops Economics

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Justification/Rationale: Wireworm is a term used in referring to the larval stage of all click beetle species (Coleoptera: Elateridae). In recent years, wireworms have been resurging as devastating pests of a wide range of crops in the Pacific Northwest (PNW), USA. The sugar beet wireworm (*Limonius californicus*) is currently the most commonly present, and damaging, species of wireworms in Idaho. Wireworms can stay in the soil for several years (up to 10 years) and infest crops in almost any rotation, threatening the livelihood of farmers. Wheat, one of the major crop commodities in Idaho, comprising about 17-percent of total crop cash receipts[1], is also challenged by this pest.

Neonicotinoid seed treatments, the only class of insecticides registered for application in wheat, have failed to provide acceptable levels of control. Fipronil, however, is currently one of the main insecticides, which has been proven effective in controlling wireworms in other crops, e.g., potato. However, legal use of fipronil in wheat requires special approval from the EPA. In 2017, Idaho wheat producers, represented by Idaho Wheat Commission (IWC), made progress toward submission of a Section 18 request, for fipronil, to the ISDA, but the application did not move forward to the EPA due to a missing estimate of economic loss to wireworms. The aim of this study is to help address this issue to aid Idaho wheat farmers in their wireworm control efforts.

Remote-sensing technologies can provide considerably more efficient analyses of crop stress and damage in large-scale farming than the traditional ground scouting and estimating methods. Here, we are proposing to identify field-scale spectral signatures associated with sugar beet wireworm damage on wheat crops. These measures combined with ground-sourced data on yield and wireworm count, can be used to estimate yield and profit losses.

Objective: Quantify economic loss caused by the sugar beet wireworm in spring wheat in Idaho.

Sub-objective 1: Identify spectral signatures associated with wireworm damage early and late into the growing season; and,

Sub-objective 2: Assess yield and economic losses in relation to wireworm numbers and distributions within field.

Procedures/Plan of work:

This study will be conducted in six commercial wheat fields in southern Idaho that are known to be infested with wireworms. Prior to planting, each field will be thoroughly surveyed for wireworms by placing at least one solar bait trap per acre (we are considering 20-30 acres/field).

Later in the season, a hyperspectral sensor mounted on an unmanned aerial vehicle (UAV) will be used to capture ultra-high-spatial resolution images 3- and 12-weeks post-emergence. The

[1] For ID, cash receipts for wheat in 2018 were $523.5 million and the total for all crops was $3.16 billion (USDA-ERS, 2019).

captured images will be mosaicked, georeferenced and radiometrically calibrated. Digital surface models (DSM) will be generated and analyzed later to see if wireworm damage is influenced by field topography (specifically hillsides) and other landscape variables. All solar bait traps will be placed at the time of each imaging, then collected and counted for the number of wireworms within 10-days.

The captured images will also be used to extract canopy spectral signatures and develop different vegetation indices (VIs). VIs are expected to be highly correlated with the evidence of wireworm presence (e.g., reduction in vegetation cover, failed germination, delayed crop maturation). Thus, they will be examined as variables for early detection of infestations. Estimations will later be evaluated based on ground and field visual observations. The ground data include wireworm counts from solar bait traps, visual scores of percent germination on a gridded map of the field, and grower-provided crop yields. We will then integrate artificial intelligence with a VI-based model to predict the final yield on a per acre basis. We will compare the predicted yield for healthy and infested areas to estimate the percentage of loss for each acre. At maturity, fields will be harvested, and yield maps will be generated using yield monitoring systems on grower combines. The predicted yield from VI-based model will be compared with the actual final yield, and in relation to the high-resolution per-acre wireworm count data, for validation. The VI-based data will be used in combination with wider range satellite data and the USDA area planted data for wheat to obtain estimates of aggregate yield losses due to wireworm. Since historical satellite and area planted data are available, we will calculate estimated statewide yield losses for the previous five years. These aggregate yield losses combined with planted area estimates will provide estimates of production losses. These annual production losses are then multiplied by the annual marketing year average prices to obtain statewide economic losses due to wireworm.

Duration: Spring 2020 through Spring 2022. This is the first year of a two-year proposal.

Cooperation/Collaboration: This is a cooperative project between Drs. Rashed, Shafian, and Hatzenbuehler programs.

Anticipated Benefits, Expected Outcomes and Impacts, and Transfer of Information: A main goal is to provide needed information to the IWC in their application to the ISDA to submit a Section 18 waiver request to the EPA. We also expect to produce at least 1 professional research publication focused on the use of UAV in estimating yield loss to wireworms in wheat. Other publications on the use of UAV in monitoring for pest conditions in cereals would be possible. The results will be shared at the professional meetings of national, regional, and local levels. We also expect to train our newly recruited M.S. student in agricultural research methodologies, UAV utilization for in-field assessment of wheat crop status. We will include this project in our regular updates during field days, cereal schools, and other events.

Literature Review: Spectral data collected by remote sensing technologies are used in a broad range of environmental studies such as vegetation analyses and plant community structure (2, 3, 4, 5). Despite the technological and analytical advances, remotely sensed data are underutilized in the study and management of pests in agricultural ecosystems. Efforts on this subject have primarily been limited to laboratory and field experiments evaluating reflectance spectra of pest-infested plants collected by sensors located within a few meters of the plant canopy.

Remotely sensed data that have shown promising results in assessing plant chemistry and functional traits in complex ecosystems (5,6,7,8) and may also provide critical information on the status and severity of pest infestations in crop fields. Pest infested plants such as wheat, soybean, and cotton, consistently showed lower VIs than the non-infested plants (9, 10, 11). Recently, data collected from UAVs have been used to map the distribution of cryptic pest species such as grape *Phylloxera* in vineyards (12). Spectral data from distant platforms, including UAVs and satellites, have the potential to provide frequent, efficient, and cost-effective tools to map pest infestations and yield loss in agricultural areas, including wheat fields.

References:

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12. Vanegas, F., Bratanov, D., Powell, K., Weiss, J. & Gonzalez, F. A novel methodology for improving plant pest surveillance in vineyards and crops using UAV-based hyperspectral and spatial data. Sensors 18, 260, https://doi.org/10.3390/s18010260 (2018).

FY2021

IDAHO WHEAT COMMISSION - BUDGET FORM

Principal Investigator: Arash Rashed

If applicable,	**Allocated by**	**Idaho Wheat Commission**	**during FY 2019**	**$ -**
If applicable,	**Allocated by**	**Idaho Wheat Commission**	**during FY 2020**	**$ -**

REQUESTED FY2021 SUPPORT:

Budget Categories	(10) Salaries (*staff, post-docs, etc.*)	(12) Temp Help	(11) Fringe	(20) Travel	(30) OE	(70) Graduate Tuition/ Fees	TOTALS
Idaho Wheat Commission	$ -	$ 3,250	$ 574	$ 6,167	$ -	$ -	$ 9,991

TOTAL BUDGET REQUEST FOR FY 2021: **$ 9,991**

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

Budget Categories	*Rashed*	*Shafian*	*Hatzenbuehler*
(10) Salaries	$ -		$ -
(12) Temp Help	$ 1,250	$ 2,000	$ -
(11) Fringe Benefits	$ 506	$ 68	$ -
(20) Travel	$ 1,850	$ 3,272	$ 1,045
(30) Other Expenses	$ -	$ -	$ -
(70) Graduate Student Tuition/Fees	$ -	$ -	$ -
TOTALS	$ 3,606	$ 5,340	$ 1,045

Total Sub-budgets $ 9,991

Brief Explanatory Comments: (see FY2021 RFP for guidance)

Rashed will use TH funds to hire assistance for trapping and counting wirewroms; Shafian will us TH to help with marking fields and collecting arial data
Travel funds cover two trips (primarily mileage) to fields for Rashed as well as field trips (mileage and lodging for two) for Shafian.
Travel for Hatzenbuehler covers mileage for trips to field sites (if needed) and presentations.

Fall 2019 Version