

PROJECT NO: BJKT04, BJKT05

TITLE: A survey of central and eastern Idaho wireworm species and evaluating ecological and chemical approaches to maximize cereal production

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JUSTIFICATION: Wireworms are the larval stage of click beetles (Col., Elateridae), which have been causing significant damage to cereals crops in Idaho. Available registered insecticides for wireworm control in cereals (i.e., neonicotinoids) have provided very limited protection, if any at all. The failure to provide uniform protection with new insecticides has been attributed to species-dependent susceptibility, as well as to the high wireworm pressure. Recently, there has been more emphasis on exploring integrated pest management approaches to achieve sustainable pest control.

Some of the variability in insecticide efficacy may be due to the existing ecological and behavioral differences among species, or even potential genetic heterogeneity within populations. As soil-dwelling insects, wireworm behavior and survivorship can also be influenced by soil physical, chemical, and biological properties. Thus, an understanding of soil health characteristics and other ecological factors that can affect wireworm fitness in its environment would be essential in developing management practices that are aimed to limit damage in a sustainable manner.

Our first year study identified four wireworm species in southern Idaho. More than 77% of the collected samples belonged to the sugar beet wireworm species (*Limonius californicus*), which is one of the least susceptible species to neonicotinoid seed treatments. We also showed that multiple species can be present within a field and that the time of activity of each species appears to be dependent upon environmental variables; a topic which requires further investigation. Overall, wireworm numbers were positively correlated with maximum air temperatures and precipitation at our dryland locations in eastern Idaho, but not in irrigated fields. This proposal will continue to study species composition with respect to soil health and other ecological variables. We have established collaborations with growers, researchers, and industry to evaluate a combination of ecological and chemical approaches to limit wireworm damage in cereals.

Hypothesis: Wireworm species differ in their ecology, and sustainable management practices can be implemented based on a clear understanding of their interaction with the surrounding environment. To evaluate this hypothesis we will address the following objectives:

- I) Conduct a comprehensive survey of wireworm species complex, and within population variations, throughout the year and at different soil depths,
- II) Characterize soil physical, chemical, and biological properties as related to soil health and to determine the influence of these parameters have on wireworm populations,
- III) Quantify ecological traits of the most common wireworm species in each region, which can be used to effectively monitor and suppress wireworm populations,
- IV) Determine wireworm damage in response to various wheat varieties and seeding depths,
- V) Examine effects of cultural practices, and evaluate insecticide efficacies, on the most damaging wireworm species.

PROCEDURES: To address **Objective I**, wireworm populations will be monitored in 10 infested fields in south central (Kimberly, Twin Falls, Picabo), eastern (Aberdeen, Idaho Falls), and western (Parma) Idaho. Up to 5 solar bait stations will monitor populations in every field. Baits will be placed at 6, 18, and 24 inches deep (three traps at each station). Traps in these 10 fields will be replaced every 2-3 weeks throughout the year (including winter, when feasible), allowing monitoring of different species at different soil levels over time and in response to environmental conditions. A subsample of the collected wireworm samples from each field will be sent to Dr. Forney at the Institute of Bioinformatics and Evolutionary Studies (IBEST) for genetic analysis. Additional quantitative data is expected to be collected with the help from growers. Solar bait traps will be mailed to participating growers every two weeks starting March 2015 (prior to planting). To address **Objective II**, composite soil samples, from the 0 to 6, 6 to 18, and 18 to 24 in depth, will be collected, at each trapping, location every 4 to 5 weeks (during the season). Bulk density will be determined using a core chamber, and soil texture for depth intervals by the hydrometer method. Water content and soil chemical and biological analyses will be conducted for each depth interval to determine pH, inorganic-nitrogen, total nitrogen, total carbon, soil organic matter, extractable-phosphorus, and soil CO₂ respiration. These are key factors influencing soil health. Information on soil health, climate, and crop rotation will be used to evaluate the effects of environmental factors on wireworm species composition (spatial and temporal), density, and vertical movement as a part of **Objective III**. Wireworms collected through our monitoring program will be maintained in the greenhouse and used to achieve objective IV. **Objective IV** is set to quantify sugar beet wireworm (most common species in Idaho) response to wheat varieties and seeding depths (tub experiments). Collaborations have been established to conduct insecticide efficacy trials, and to evaluate the effectiveness of till versus no-till practices on wireworm populations and soil properties (**Objective V**). Integrated approaches and ideas are expected to develop as data on species composition, movement, and seasonal fluctuations emerge.

DURATION: Spring 2014 through Winter 2016. This would be the 2nd year of a 3-year proposal.

COOPERATION: This is a cooperative project between Dr. Rashed, Dr. Marshall, and Dr. Rogers's laboratories at the Aberdeen R & E Center. Moreover, we have also gathered a team of researchers from 7 different institutions and are approaching federal resources to support wireworm research in the PNW.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER: This research will result in plotting a detailed distribution map of wireworm species in southern Idaho. A visual key to wireworm species is currently being developed to facilitate onsite species identifications. This proposal has been expanded to address the relationship between soil health and wireworm species activity. In addition to our recent established collaboration with IBEST, the presence of new research expertise, established collaboration with producers for large-scale evaluation of cultural methods, and our new findings on wireworm species and their phenology (in relation to plant developmental stage) has allowed us to add new components, which are to be addressed in the upcoming season. We organized a wireworm symposium at the Annual Entomological Society of America meeting 2014, which attracted world-renowned researchers from Canada, Europe, and the US.

LITERATURE REVIEW:

Historically, wireworm damage was controlled by using environmentally persistent chemistries such as DDT and lindane (e.g. Vernon et al. 2009). These products, however, are now banned due to environmental concerns and potential human health risks (Vernon et al 2009). Although substitute chemistries provided some level of protection, wireworm susceptibility to the new generation of chemicals varied depending on the species (Van Herk et al. 2007) and the pressure level. Moreover, anecdotal observations suggest potential among-population variability in response to neonicotinoid seed treatments within the same species.

Recently, more emphasis has been placed on alternative control measures to achieve more successful and sustainable damage control in conjunction with seed treatments. The effectiveness of any IPM program in controlling wireworms depends on a clear knowledge of the present species and their ecology (Furlan 2005). In fact, there are hundreds of wireworm species in North America, of which a few are known to inflict considerable damage to wheat (Toba et al 1985). Our first-year survey revealed the presence of at least 4 co-occurring species: Prairie grain wireworm (*Solatosomus aeripennis*), sugarbeet wireworm (*Limonius californicus*), *Aeolus mellillus*, and *Hadromorphus glaucus*. Sugarbeet wireworm (77.7% of collected samples) is the most damaging species to wheat producers and is believed to be the least susceptible to neonicotinoid seed treatments.

Unfortunately, knowledge of wireworm ecology and control is generic without taking among-species variations into account (Furlan 2005). For instance, wireworm species may vary in the range of plants they utilize (Pazmand and Traugott 2005), and the soil characteristics (such as pH, texture, organic matter, and moisture) they are associated with (Barsics et al 2013). It has been also shown that soil architecture, CO₂ (Barsics et al 2013; Gfeller et al 2013), and volatile organic compounds released from roots (Gfeller et al. 2013) can affect wireworm movement and survival. Such ecological traits can be used in trap cropping and baiting various wireworm species as a part of a sustainable IPM program.

REFERENCES

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IDAHO WHEAT COMMISSION - BUDGET FORM

Allocated by Idaho Wheat Commission during FY 2014

Allocated by Idaho Wheat Commission during FY 2015 \$ 36,400

REQUESTED FY 2016 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	Grad Fees	TOTALS
Idaho Wheat Commission	\$ 12,000	\$ 11,000	\$ 3,605	\$ 5,000	\$ 2,500	\$ -	\$ 34,105
OTHER RESOURCES (not considered cost sharing or match Industry UI (salaries, o Other (IBC)							
			\$7,000	\$17,436	\$14,615		
			TOTAL OTHER RESOURCES \$				39,051

TOTAL PROJECT ESTIMATE FOR FY 2016:	\$ 34,105 (Requested)	\$ 39,051 (Other)	\$ 73,156 (Total)
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BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	<i>Rashed</i>	<i>Marshall</i>	<i>Rogers</i>
Salary	\$ 12,000	\$ -	\$ -
Temporary Help	\$ 10,000	\$ -	\$ 1,000
Fringe Benefits	\$ 3,310	\$ -	\$ 295
Travel	\$ 4,000	\$ 1,000	\$ -
Operating Expenses	\$ 500	\$ 1,000	\$ 1,000
Graduate Student Fees	\$ -	\$ -	\$ -
TOTALS	\$ 29,810	\$ 2,000	\$ 2,295
		Total Sub-budgets \$	34,105

10.24.2014 - Version