PROSPECTS FOR WIREWORM MANAGEMENT IN GRASS SEED PRODUCTION SYSTEMS

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Introduction

Wireworms, the long-lived (approximately 2–5 years) larval stage of click beetles, are economically important crop pests that cause damage to germinating seeds and seedlings of numerous vegetable and field crops worldwide (Vernon and van Herk, 2013). This damage results in stunted plant growth, poor stand establishment, and yield loss. Adults feed only on flowers and pollen and therefore do not cause substantial damage to crops.

Adults are one-third to one-half inch long, slender, brown to black beetles. When placed on their backs, they will "spring" into the air with a distinct clicking action to right themselves. Adult wireworms usually emerge, mate, and lay eggs from late spring through summer, depending on the species. Small, white eggs are laid in clutches in the soil. Many species are attracted to grasses to lay eggs.

Larvae are one-quarter to 1 inch long, slender, segmented, yellow-brown-bodied insects with a dark head capsule and three pairs of small legs behind the head. The last segment of the body is usually pronged, forked, or "keyhole-shaped" at the end. Wireworm species identification is extremely difficult. The shape of the tail with appendage designs on the end can help distinguish among genera (Dreves et al., 2021).

Common wireworm genera that are encountered in cereals and other host crops of western Oregon include a complex of *Limonius* species (*Limonius canus*, the Pacific Coast wireworm; *Limonius californicus*, the sugar beet wireworm; and *Limonius infuscatus*, the western field wireworm). In eastern Oregon, *Ctenicera* species (Great Basin wireworms) occur, in addition to *Limonius* species. Several invasive species from Europe (such as *Agriotes obscurus* and *A. lineatus*) have also been reported in Washington, Oregon (Andrews et al., 2008), and the Fraser Valley of British Columbia in small fruit, vegetable, ornamental, and forage cropping systems.

Over the past 4 decades, wireworm damage has been effectively and inexpensively managed by the first generation of highly toxic and persistent preplant insecticides, such as organochlorines and organophosphates, which are applied to soil and seeds. Due to phasing out of some of these key insecticide groups, wireworms are reemerging as a problematic pest in the Pacific Northwest region of the United States. Better understanding of basic wireworm biology and ecology, the species complex present in cool-season grasses grown for seed, and efficacy of novel insecticide groups is required to develop alternative management strategies for Oregon grass seed crops.

A new insecticide containing the active ingredient broflanilide (Teraxxa) was recently registered by BASF as a seed treatment for the control of wireworms in wheat and other small grain crops. Broflanilide represents a new mode of action (Group 30) and belongs to a class of insecticides known as "meta-diamides" (Nakao and Banba, 2016). Another new insecticide with the active ingredient chlorantraniliprole (Group 28), trade name Vantacor, was recently registered for use in grass grown for seed.

Field efficacy data for wireworm control in Oregon grass seed crops are needed for establishing use patterns for the registered products and to support future registration of promising chemistries. The objectives of this study were as follows:

- To determine the time of year when wireworms cause damage to grass seed.
- To determine the effectiveness of the new insecticides broflanilide (Teraxxa) and chlorantraniliprole (Vantacor) against wireworms in grass seed crops.

Materials and Methods

2021 monitoring efforts

Adult trapping efforts consisted of using proprietary pitfall traps, Vernon Pitfall Traps (VPTs), which deploy an aggregation or pheromone lure specific to the targeted species (*Limonius* spp., *A. obscurus*, and *A. lineatus*). These traps were deployed in grass seed crops at one commercial fine fescue field in Marion County, one research plot of perennial ryegrass at OSU's Hyslop Research Farm, and one research plot with both tall fescue and fine fescue at OSU's Vegetable Farm. At each site, two VPTs per species were installed, totaling six traps per site placed at least 18 feet apart.

Traps were checked weekly from May through June 2021. Insect counts were made, and identification to the species level was confirmed in the laboratory.

For larval sampling, five commercial grass seed fields (both tall fescue and perennial ryegrass) in Benton, Polk, and Marion counties were selected based on historic wireworm infestations as reported by growers and crop consultants. A commonly used baiting technique for larval sampling in cereal crop systems was used in the fall of 2021 (Morales-Rodriguez et al., 2017). This method entailed burying a small nylon stocking filled with wheat and barley seed (bait bags) that had been soaked in water for 24 hours to imbibe the seeds and initiate germination. After bait bags were buried in the soil, the seeds released CO_2 to attract nearby wireworms. We prepared five stocking baits per site and buried them in random locations within each field. The bait traps were checked on a weekly basis to identify a field site with reliable wireworm pressure sufficient for conducting an insecticide efficacy trial.

Field efficacy trial

Selected foliar insecticide treatments for wireworm control were evaluated. This experiment was performed in a commercial tall fescue seed field in Polk County. The field was planted in spring 2021 with the cultivar 'Sunset Gold' at a seeding rate of 8 lb/acre with a 12-inch row spacing. Seeding depth was approximately 0.75 inch. The experimental plots were 30 feet long x 10 feet wide, with a 5-foot buffer separating each plot. The experimental design was a randomized complete block with four replications.

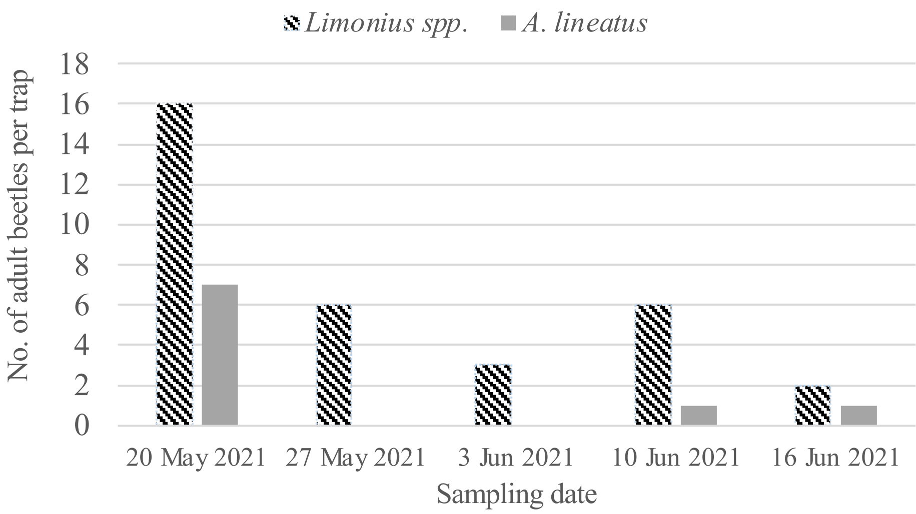

Figure 1. Species composition of wireworm species (*Limonius* spp. and *Agriotes lineatus*) detected during the 2021 monitoring period in a commercial fine fescue field in Marion County, OR.

Insecticide treatments included:

- Vantacor (2.5 fl oz/acre)
- Lorsban (24 fl oz/acre)
- An experimental broflanilide product, BAS4007I (1.14 fl oz/acre and 2.27 fl oz/acre)

Control plots were not treated with any insecticides.

Treatments were applied on October 12, 2021, using a CO_2-pressurized backpack sprayer (Bellspray Inc., Opelousas, LA) at a spray volume of 20 gal/acre at 24 psi through AM 11002 nozzles. Insect counts for wireworm larvae were taken posttreatment by deploying bait bags containing germinating wheat and barley seed (as previously described) at the center of each plot. Data were collected at 3, 7, and 28 days after treatment (DAT). Data were analyzed by ANOVA, and means were separated using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

Monitoring

No wireworms were detected in the traps deployed in perennial ryegrass at OSU's Hyslop Farm during the monitoring period from May through June 2021. A total of ten *Limonius* spp. adults were captured at the OSU Vegetable Farm in both tall and fine fescue during the 2021 monitoring period, but there was no detection of *A. obscurus* or *A. lineatus* at this site.

Adults of both *Limonius* spp. (33 total) and *A. lineatus* (9 total) were trapped in the commercial fine fescue field site during 2021 monitoring efforts (Figure 1). This is the first report of *A. lineatus* in a commercial grass seed field in western Oregon, indicating the westward movement of yet another important invasive pest species.

Efficacy results

Bait trapping efforts during fall 2021 resulted in the identification of a field site with reliable pest pressure (up to six larvae per bait station) to conduct an insecticide efficacy trial. At 3 DAT, the untreated control and Vantacor treatments had an average of 5.5 wireworms per bait station (Table 1). Treatment means for Lorsban (average of 2.2 wireworms per bait station) and BAS4007I (average of 4 and 4.5 wireworms at low and higher application rates, respectively) were statistically different from the untreated control.

At 7 DAT, Vantacor had an average of 1.7 wireworms per bait station, followed by the untreated control (an average of one wireworm per bait station), Lorsban (an average of one wireworm per bait station), and BAS4007I (an average of 0.7 and 0.5 wireworms at low and higher application rates, respectively). At 28 DAT, there was an overall decline in wireworm captures in all treatments.

There were no differences among the insecticide treatments (mean wireworm larvae per bait station per treatment) at 3, 7, or 28 DAT. No phytotoxicity or differences in plant vigor were observed with any insecticide treatment. This trial will be repeated in fall 2022 to validate the efficacy data.

References

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Table 1. Trade names, active ingredients (class), rate, and mean number of wireworms per bait station per sampling date.

Trade name	Active ingredient (insecticide class)	Rate	Wireworms/bait station		
			---------------- (mean no.) ----------------		
			3 DAT	7 DAT	28 DAT
Untreated control	—	—	5.5	1.0	0.7
Vantacor	Chlorantraniliprole (Group 28)	2.50 fl oz/acre	5.5	1.7	0.2
Lorsban	Chlorpyrifos (Group 1B)	24.00 fl oz/acre	2.2	1.0	0.0
BAS4007I	Broflanilide (Group 30)	1.14 fl oz/acre	4.0	0.7	0.5
BAS4007I	Broflanilide (Group 30)	2.27 fl oz/acre	4.5	0.5	0.0
P-value			0.5966	0.6419	0.4473