Early application of *Metarhizium brunneum* for management of wireworm in popcorn, *Zea mays* var. *everta*.

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INTRODUCTION

Wireworms:

- Larvae of various click-beetle species
- 800 species worldwide. About 30 known species are serious agricultural pests in Canada.
- *Agriotes obscurus* (Coleoptera: Elateridae) and *A. lineatus* are the species of primary concern to corn crops in western Canada.
- Introduced from Eurasia.
- Can live in soil for several years before pupating into adult click beetles.
- Attracted to sources of CO_2 in the soil, such as the growing roots which they feed on, including crop roots.
- Can be distracted from crop roots by other sources of CO_2 in the soil from…
  - o Rolled oats used as bait
  - o High organic matter in soil, eg. soils in an organic farm, tilled in mulch or cover-crops, etc.

Corn:

- *Zea mays*, (Cyperales: Poaceae):
- Important crop in the Fraser Valley, especially in Chilliwack, Agassiz, and Abbotsford.
- As a grass, it is highly susceptible to damage by wireworms.
- Damage can be fatal to emerging corn seedlings.

Metarhizium brunneum (Hypocreales: Clavicipitaceae):

- An entomopathogenic fungus, a variety of which was isolated by Todd Kabaluk of Agriculture Canada from a wireworm cadaver found in a field in Agassiz BC.
- Has been shown to control wireworm damage.
- Application timing may be a factor in its effectiveness.
- Few studies have looked specifically at whether the timing of *Metarhizium* application, in relation to timing of the crop, has any effect on its efficacy in wireworm control.

Attract and kill method: Oats applied with *M. brunneum* to lure wireworms by releasing CO_2 during decomposition.

Left to right: Treatments being weighed and applied. A wireworm. Mature corn plants.

OBJECTIVE

Compare *M. brunneum* treatment at time of seeding to application four weeks before seeding, in terms of wireworm damage and popcorn yield.

METHODS

Location: KPU Orchard, Richmond, BC

Experimental design:

- Randomized complete block design with eight replicates.
- 4 plots (2.25 x 2.5 m) per replicate, for a total of 32 plots
- Each treatment plot contained five rows of corn (2.5 m) planted 25 cm apart, two of which were buffer rows, and the centre row being the test row.
- Rolled oats applied at 10 g/m in banded treatment
- *M. brunneum* applied at 10.5 g/band
- Unplanted buffers < 2 m around study site
- Treatments were buried 10-15 cm below ground, halfway between each corn row (four treatment bands per plot).

Treatments (banded application, conidia and oats not mixed):

A) *M. brunneum* with oats 4 weeks prior to seeding
B) Oats 4 weeks prior to seeding
C) *M. brunneum* applied day of seeding
D) No treatment (control)

Data collection:

- Samples collected from the middle row in each plot
- Measurements: Plant height, plant weight, cob count, seed weight, etc.

Trenches dug for treatments

Seeding corn

Corn growth after one month

Statistical analysis was completed using ANOVA (α = 0.05) in jamovi statistical computing environment for R. Data were tested for normality (Shapiro-Wilk), and normality corrections applied where needed.

RESULTS

No treatment effect was detected on wireworm survival (Fig. 1), cob yield (Fig. 2), kernel yield (Fig. 3), or any other dependent variable. Live wireworm samples taken from the plots did succumb to *M. brunneum* infections in-situ.

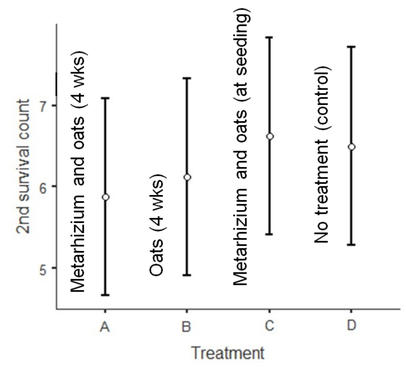

Figure 1. 2nd survival count by treatment (Standard error)

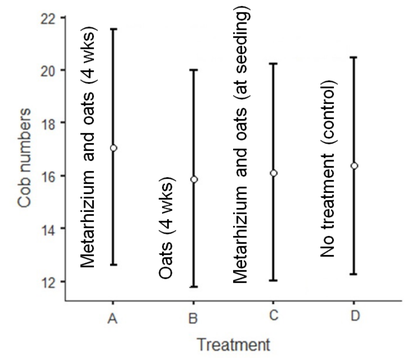

Figure 2. Cob count by treatment (Standard error)

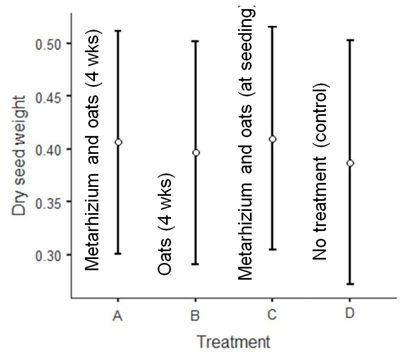

Figure 3. Seed weights by treatment (Standard error)

Wireworm infected with *M. brunneum*.

DISCUSSION

No treatment effects were detected. Possible reasons include:

- *M. brunneum* was applied at the same site in 2018 and 2019, perhaps contributing to residual activity that masked treatment effects.
- The high organic matter content of the soil may have contributed to CO_2 emissions that masked emissions from oats intended to lure wireworms to infective conidia.

Previous attempts to direct-seed corn at the site in 2015, 2017 and 2018 failed due to wireworm-induced seedling mortality. The success of direct seeding in this study may support the hypothesis of residual *M. brunneum* activity.

Additional factors that may have affected the results:

- *M. brunneum* conidia applied at the time of seeding may have repelled wireworms, especially if residual conidia were already present.
- Soil at the experimental site has high levels of organic matter, possibly creating unaccounted for sources of CO_2

Interesting questions:

- Does increased organic matter in soil in organic production systems influence efficacy of *M. brunneum* as a biocontrol for wireworms?
- Does *M. brunneum* application in prior growing seasons have residual effects?
- How long does applied *M. brunneum* persist in soils?
- Do wireworms respond to *M. brunneum* conidia densities when seeking food?

CONCLUSION

This test detected no significant treatment effect.

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