Biological control of wireworm *(Agriotes lineatus)* in potato with *Metarhizium brunneum* fungus

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Introduction

The wireworm (*Agriotes lineatus*) is the the larval stage of the click beetle. Its broad host range includes carrots, cucurbits, rutabagas, onions, sweet corn, potatoes, sugar-beets, beans and peas. It tunnels into potato tubers, rendering them unsuitable for sale, and reducing crop yield.

Organophosphate insecticides that have historically been used to control wireworms are detrimental to the ecosystem, threaten human health and wellbeing, and are unavailable to organic farming operations. Wireworms have developed resistance to some organophosphates; and others are no longer registered for agricultural use.

A potential alternative is the use of non-toxic biological controls, often in the form of bacterial, fungal or nematode microbial agents.

Metarhizium brunneum is an entomopathogenic fungus that kills wireworms, making it a potential biological control agent. Previous studies have found it to be effective in reducing crop damage associated with wireworm feeding (Ansari et al., 2009; Kabaluk et al., 2017; Brandl et al., 2017; Reddy et al., 2014).

Wireworms are attracted to CO_2 released through plant roots. Decaying rolled oats also release CO_2, making them a potential lure to attract wireworms to *M. brunneum*.

We tested the efficacy of *M. brunneum* with, and without rolled oats, as a biocontrol of wireworm in potato grown in Richmond, British Columbia.

Fig 1. Research site (red box with star) at the Kwantlen Polytechnic University Orchard in south Richmond.

Methods

The study was conducted on a 200 m^2 section of the Kwantlen Polytechnic University orchard, at the corner of Gilbert and Dyke road in Richmond, B.C. (Figure 1). It employed a Randomized Complete Block Design with six replicates and three treatments (Figure 5):

1. *M. brunneum* and oat (Metarhizium); and
2. *M. brunneum* without oat (MetaOat); and
3. Untreated control (Control).

On July 23rd, each experimental plot (2 x 4 m) was planted with 21 seed potatoes (cv. 'Orchestra'), spaced 30 cm apart in three rows spaced 1 m apart. A 1 m unplanted buffer was left between plots in each row. Four grams of cultured *M. brunneum* on rice was deposited below each tuber in the two *M. brunneum* treatments. The cultured fungus was blended with rolled oats in the MetaOat treatment only (Figures 2, 3). Potatoes were hilled after seeding, and just before row closure.

Potatoes were harvested from the center row of each plot on October 13th. Plant count, potato count, total yield, wireworm-damaged yield, and degree of wireworm damage were recorded. Wireworm damage was considered present with >5 mm tunneling into potato flesh.

Data were analyzed by ANOVA ($\alpha = 0.05$) in the R statistical computing environment.

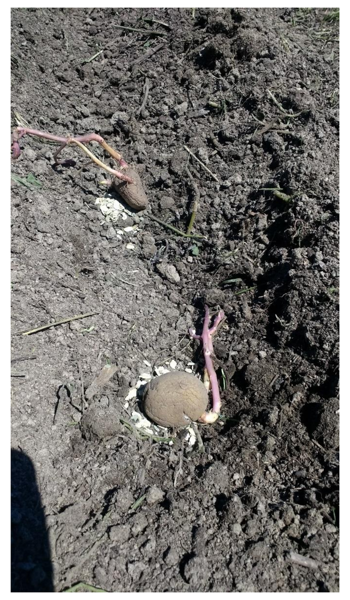

Fig 2. *Metarhizium* and oat treatment under seed potato

Fig 3. *Metarhizium* and oat mixture

Fig 4. Seed potato row in field

A	C	A	C	C	B
C	B	C	A	B	C
B	A	B	B	A	A

North--South

A: Metarhizium and Oat
B: Metarhizium
C: Control

Fig 5. Experimental design and treatments

Results

Most potatoes suffered some wireworm damage across treatments (Figure 6). No statistically significant treatment effects were observed. The proportion of potatoes that suffered wireworm damage was 33% lower in the MetaOat treatment than the Control treatment, and this difference approached statistical significance (p=.067) (Figure 6). MetaOat treatment plots tended to produce fewer undamaged potatoes, and more damaged potatoes, than control plots (Figure 7), but results varied considerably.

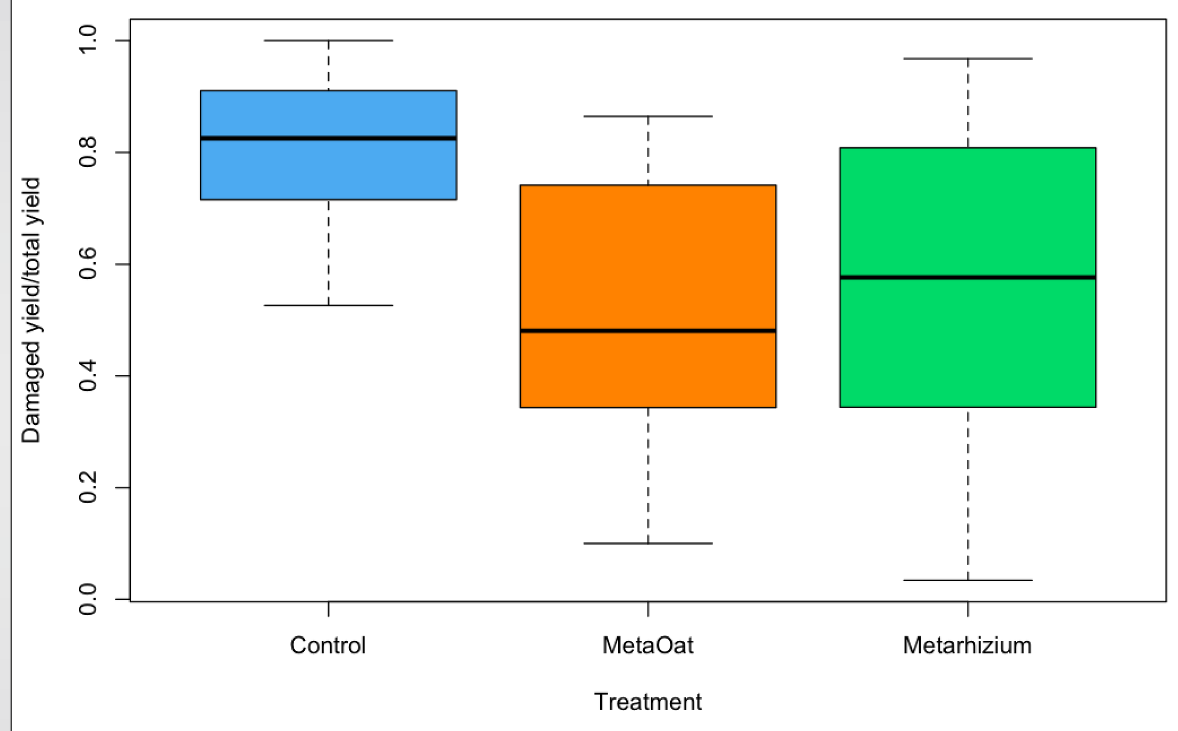

Fig 6. Damaged potato yield/total potato yield for the control, *Metarhizium* and oat, and *Metarhizium* treatments. The difference between the Control and MetaOat treatments approached statistical significance ($p < .1$).

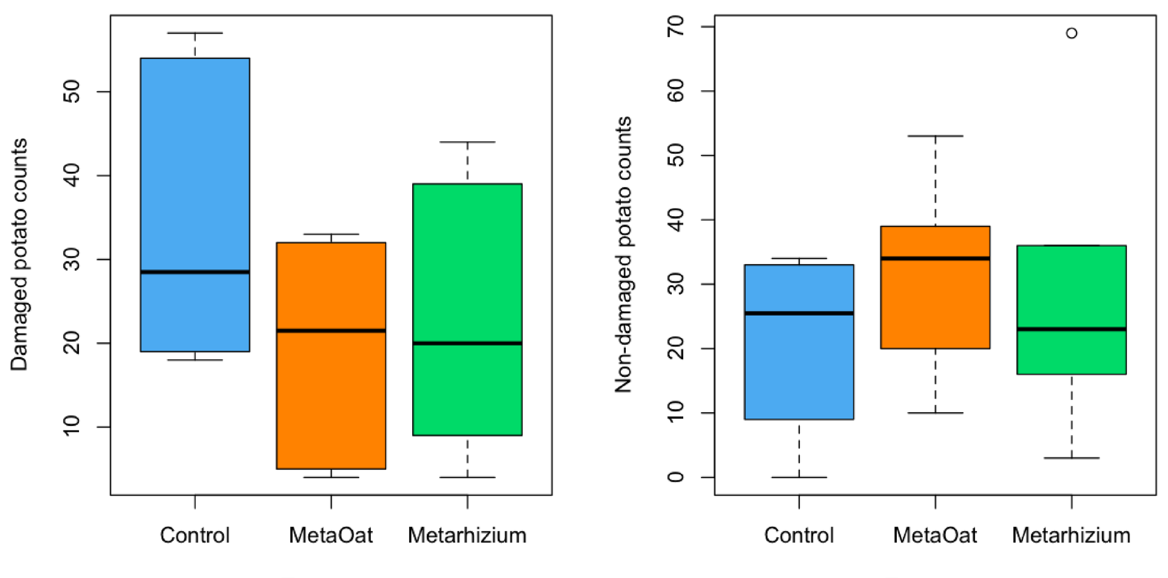

Fig 7. Damaged potato counts (left) and non-damaged potato counts per plot for the control, *Metarhizium* and oat, and *Metarhizium* treatments. No significant difference was found between treatments.

Conclusions

No significant treatment effects were detected in this experiment. Numerical trends suggest that *M. brunneum* and oats may have reduced wireworm damage to potato, but this effect did not achieve significance, due to considerable variability within treatments. The observed trends were consistent with reports from previous studies, in which *M. brunneum* and oats have reduced damage due to wireworm feeding.

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