PT406
Development of biological control of potato wireworm

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Know-how for Horticulture™

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INSTITUTE FOR HORTICULTURAL DEVELOPMENT
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FINAL REPORT TO HRDC

PROJECT PT 406

DEVELOPMENT OF BIOLOGICAL CONTROL FOR POTATO WIREWORM

REPORT PREPARED BY
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DECEMBER 1996

INDUSTRY SUMMARY

This project aimed to test and develop a biological control agent for use against the potato wireworm. The biological control agent was a strain of the insect killing fungus *Metarhizium anisopliae.*

The fungus was produced by CSIRO Division of Entomology and tested at sites known to have potato wireworm. These sites were paddocks used for potato production. Sites at which trials were conducted were in Gembrook, Koroit and in the Melbourne area.

Results of the trials were inconsistent. Some results showed significant reductions in wireworm damage when the fungus was applied when compared to controls, but other results showed no difference between fungal treated and control plots.

Trials where wireworm populations were high indicated that although the use of the fungus resulted in less damage compared to untreated controls, the level of damage was still too high to be commercially acceptable.

The use of a sticker improved application of *M. anisopliae* to the potato bait (seed piece) but it did not result in control of potato wireworm.

The use of *M. anisopliae* for the biological control of potato wireworm continued to show potential, but the prospect of a commercial product being produced in the near future is remote.

TECHNICAL SUMMARY

This project aimed to test and develop a biological control agent for use against the potato wireworm, *Hapatesus hirtus*. The biological control agent was a strain of the entomopathogenic fungus *Metarhizium anisopliae*.

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Introduction

The potato wireworm, *Hapatesus hirtus*, is a serious pest of potatoes in some parts of Victoria. It is not generally a concern for most potato growers, but is a locally severe problem. This species is native to Australia, and is not an introduced pest. Until 1987 the organochlorine, dieldrin, was used to prevent damage by potato wireworm.

Alternative chemical control has not been as successful as that provided by dieldrin, but some level of control has been achieved by using the organophosphate insecticides, chlorpyrifos and phorate.

Research on the biology of the wireworm (by Dr Paul Horne, Agriculture Victoria) has allowed more precise control, by assessing the risk of wireworm damage. This is achieved by first mapping the wireworm population in a paddock and identifying any areas of risk. The damaging stage is the immature larva (wireworm). The larva then matures through a pupal stage to become an adult click-beetle.

Research by Dr Richard Milner (CSIRO) identified an isolate of the hyphomycete insect killing fungus, *Metarhizium anisopliae*, that is highly effective in killing potato wireworm larvae.

The wireworm larvae live for several years in the soil, burrowing into, and feeding on, the seed piece and new tubers (Horne and Horne 1990). The objective of this project was to find out if treating the seed piece with *M. anisopliae*, and so killing any wireworms present before new tubers were formed, would prevent damage.

The difference between this approach and that of using the conventional chemical insecticides, is that a poisonous barrier is not required. The seed piece itself is the bait and repellent chemicals are not used. It was not known whether the *Metarhizium* would act rapidly enough to prevent damage to tubers, or whether any additives used to improve application may repel wireworms from the bait.

Materials and Methods

Hapatesus hirtus larvae (the wireworm) were field collected and screened by Dr Milner at CSIRO against different strains of *Metarhizium*. The best strain was isolate FI522, and this was confirmed in several assays.

Potato wireworm live in the soil for several years and so are present in a paddock before it is planted to potatoes. Even when growers know they have a problem with potato wireworm in a particular paddock, it is difficult to know just where in the paddock they are concentrated.

Where the paddock was very large, we located suitable infestations by first baiting with potatoes. That is, potatoes were buried in the soil in different parts of the paddock and left for approximately one month and then dug up. The number of wireworms, and damage by wireworms was recorded. A map of the paddock in terms of wireworm abundance was produced allowing the best site to be found.

The main trial sites were in Koroit and Gembrook, at paddocks with a history of wireworm damage. The Koroit site was used for 2 successive years, the first year as a grass paddock. Additional smaller scale trials were carried out at Kinglake and Panton Hill. The design of each trial was such that it took into account factors such as the patchiness and densities of wireworm populations and the size of the paddocks.

A suspension of *M. anisopliae* spores was made up for each application. The rate used was 0.2g/ litre of spores (1×10^{12} spores/ g). Potato baits (whole potatoes) were dipped in the suspension and buried in the soil.

Gembrook Trial

This trial was performed by planting four plots of treated seed pieces in the area at highest risk of wireworm damage. Each plot was 10m x 10m.

Seed pieces were planted in December and assessed first in April and then May. They were assessed twice as damage levels were very low in the first assessment and damage generally increases if the crop is left longer. Damage to new tubers in treated areas was compared with (paired) untreated controls. The outer 1.5m of each plot was used as a buffer and assessed separately.

Koroit Trial 1

This trial was performed in 3 stages in a pasture paddock previously used for potato production (and to be used the following year). Firstly the paddock was mapped using potato baits to identify the areas of greatest infestation. The trial was located in an area where damage was estimated to be around 30%.

The second stage, in August, involved putting treated and untreated baits in a grid. A 3 x3 Latin square design was used, with each plot being 20 x 20 m. In each plot 25 seed pieces were buried. Two types of treatments were used: one with baits dipped in

Metarhizium suspension and another with dipped baits and about 250ml of suspension poured in with the bait. All of these baits were removed and assessed for damage in October.

The third and final stage was to place untreated baits in all plots to measure wireworm activity in plots that had Metarhizium anisopliae treatment versus untreatd plots. The baits were placed in October and assessed in December.

Koroit Trial 2

This trial used the same site as Koroit Trial 1, but in a potato crop rather than a grass paddock. A soil applied insecticide (chlorpyrifos) was used by the grower in all areas in the paddock except two strips used for the trial site. Therefore, the design was to have 5 paired plots, 3 plots in the high risk area and 2 plots in the lower risk area.

Each plot was 10 m long by 4 rows wide, making a total of 50 m by 4 rows of treated area. This was planted by hand in October and assessed in January.

Assessment was made by harvesting all tubers from treated sites, 100 tubers from adjacent untreated areas, and inspecting them for wireworms and wireworm damage. The outer 1.5m of each treated plot was assessed separately as a buffer zone.

Stickers to assist with coating the seed piece could possibly improve effectiveness of *Metarhizium anisopliae.* Laboratory testing showed that one sticker, methyl-hydroxy cellulose, would not interfere with the germination of the fungus and so this was used in the Koroit 2 trial.

An additional trial was planned at another site with a history of wireworm damage, but this was cancelled when inspection showed very few wireworms present.

Results

Gembrook Trial

Results at this site were poor, with the first assessment showing very low levels of damage and practically no difference in wireworm damage levels between treated and untreated plots. The results were Untreated Control 6.4% damage, Treated 6.0% damage.

The second (larger) assessment showed very similar results with 5.09% damage in the untreated control and 4.7% damage in the treated areas.

Koroit Trial 1

Baiting the paddock was successful in identifying areas of greatest abundance of wireworms and also the likely degree of damage. Baiting at the trial site recorded 30% damage, and subsequent damage to control plots was 35% in October.

In the December assessment, the number of wireworms in *Metarhizium* treated plots (12%) was lower than in the untreated controls (48%) and in the treated baits plus liquid suspension (40%). However, the variation was so high that this result could not be considered significant.

Wireworms were found in treated and untreated baits. This confirmed that *M. anisopliae* does not repel the wireworm larvae.

Koroit Trial 2

In this trial, there was less damage in the treated plots, and the result was statistically significant ($p<0.05$) using analysis of variance (figure 1). The *M. anisopliae* treated plots had an average of 17% damage, versus 53.3% damage in untreated controls.

The level of damage in treated plots was still far too high to be acceptable. Although the damage had beEn reduced 17% damage is more than growers or processors would accept.

Discussion

Wireworms move vertically in the soil, following moisture gradients, at different times of the year. Therefore, they would normally descend deeper into the soil over summer to avoid dry areas. In irrigated potato crops they remain high in the soil profile and so affect developing tubers. It is unknown how frequently, or what proportion of the population of potato wireworms, move vertically into the region where potato tubers develop. If this movement is not synchronised within a population, then the results with *M. anisopliae* would be worse than if the movement was the same for all individuals.

The lack of success in the Gembrook trial may well have been due to poor application of the fungus to the seed piece. The greater degree of control achieved in the Koroit Trial 2 could in part be due to the use of a sticker. Temperature will influence the effectiveness of *M. anisopliae*, but this was not considered limiting during these trials. Soil temperature was above the threshold for the fungus to work.

This project dealt with a soil dwelling insect with a long life-cycle, variable and often low population sizes, patchy distributions and vertical migration. With such an insect there will always be difficulties in obtaining clear results. However, the limited resources available for this project have allowed laboratory screening and field testing of a naturally occurring biological control agent, with a significant reduction in pest damage resulting. The degree of control is not such to warrant a commercial product yet, but the approach was worth investigating. The method may be applied with greater success to other species of wireworms that attack potatoes overseas. In those cases where population sizes and economic damage levels are greater, the method may well prove more successful.

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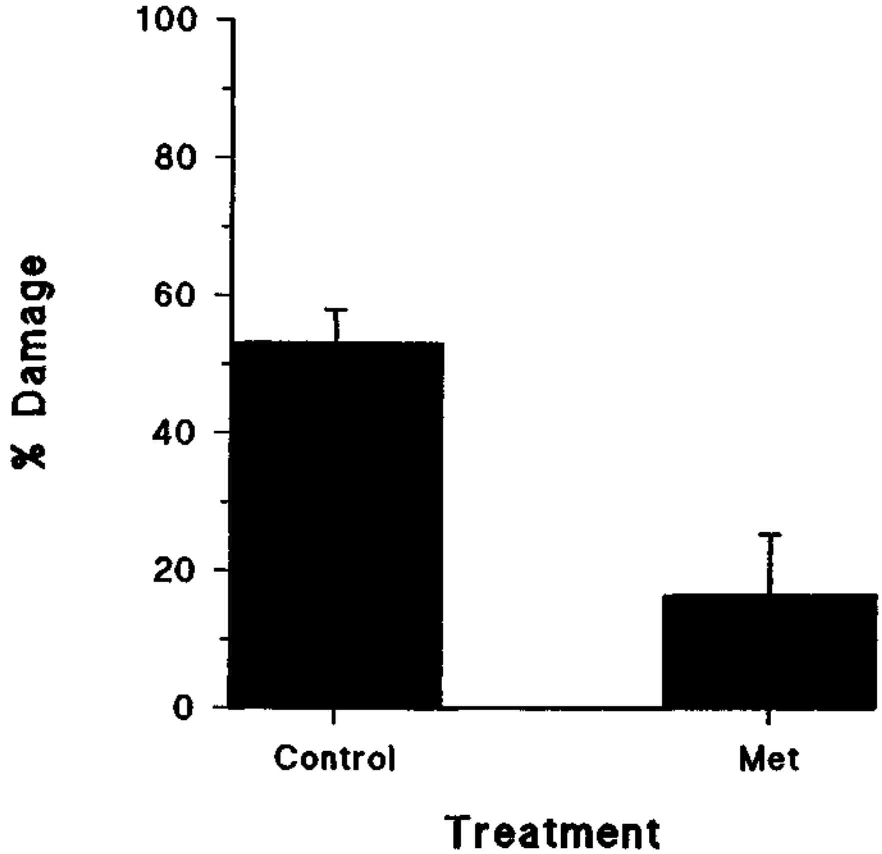

Figure 1: Percent damage to tubers in Koroit Trial 2.