BC FoodWeb

BRITISH COLUMBIA WINE GRAPE COUNCIL

Government research report

Emerging strategies for climbing cutworms in wine grapes

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KEY TAKEAWAYS

The goal of this project was to develop new biological control tools for climbing cutworms in vineyards by evaluating whether entomopathogenic nematodes and fungi could provide effective alternatives to conventional insecticides.

- Entomopathogenic nematode *Steinernema feltiae* is the most effective against both species of cutworms at 15°C.
- The fungal strains OK-373 and ISH-252 caused mortality in cutworms more quickly under low temperature conditions compared to the five other strains.
- Further studies are needed to confirm effective combinations of nematodes and fungi in realistic vineyard conditions.

How can this information be used?

This report summarizes research conducted from 2018 to 2020 by researchers at Kwantlen Polytechnic University and Agriculture and Agri-Food Canada. The project aimed to develop new biological control tools for climbing cutworms in vineyards by evaluating whether entomopathogenic nematodes and fungi could provide effective alternatives to conventional insecticides.

The research results demonstrate a promising approach to climbing cutworm management and highlight areas where further work is needed before widespread development of commercial products.

Production Type

- Wine grapes

Practice Benefit(s)

- Pest management
- Reduce pesticide inputs

Research Location

- Okanagan and Similkameen Valleys, BC

Key Terms

- *Entomopathogen:* Naturally occurring microorganisms that infect and kill insects. Entomopathogens include fungi, bacteria, nematodes, and viruses, some of which are highly specific to particular insect species.
- *Nematode:* Soil-dwelling worms that play a variety of roles in vineyard ecosystems. While some species are plant pests and can spread diseases, others are beneficial and can be used as control agents to infect and kill insect pests.
- *Parasitoid:* An insect that spends its immature stage living on or inside another insect host, feeding on it as it develops and eventually killing it.

Why was this research done?

Climbing cutworms are a persistent pest of table and wine grapes in British Columbia's Southern Interior. Among the 25 species recorded in the region, the Barnes' cutworm (*Abagrotis orbis*) and the invasive lesser yellow underwing (*Noctua comes*) are responsible for most vineyard damage (Figure 1).





Figure 1. Barnes cutworm (*Abagrotis orbis*) (left) and lesser yellow underwing (*Noctua comes*) (right). *Abagrotis orbis* adults are grayish-brown with scattered black speckles on their forewings. *Noctua comes* adults have bright yellow-orange hindwings with a large black spot and dark marginal band. Caterpillars can reach 4-5 cm in length when fully grown, while adult moths typically have a wingspan of 2-2.5 cm. Photo by H. Schonhofer

Damage occurs when caterpillars feed on developing grapevine buds and shoots (Figure 2), reducing yield and affecting fruit quality. An economic threshold of about 3% bud damage has been reported for climbing cutworms. Detecting infestations can be difficult because larvae emerge from the soil at night to feed and remain hidden in the soil during the day. Their patchy distribution within and among vineyards further complicates monitoring and makes damage difficult to predict. As a result, growers have traditionally relied on broad-spectrum insecticides for control. However, growing concerns about insecticide resistance, impacts on beneficial insects, and limited options for organic producers have highlighted the need for alternative management tools.

In response to these challenges, researchers from Kwantlen Polytechnic University and Agriculture and Agri-Food Canada conducted a series of laboratory and greenhouse experiments between 2018 and 2020. **Their goal was to evaluate the potential of entomopathogens as biological control agents for climbing cutworms.** Entomopathogens are naturally occurring microorganisms (such as fungi, bacteria, nematodes, and viruses) that infect and kill insects. Unlike broad-spectrum insecticides, many target only a narrow range of insect species, reducing risks to beneficial insects and other non-target organisms. This level of specificity can help maintain the natural pest suppression and biodiversity that support resilient agricultural ecosystems.



Figure 2. Cutworm larvae feeding on bud. Photo by H. Schonhofer

Despite their potential advantages, entomopathogens are living organisms whose effectiveness depends on environmental conditions. This presents an important challenge for climbing cutworm management. Much of the cutworm life cycle is spent in the soil, and the greatest feeding damage occurs during the cool spring and fall months, when young larvae are actively growing (Figure 3). Any biological control agent intended for vineyard use must therefore remain active under these conditions. **To address this question, researchers evaluated entomopathogenic nematodes and fungi in a series of soil-based experiments conducted at temperatures ranging from 15°C to 25°C. Their goal was to identify nematode species and fungi strains that are effective in conditions in the Okanagan Valley to showcase its potential for development into a commercial product.**

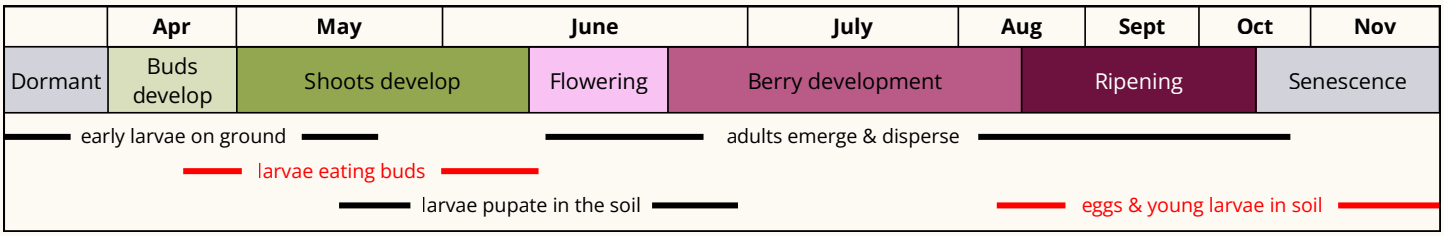


Figure 3. Cutworm lifecycle and high vineyard damage in red.

What was the outcome?

Researchers conducted laboratory and greenhouse experiments to identify and evaluate entomopathogenic nematodes and fungi as potential biological control agents for climbing cutworms. The experiments and key findings are summarized below in four phases. Readers interested in the experimental design and statistical analyses can refer to the full report linked at the end of this document.

The research began by screening different nematode species (Phase 1) and fungal strains (Phase 2) to identify the most promising candidates. Later experiments evaluated their performance at different application rates and temperatures, and investigated whether combining nematodes and fungi could improve cutworm control (Phase 3). The most promising treatments were then assessed in growth chamber conditions to determine whether laboratory results translated to more realistic growing environments (Phase 4).

Phase 1: Which entomopathogenic nematodes are effective against climbing cutworms?

Researchers conducted multiple trials testing three nematode species (*Heterorhabditis bacteriophora, Steinernema carpocapsae*, and *Steinernema feltiae*) against the Barnes' cutworm and the lesser yellow underwing under different treatment conditions and temperatures ranging from 15°C to 25°C.

S. feltiae showed the greatest potential for both climbing cutworms control under low temperatures. At 15°C, it reached about 80% mortality by day 4. In comparison, *S. carpocapsae* also controlled cutworms but acted more slowly, reaching about 80% mortality around days 9 to 11. At 17°C, *S. feltiae* reached about 80% mortality by day 6, while *S. carpocapsae* required until about day 13 to reach a similar level of mortality.

Researchers then tested a range of application rates for *S. feltiae* and *S. carpocapsae*. Although both species caused significant mortality across all rates tested, *S. feltiae* performed better at 15°C. As a result, two lower application rates of *S. feltiae* (6 and 25 IJ/cm^2) were selected for later experiments combining nematodes with fungi.

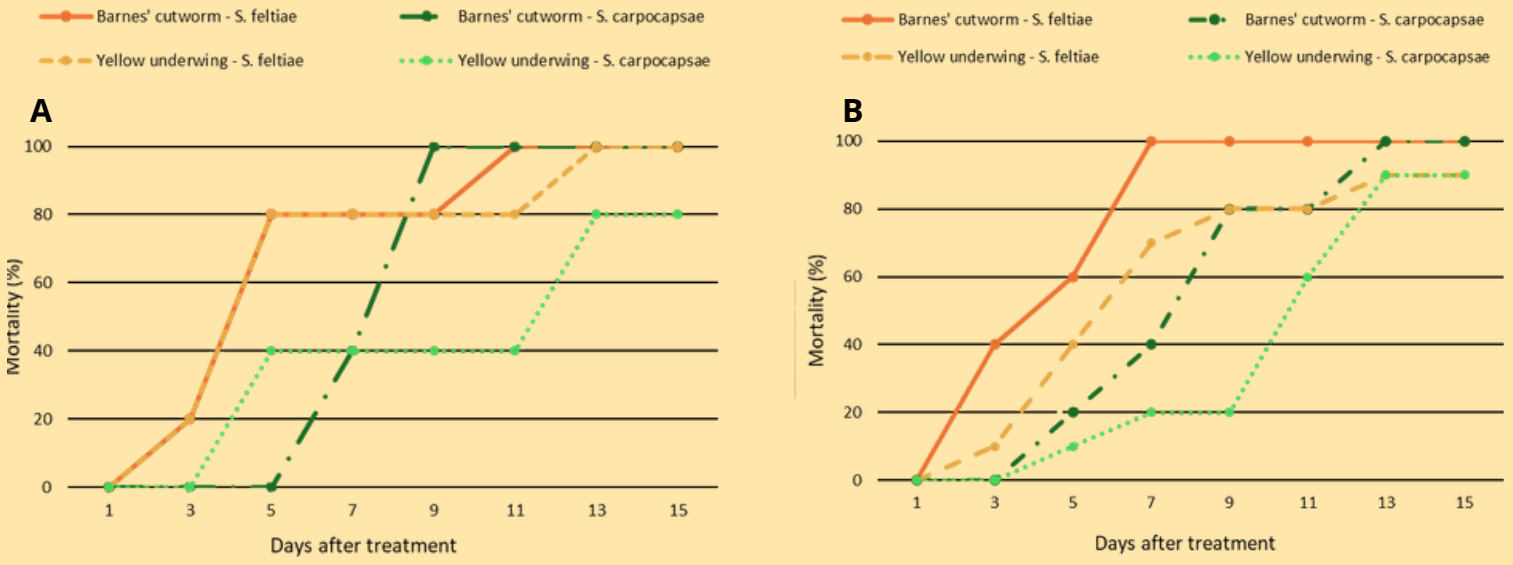


Figure 4. Mortality of Barnes' cutworm and lesser yellow underwing following treatment with *Steinernema feltiae* and *Steinernema carpocapsae* at 15°C (A) and 17°C (B). Values show the percentage of cutworms that died over time after treatment in laboratory trials.

Phase 2: Which strains of the fungus Beauveria bassiana are effective against climbing cutworms?

Researchers tested seven strains of the fungus *Beauveria bassiana* against climbing cutworms at 15°C, 20°C, and 25°C. All strains infected and killed the two speicies of cutworms, but four strains (OK-372, OK-373, ISH-252, ISH-190) caused high mortality at 15°C. OK-373 and ISH-252 caused mortality more quickly under low temperature conditions across repeated experiments. These two were selected to be combined with nematodes in later experiments.

Researchers also found that the Barne's Cutworm was generally more susceptible to fungal infection than the lesser yellow underwing.

Phase 3: Can nematodes and fungal strains be combined to have more effective control against cutworms?

Researchers tested nematode-fungus combinations to see if together they would provide better control of cutworms than either could alone. Researchers combined the nematode *S. feltiae* at two application rates (6 IJ/cm^2 or 25 IJ/cm^2) with fungal strains (OK-373 or ISH-252). These combinations were compared against a commercially available biocontrol product, BotaniGard.

Many of the combinations produced additive or synergistic effects, meaning the fungal strains and nematodes worked as well as, or better than, expected when compared with their individual performance. Combinations using the higher application rate of *S. feltiae* more often produced additive effects, whereas the lower application rate frequently resulted in synergistic effects. A synergistic effect means the combination performed even better than expected, resulting in greater cutworm mortality than either agent could achieve on its own. This finding is encouraging because it suggests that lower nematode application rates may still provide effective control when combined with fungal treatments.

Further field studies are needed to identify the most effective combinations, application rates, timing, and environmental conditions for consistent cutworm control under vineyard conditions.



Figure 5. Yellow underwing larva infected with *B. bassiana*. Photo by S. T. Adabi.

Phase 4: Do these combinations remain effective under greenhouse conditions?

Dandelions are commonly found in vineyard alleyways and may provide an alternative food source for cutworms in spring, which may help reduce feeding on developing grape buds and shoots. Because cutworms showed a preference for dandelions, researchers tested the most promising combinations of nematodes and *Beauveria bassiana* on potted dandelion plants grown in a growth chamber under cool-temperature conditions.

Treatments containing *S. feltiae* generally had greater cutworm mortality than fungal treatments applied alone. However, most combinations did not perform as expected. Many combinations were less effective together than would be individually. One notable exception was the fungal strain ISH-252, which produced an additive effect when combined with *S. feltiae* against the Lesser Yellow Underwing (*Noctua comes*). These results suggest that while some nematode-fungus combinations remain promising, their performance may be influenced by environmental conditions and application methods. Additional research is needed to identify combinations that consistently improve cutworm control under vineyard conditions.



Figure 6. Treated potted dandelion covered with mesh. Photo by S. T. Adabi

What's next?

This research provides a foundation for further studies to evaluate the combination of nematodes and fungal strains for commercial use in vineyards. It also highlights how effective alternatives to conventional insecticides can be, although these studies showed that not all cutworms respond the same and that different entomopathogens may need to be investigated and refined for optimal mortality against specific species.

How was the research done?

We conducted a series of laboratory and controlled plant experiments between 2018 and 2020 at the Institute for Sustainable Horticulture at Kwantlen Polytechnic University. The work was organized into eight stages to test whether entomopathogenic nematodes and the fungus *Beauveria bassiana* could control the Barnes' cutworm and lesser yellow underwing under different temperatures and treatment conditions.

The first experiments compared three nematode species; *Heterorhabditis bacteriophora, Steinernema carpocapsae, and Steinernema feltiae* at 15°C, 17°C, 20°C, and 25°C. Nematode suspensions were applied to filter paper in individual cups containing one cutworm larva, and mortality was monitored daily. We then tested different application rates of *S. feltiae* and *S. carpocapsae* in soil to determine how concentration and temperature affected cutworm mortality.

We also tested seven *B. bassiana* isolates against both cutworm species. Broccoli leaf discs were treated with fungal suspensions and placed in cups with individual larvae. The most promising fungal isolates, OK-373 and ISH-252, were then selected for further testing with *S. feltiae*. BotaniGard, a commercially available *B. bassiana* product, was included as a positive control in the combination trials.

Next, we tested combinations of *S. feltiae* with OK-373 and ISH-252 to determine whether using the nematode and fungus together could improve cutworm control. We also tested application timing by applying *S. feltiae* either one week or two weeks after the fungal treatment. The one-week interval was selected for further plant-based testing.

Finally, We moved from cup-based experiments to potted plants. We first compared dandelion and shepherd's purse as host plants and found that the larvae preferred dandelion. The most promising treatments were then tested on potted dandelions, with the fungal treatment applied first and *S. feltiae* applied one week later, to see how the treatments performed in a more realistic plant environment.

Biocontrol agents: *The nematodes used in this study were commercially sourced, while the B. bassiana isolates included strains collected from coastal and Okanagan regions of British Columbia, along with one tropical isolate. These experiments were designed to identify promising biological control approaches for further testing and are not recommendations for direct vineyard application. For full study methods, treatment rates, experimental conditions, and data analysis please visit the formal report. For general information about climbing cutworm management, please visit BCWGC Production Guide for Grapes.*

About this brief

This brief was prepared by Nisa Chavez and Yussuf Adedeji from the BC Food Web team, with the help of Sepideh Tahriri Adabi, and is based on the following research reports and resources:

- BC Wine Grape Council. (2023). Cutworm management. September 21, 2023 R&D Committee Meeting.
- Institute for Sustainable Horticulture, Kwantlen Polytechnic University. (2021). Novel approaches to IPM strategies for climbing cutworm in wine grapes: Final technical report. Canadian Grapevine Certification Network and BC Wine Grape Council.
- Lowery, T., Weis, M., & Buchler, H. (2020). Insect and mite pests of grape in the southern interior of British Columbia. BC Wine Grape Council.

Want to learn more?
For any questions regarding this research, contact Sepideh Adabi at sepideh.tahririadabi@kpu.ca

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