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Research Brief

Soybean Gall Midge Susceptibility to Insect-Killing Nematodes

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Key Findings:

- Soybean gall midge recently emerged as a new pest of soybean in eastern South Dakota.
- Four insect-killing nematode species infected and killed soybean gall midge larvae.
- More soybean gall midge larvae were infected at the highest application rate.
- Observations indicate nematodes can enter galls with soybean gall midge larvae.

Background

The soybean gall midge (SGM), *Resseliella maxima,* was identified as a new species – and new pest of soybean – in South Dakota in 2018. By the end of 2023, SGM was reported from 164 counties in 7 states.

The adult, a midge, lays eggs in cracks that naturally form in stems below the cotyledons of V2-V3 soybean plants, or cracks that develop when plants are damaged by weather events like hail or wind. The eggs induce a gall (dark, swollen part of stem) to form. The larvae feed and develop between living and dead plant tissue in the gall, reducing the uptake of water and nutrients by the plant and causing plants to wilt and abort pod development. Plants will die when population pressure is too high. Chemical insecticides have been evaluated but are largely ineffective against this pest. As a result, alternative management tools are needed to suppress SGM.

Above: Peeling back the epidermis of an infected soybean stem reveals soybean gall midge larvae.

Left: Young larvae start out clear and transparent and turn orange over time as they develop and mature.

Entomopathogenic (insect-killing) nematodes are parasites of insects that naturally occur in agricultural soils. Insect-killing nematodes have been shown to infect and kill larvae and pupae of other gall midge species in laboratory and field trials, and are able to move inside plant galls containing larvae of another pest. SGM spends a portion of its life cycle in the soil. Older larvae move into the soil to pupate and also survive winter, where they may naturally encounter insect-killing nematodes.

Objective

Insect-killing nematodes have not yet been evaluated against SGM, but they may be able to contribute to sustainable and long-term management of this pest in soybean. The objective of this study was to evaluate the susceptibility of SGM larvae to four nematode species in the laboratory.

Progression of soybean gall midge nematode infection

Nematodes surround healthy larva and attempt to enter and infect it.

Infected larvae die and lose color over time.

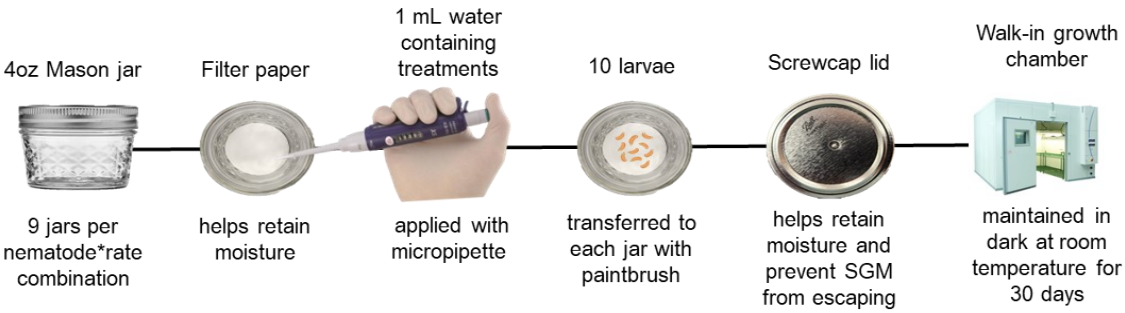
Nematodes emerge out of infected cadaver once food is depleted.

Methods

Soybean gall midge. Entire plants showing symptoms of SGM infestation were collected from two soybean fields in Minnehaha County in August, 2023, and stored in a dark cold room (48°F). Larvae collected from these plants were used within 72 hours.

Insect-killing nematodes and rates. Four commercially-available nematode species including *Heterorhabditis bacteriophora, Heterorhabditis indica, Steinernema carpocapsae,* and *Steinernema riobrave* were evaluated in this study. Each nematode was tested at 3 rates: 1X field application rate (25 nematodes per cm^2), 4X, and 10X the field rate. We also evaluated a water control that did not include nematodes.

Inoculation study. SGM larvae were evaluated for nematode infection for 30 days. The number of dead and alive larvae were counted, and dead larvae were dissected to confirm the presence of nematodes. Dead larvae containing nematodes were considered to be infected. Infection rates were calculated by dividing the number of infected larvae by the starting total.

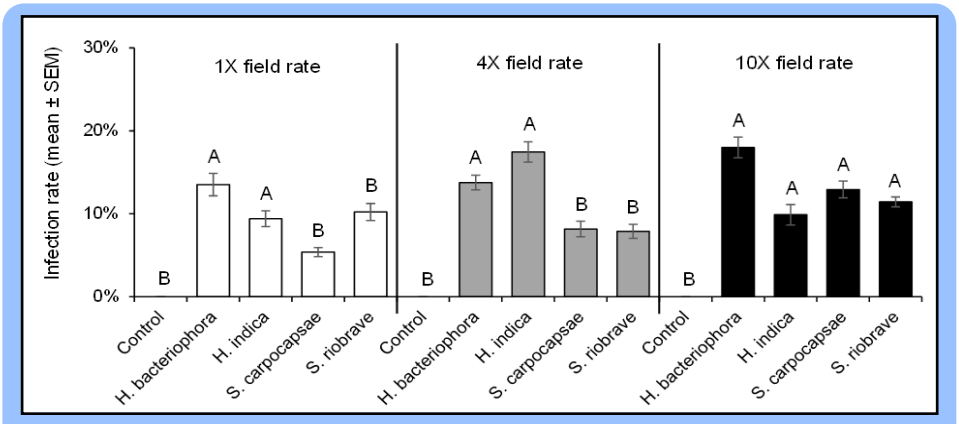


General setup of laboratory experiment used to test SGM susceptibility to insect-killing nematodes.

Results

We confirmed that all four nematode species could infect and kill SGM larvae in the lab. Rates of SGM larvae infection were generally higher at higher nematode application rates. At the highest nematode application rate, more than 10% of SGM larvae became infected and died.

These results suggest that insect-killing nematodes may be able to reduce SGM populations. Although nematodes caused low SGM mortality, they were still more effective than the only other known biological control agent, a parasitoid wasp, which was reported to kill only 1% of SGM larvae. When developing this experiment, we confirmed that nematodes entered galls with SGM larvae. Nematodes may be more advantageous than insecticides which cannot penetrate the gall.



SGM infection rates caused by four nematode species at three application rates. Nematode treatments were compared to a control treatment that did not contain nematodes. Each bar represents the average SGM infection rate after being exposed to nematodes (or water for the control) for 30 days. Nematode application rates included 1X field application rate (25 nematodes per cm^2) (white bars), 4X field rate (gray bars), and 10X field rate (black bars). For each application rate, bars with the same uppercase letters are statistically similar, while those with differing letters are significantly different.

Left: We confirmed that nematodes are able to enter the plant gall and infect SGM larvae. Nematodes emerge from the larva once food resources are depleted and seek out new hosts to infect.

Considerations and Next Steps

- Nematodes evaluated in this study were continuously maintained in the lab and are not adapted to the local environment, nor were they previously exposed to soybean gall midge.
- Nematodes isolated from local soils are preadapted to local environmental extremes like drought and cold, and should be better able to persist over time after a single field application.
- Future work will evaluate locally isolated insect-killing nematodes, like a strain of *S. carpocapsae* isolated in Brookings, SD, at three field sites for soybean gall midge management.

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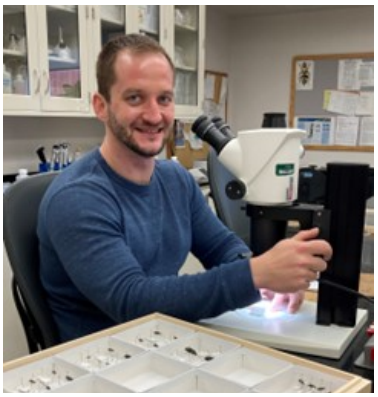

Questions or comments?
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About NCARL

The North Central Agricultural Research Laboratory (NCARL) is a USDA-Agricultural Research Service laboratory located in Brookings, SD. The goal of NCARL is to develop, document, and promote soil, crop, and pest management practices that are ecologically sustainable while maintaining producer profitability.