University of Guelph update

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Entomopathogenic nematodes: What they can do and how to use them?

With the passing of the Cosmetic Pesticide Ban Act last month, the need for more information on the availability and efficacy of alternatives to synthetic pesticides is greater than ever. As most of you are aware, golf courses are exempt from the ban, but there is a requirement that all golf courses in Ontario become accredited in Integrated Pest Management (IPM). That means looking to alternatives to conventional pesticides for the management of diseases, weeds and insects.

One area where a great deal of research has been conducted is in the use of entomopathogenic nematodes (EPN) for insect pest control. Nematodes are microscopic roundworms that exist in almost every niche on the planet. Some nematodes cause damage to plant roots, but they are different species from the ones that are used as biological control agents for the management of insects. With all the research that has been done on nematodes for insect control, it may be surprising that they are not used more often on golf courses, especially in environmentally-sensitive areas where synthetic pesticides may not be permitted. This is likely due to variability in efficacy that has been reported with their use. The purpose of this article is to introduce you to the mechanisms by which EPN reduce insect pest populations and to some of the precautions that need to be taken to ensure that maximum efficacy is achieved.

How they work

The entomopathogenic nematodes we use on turf fall within two genera: *Heterorhabditis* and *Steinernema.* There are a number of species within these genera that are effective at reducing insect pest populations, and the choice of species is usually related to the target insect host, as some of them are host-specific. Once a suitable insect host is encountered, the nematodes enter the larvae of insects through natural openings (e.g. mouth, anus or spiracles). Inside the body cavity of the insect host, the nematodes release bacteria that are toxic to the insects and usually kill the host within two days. The nematodes then feed on the nutrients within the larval body, and continue to go through their life cycle until all the nutrients are depleted. At that point, the juveniles leave the host body in search of new hosts. The entire cycle takes only a few days to complete with thousands upon thousands of juveniles emerging to search for a new host.

How effective are they?

Research has shown that entomopathogenic nematodes can be extremely effective, with efficacy of up to 90% reported in studies conducted in New Hampshire and Ohio. In addition to high efficacy, the various nematodes available infect a number of different insect pests, from the scarab beetles (June beetle, Japanese beetle and European chafer) to the Lepidopteran pests (cutworm and webworm) and the weevils (billbug and annual bluegrass weevil). So, why don't we see them used more often? For one thing, as an industry we are used to seeing immediate results, as this is what tends to happen when we apply a synthetic pesticide. The EPN take a minimum of 48 hours to effectively kill their insect hosts and sometimes an effect is not seen for almost a week. Furthermore, to get efficacy in the range of 90%, it often takes prolonged or sustained survival of the EPN in the soil. The number of insects that are initially killed upon application is directly dependent on the number of nematodes added to the soil. However, unlike conventional pesticides, the nematodes can persist in the soil by reproducing within the insect hosts over and over again. Therefore, over time, the population levels of the EPN can rise exponentially and eventually, reduce insect population levels to negligible levels.

Damage to golf course turf from animals routing for grubs.
Photo supplied by Pam Charbonneau

One Ontario superintendent who can attest to the effectiveness of EPN for insect control is Paul Brown, Sarnia Golf and Curling Club. At the suggestion of a sales associate, Paul began using nematodes in 2006 to deal with a problem in his fairways with black turfgrass ataenius (*Ataenius spretulus*). Paul states "we simply opened the package, poured the contents into our sprayer, and sprayed the fairway. Two weeks after spraying, [the sales associate] dropped back in. We went out [to survey the fairway] and low and behold, my ataenius were all dead. I was very impressed." Paul used the nematodes again the next year to combat a very large population of Japanese beetle (*Popillia japonica*)

In combination with the use of pheromone traps for the adults, through the use of EPN Paul was able to reduce grub population levels by an estimated 90 percent on his fairways.

Contents of pheromone trap indicating large infestation of Japanese beetle on golf course site.
Photo courtesy of Paul Brown, Sarnia Golf & Country Club

Proper nematode choice, application and precautions

Even though the research suggests that use of EPN for insects can be extremely effective we still see a great deal of variability out there in the field when turfgrass managers try to combat insect issues with nematodes. It is likely that much of that variability can be attributed to improper species selection, application method and poor handling of the nematodes. Most of the EPN species are very sensitive to environmental factors, including desiccation and temperature extremes and usually have a relatively short shelf life (3 to 6 months). The first consideration when deciding to use EPN for insect management is making sure that you choose the appropriate nematode for your specific pest (Table 1). One of the more stable species of EPN is *Steinernema carpocapsae*, but it is considered an "ambusher," meaning that it sits and waits for its prey to pass by. As such, it is most effective for mobile insects that travel on the surface of the turf including weevil pests, cutworms and webworms. In contrast, the EPN *Heterorhabditis bacteriophora* is known as a "cruiser," meaning it is very mobile and actively seeks out its prey. This makes it an excellent predator of sedentary insect pests such as the white grubs.

Once the species of EPN is chosen based on the target host, proper care must be taken to handle the nematodes properly, both before and after application. The nematodes are shipped in a cooler and must be kept cool (a refrigerator should do) until you are ready to use them. As mentioned above, the nematodes have a relatively short shelf life of 3 to 6 months, so they need to be ordered just before they are ready to be applied (or at least within the same season). They can be applied using a conventional sprayer, but only at relatively low pressure (< 50 psi) and with the use of coarse filter. Of equal importance is ensuring that the soil is moist upon application and even more so, that irrigation is applied immediately post-application. When treating for sub-surface feeders such as white grubs, the nematodes cannot be allowed to dry on the turf surface or they will die. They are sensitive to both ultra-violet light and desiccation, so watering them into the soil is extremely important. Research suggests that approximately 0.25 inches (~ 0.64 cm) should be applied post application to get the nematodes to the target insects and ensure that the soil stays moist. The surface-active species – *S. carpocapsae* is a bit more tolerant of desiccation and although it still needs to be maintained with some moisture, it can survive on the surface to combat the more mobile surface feeders. Finally, the timing of application is considered important as unlike with conventional insecticides, the nematodes are not persistent in soil in the absence of the target host. They are obligate parasites and without a host on which to feed, they will die and need to be re-applied.

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Table 1. List of nematode species available for use on turf in Ontario and conditions for their use:

Nematode species	Type	Temperature range for activity	Target pest [1]
Steinernema feltiae	Cruiser	10-30C (50-86F)	Leatherjacket
Steinernema carpocapsae	Ambusher	12.5-32C (55-90F)	Bluegrass billbug, Annual bluegrass weevil, Cutworms, Sod webworms, Armyworms
Heterorhabditis bacteriophora	Cruiser	12.5-30C (55-86F)	Scarab grubs (Oriental beetle, Japanese beetle, European chafer, Black turfgrass ataenius)

[1] Please note that mention of target pests does not suggest consistent control in research trials

Practical use for the golf course superintendent

Based on the research and also from stories from some local superintendents, the use of EPN has the potential to be very effective for reducing population levels of insect pests. However, much more knowledge and thought has to go into their application in order for them to be nearly as effective as synthetic insecticides. There are still a number of unanswered questions such as how to successfully use these nematodes on a large scale and choosing the correct species and application timing to treat insect pests in Ontario specifically. Likely your best bet is to do something similar to Paul Brown when he first decided to give the EPN a try. Choose one area – a fairway, a section of fairway, an approach, etc. and apply the nematodes to just that area. Make sure that you treat these as living organisms – keep them cool, do not expose them to any extremes in temperature, and maintain proper soil moisture. With a little trial and error and some experimentation, you may find that you have a sustainable, environmentally friendly option for insect management at your disposal.

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Summer Patch Study

There is currently a study at the University of Guelph being conducted on the disease summer patch, specifically on annual bluegrass.

We are looking for volunteers who have had issues with this disease to allow us to come and collect isolates from your golf course.

If you are interested in being part of this study, please contact:

Melissa Bassoriello (mbassori@uoguelph.ca) or

Katerina Jordan (kjordan@uoguelph.ca , 519-824-4120 x56615).