Thanks to Pam Charbonneau, OMAFRA Turfgrass Specialist, for the following information about Nematodes:

Insect Parasitic Nematodes

Nematodes ("roundworms") are slender, tapering worms. There are thousands of species of nematodes; many attack plants, others break down organic matter, and there are beneficial species that attack insects. Although some nematodes are quite long (e.g., horsehair worms), most are microscopic. Among them are the insect parasitic nematodes.

To date, the nematodes available in commercial products have been species of *Steinernema* or *Heterorhabditis*, although others are under development.

Advances in rearing techniques have made it possible to produce them economically in large numbers, which has encouraged their commercialization. They seek out and kill various insect pests and are used rather like insecticides. Insect-attacking nematodes have a life cycle consisting of an egg, four juvenile stages and the adult. Both species have a specialized, infective juvenile stage, which is the stage that attacks insects. It is non-feeding and thus can survive in the soil for extended periods until it is able to find a susceptible host.

Nematodes find hosts by detecting the hosts' carbon dioxide and excretory products. Infective juveniles enter hosts through natural openings, such as the mouth, anus or breathing pores. These nematodes carry specific bacteria in their intestines. When the nematode enters the host insect, the nematode releases bacteria into the host, where they rapidly multiply. The bacteria kill the host by releasing protein-destroying enzymes, usually within 24 hours. Nematodes feed on the host remains and complete two or three generations inside the host. When the host's insides are gone, large numbers (up to 100,000) of infective juveniles leave the host and begin to search for new hosts. At room temperature (21°C), it takes *Steinernematid* nematodes about 7–10 days from infection to the emergence of new infective nematodes. *Heterorhabditid* nematodes take about 12–15 days. As their range of insect hosts is quite wide, nematodes can be used against many pest species. Furthermore, nematodes are tolerant of spray pressures up to 2,000–2,800 kPa and may be field applied with standard spray equipment. Nematodes are not affected by many insecticide compounds and may be incorporated into ongoing turf IPM programs.

Target Pests

Various species of insect parasitic nematodes can be used to control the larvae of root weevils, craneflies (leatherjackets), fungus gnats and other turf pests. Generally, *Steinernema carpocapsae* is better suited to webworms, cutworms, girdlers and wood-borers, while *S. feltiae* is more suited to fly larvae. Other species particularly suited to control white grubs and other root weevils may become available in the future.

In a study conducted at Laval University in Quebec, it was found that the nematode species *Steinernema glaseri* was the most virulent against European chafer larvae. It should be noted that *Steinernema glaseri* is not commercially available. The ability of *S. glaseri* to infect its hosts is often attributed to its searching strategy, in that it "cruises" for immobile hosts. This species was also most effective on European chafer larvae in sandy soil. The larger spaces in sandy soil likely make it easier for the nematode to move about and find its host. In addition, European chafer mortality was highest at high soil-moisture levels.

Studies indicate that very high concentrations of nematodes are necessary for acceptable levels of European chafer control. Certain strains of nematodes have been marketed for control of turfgrass insect pests. At the moment, the use of insect parasitic nematodes is not economically viable in comparison with currently registered insecticides. In urban settings, the diversity of soil types and soil moisture levels makes the use of nematodes more difficult. In a similar study, also conducted at Laval University, it was found that *Heterorhabditis megidis* and *Steinernema carpocapsae* were the most virulent species against cranberry girdler.

Use

Nematodes are sold in a dormant stage so that they survive storage and shipping. To apply, mix the nematodes in water and apply them to the soil. They can also be applied through irrigation systems. Since products differ, always follow application instructions with the product. They will settle out in spray tanks if not agitated properly. Also, they need a water film to reach their targets. When applying to soil to treat various pests, the soil must be moist, though not too wet. Even though nematodes can move to seek out insect pests, they cannot go very far (a few centimetres), and the nearer you can get them to the insect, the more likely they are to be able to infect that insect. Good coverage is essential. After applying nematodes onto the soil surface or turf, irrigate immediately. This helps wash the nematodes down through the vegetation and into the soil. They are susceptible to ultraviolet light, so must be watered in to get them out of the sunlight.

As biologicals, nematodes are very sensitive to certain environmental factors:

- They break down in ultraviolet light.
- They dry out easily.
- They perform best between 12°C and 30°C.

Currently, nematodes have not been widely adopted for use by the turf industry because of their high cost and because the environmental conditions necessary to guarantee the success of the nematode treatments rarely exist