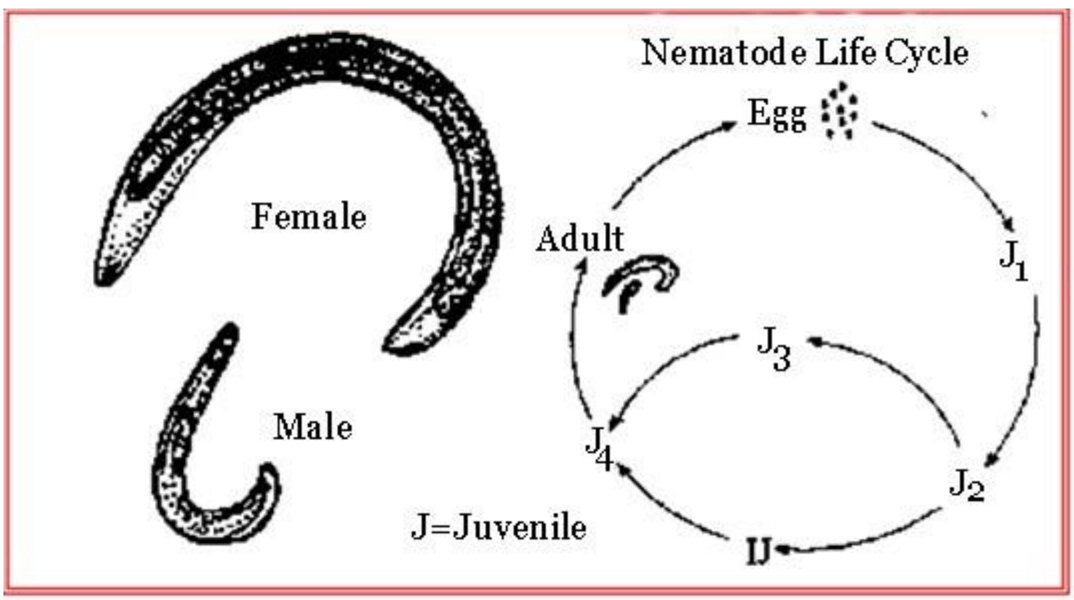
Beneficial Nematodes

The use of insect parasitic nematodes and other biological control agents to manage insect pests has grown in popularity. This is primarily due to the changing problems associated with pest control. For example, many pests have developed resistance to certain pesticides, new pests have arisen to replace those successfully controlled, the effectiveness of natural control agents (predators, parasites and pathogens) has been reduced by pesticide use, pesticides are no longer inexpensive to use, and there is increased concern about pesticide safety and environmental quality. These beneficial organisms can be an important component of an integrated pest management (IPM) program for ornamental crops and turf grass sites.



What are beneficial nematodes?

Nematodes are morphologically, genetically and ecologically diverse organisms occupying more varied habitats than any other animal group except arthropods. These naturally occurring organisms are microscopic, unsegmented round worms that live in the soil and, depending on the species, infect plants and animals. The two nematode families *Steinernematidae* and *Heterorhabditidae,* contain the insect parasitic nematode species. The most commonly used beneficial nematodes are *Steinernema carpocapsae*, *S. feltiae*, *S. glaseri*, *Heterorhabditisheliothidis* and *H bacteriophora*. Nematodes that are endoparasites of insects attack a wide variety of agricultural pests.

The life cycle of beneficial nematodes consists of eggs, four larval stages and the adults. The third larval stage is the infective form of the nematode (IT). They search out susceptible hosts, primarily insect larvae, by detecting excretory products, carbon dioxide and temperature changes. Juvenile nematodes enter the insect host through the mouth, anus or breathing holes (spiracles). Heterorhabditid nematodes can also pierce through the insect's body wall. The juvenile form of the nematode carries *Xenorhabdus sp.* bacteria in their pharynx and intestine. Once the bacteria are introduced into the insect host, death of the host usually occurs in 24 to 48 hours.

As the bacteria enzymatically breaks down the internal structure of the insect, the Steinernematids develop into adult males and females which mate within the insect's body cavity. Heterorhabditids produce young through hermaphroditic females. This form of nematode has the sexual organs of both sexes. As the nematodes grow, they feed on the insect tissue that has been broken down by the bacteria. Once their development has reached the third juvenile stage, the nematodes exit the remains of the insect body.

Why are these organisms beneficial?

Parasitic nematodes are beneficial for six reasons. First, they have such a wide host range that they can be used successfully on numerous insect pests. The nematodes' nonspecific development, which does not rely on specific host nutrients, allows them to infect a large number of insect species.

Second, nematodes kill their insect hosts within 48 hours. As mentioned earlier, this is due to enzymes produced by the *Xenorhabdus* bacteria. Third, nematodes can be grown on artificial media. This allows for commercial production which makes them a more available product.

Fourth, the infective stage is durable. The nematodes can stay viable for months when stored at the proper temperature. Usually three months at a room temperature of 60º to 80ºF and six months when refrigerated at 37º to 50ºF. They can also tolerate being mixed with various insecticides, herbicides and fertilizers. Check nematode product label for compatibility. Also, the infective juveniles can live for some time without nourishment as they search for a host.

Fifth, there is no evidence of natural or acquired resistance to the Xenorhabdus bacteria. Though there is no insect immunity to the bacteria, some insects, particularly beneficial insects, are possibly less parasitized because nematodes are less likely to encounter beneficials which are often very active and escape nematode penetration by quickly moving away.

Finally, there is no evidence that parasitic nematodes or their symbiotic bacteria can develop in vertebrates. This makes nematode use for insect pest control safe and environmentally friendly. The United States Environmental Protection Agency (EPA) has ruled that nematodes are exempt from registration because they occur naturally and require no genetic modification by man.

What are the target insects?

Experiments have shown that beneficial nematodes can reduce the populations of a variety of ornamental and turf pests. Control has been reported for the larvae of black vine weevil; strawberry root weevil; the clearwing borer (*Synanthedon culiciformis)* in alder and *S. resplendens* in sycamore; peach tree borer; dogwood borer; and banded ash borer with Heterorhabditis bacteriophora. White grubs (Japanese beetle, oriental beetles, chafer beetles, June beetle and Ataenius) are also controlled by this nematode. Turf larval pests controlled include surface pests such as cutworms, sod webworms and dog and cat flea larvae; and the soil inhabiting pests billbugs and crane fly can be controlled with Steinernema carpocapsea nematodes. Nematodes can be used on these and other pests as long as proper application procedures are used and the environmental conditions are favorable.

It is important to select the proper nematode species when trying to control a particular pest. *S. glaseri* has increased mobility in the soil and can target all of the various white grubs. *S. feltiae* is most effective in the habitats occupied by dipteran pests like fungus gnats. The heterorhabditid nematodes prefer a moister soil and tend to go deeper into the soil profile (3" to 6"). Nematodes should be applied at the first sign that a pest population is causing damage. If nematodes are definitely going to be used during the growing season and can be stored for up to six months under proper conditions, it is best to order them ahead of time so that they are in stock before the damaging stages of particular pests arrive. Reapplying nematodes depends on the success of the first nematodes released. Their survivorship and success are based on environmental conditions and soil type, increases in original pest population, and percentage of living nematodes actually released during the first application. Nematodes should be reapplied on seven-day intervals if damage continues.

Problems associated with nematode use.

Though nematodes can be an effective and safe pest management options, there are limitations to their use. The first is related to their manufacture and storage. It is difficult to synchronize the development of infective juveniles under laboratory conditions. Also, the nematodes must be shipped in the proper media and stored at the correct temperature. Thus, it is a good practice to check the percent viability of a package of nematodes before applying them. This can be done by placing a small amount of nematode-containing material in water and observing the live nematodes under a microscope or hand lens.

The other factors to consider relate to their actual usage. In order to ensure maximum effectiveness, it is crucial to apply them at the optimum environmental conditions needed for their survival. Therefore, it is best to irrigate the target site, both before and after application, because they need moist conditions to prevent desiccation and aid with movement to find hosts. Also, the best results are obtained when the relative humidity is high, ambient temperature is neither extremely hot or cold, soil temperature is between 55º and 90ºF, soil is moist and direct sunlight is minimal. All of these factors help prevent the nematodes from drying out and increase their survival.

Nematodes are sold to various ornamental/lawn care companies and mail-order pest management supply companies. They then sell the nematodes to consumers using various product names. In most cases, the cost of using nematodes on large areas, at the 1 billion/acre rate, would be higher than conventional insecticides, but treatment for small-scale problems should not be prohibitive

For pesticide recommendations call the UConn Home and Garden Education Center at 877-486-6271.

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