Insect Parasitic Nematodes for Cranberry Pest Management

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Several species of soil-dwelling immature insects, mainly belonging to moth (Lepidoptera) and beetle (Coleoptera) orders, cause significant damage to the roots and stems of cranberries throughout the cranberry production areas of North America. The various species of grubs cause a similar type of injury, mainly by devouring the fine roots, often so extensively that the vines may be easily pulled up along with the surface soil and rolled back like a carpet. This feeding can cause severe stunting and spindling of vines and, in the most severe cases, vines may die, leaving patches of bare bog. Often, weeds take over these bare patches, making re-establishment of vines difficult and expensive. The damage caused by cranberry girdler (Fig. 1) is somewhat different in that the larvae mainly chew on the stems and runners and, to a lesser extent, on the roots. Feeding usually entails complete girdling of the vine or its severance, leading to destruction of vines.

There are currently no chemical insecticides registered for managing the majority of these immature stages on cranberries. Maintaining a summer flood between mid-May to mid-July has been shown to be effective in managing several scarab grubs. However, this treatment will result in a total loss of the crop for that year. Although regular sanding at 3 to 4 year intervals is known to suppress cranberry girdler infestations, grower adoption of this practice has been limited to certain regions. Insect parasitic nematodes are especially suitable for use in cranberries because of some unique environmental conditions in which cranberries are grown. The cranberry root zone has high soil moisture levels, is protected from direct sunlight (and from ultraviolet radiation), and temperatures rarely reach levels harmful to nematodes.

Target Pests and Selection of Nematode Species

Insect parasitic nematodes exhibit diverse hunting strategies and have different tolerances to temperature. Certain species (e.g., Steinernema carpocapsae) are relatively inactive, remain near the soil surface, and use an “ambusher” strategy in which they stand on their tails and await passing insects. Others (e.g., Heterorhabditis bacteriophora) penetrate more deeply into the soil matrix and use an active “cruiser” strategy to locate and infect sedentary insects. Still others (e.g., S. feltiae) use an intermediate or mixed strategy. Species such as H. marelatus and H. megidis are cold adapted, whereas S. riobrave is warm-temperature adapted. Therefore, the selection of appropriate nematode species to match the biology and environment of the target pest species is very important to achieve effective control. The following (Table 1) is a list of target pests and recommended nematode species based on field research trials. Convincing field efficacy data is not available for the efficacy of insect parasitic nematodes against other cranberry pests such as cranberry whitegrub, cranberry rootgrub, oriental beetle, and striped colaspis.

Table 1. Recommended nematode species and target pests of cranberries.

<table>
<thead>
<tr>
<th>Target Pest</th>
<th>Pest Distribution</th>
<th>Nematode Species</th>
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</thead>
<tbody>
<tr>
<td>Cranberry girdler</td>
<td>WA, OR, BC, WI, MA, NJ</td>
<td>Steinernema carpocapsae, Heterorhabditis bacteriophora, H. marelatus</td>
</tr>
<tr>
<td>Blackvine weevil and strawberry rootweevil</td>
<td>OR, WA, BC, MA</td>
<td>H. bacteriophora, H. marelatus</td>
</tr>
<tr>
<td>Hoplia grub</td>
<td>MA</td>
<td>H. bacteriophora</td>
</tr>
<tr>
<td>Cranberry rootworm</td>
<td>NJ</td>
<td>H. bacteriophora</td>
</tr>
</tbody>
</table>
Storage and Handling

Formulations of insect parasitic nematodes contain living animals and, therefore, require greater care in storage and handling than is required for chemical insecticides. As a rule, read the label and follow all directions suggested by the manufacturer. Storage and handling requirements may vary for different products. Store nematodes in a cool dry place out of direct sunlight. Refrigeration is generally required. Do not freeze the product or expose to extreme temperatures. Do not open the product until the actual time of application. Avoid storing the product for extended periods and use within 1 to 2 days after receipt. Do not store as diluted product or in the tank, even overnight.

Application

Insect parasitic nematodes can be applied in cranberries through irrigation systems (chemigation), by conventional boom sprayers, or by air. Application rates vary depending on the product and target pest, but generally are in the range of 1 to 2 billion per acre. Ensure that the application equipment is thoroughly cleaned before nematode application. Although insect parasitic nematodes can be tank-mixed with many pesticides, this is not recommended because not all tank-mix combinations have been investigated for safety. In addition, there may be differences in tolerance to various insecticides among nematode species. Nematode applications should not be made for 10 to 14 days before or after the application of chlorpyrifos (Lorsban). Mix the formulated product in water and allow the mixture to stand for 20 minutes to hydrate the nematodes prior to application. The following application guidelines should be followed when nematodes are applied through the chemigation system:

- Apply nematodes during evening hours to minimize exposure to lethal sunlight.
- Nematodes should be applied to moist soil, never to hot or dry soil. Apply 1/10 inch of irrigation prior to applying nematodes to increase soil moisture.
- Nematodes should not be applied if soil temperature at 1 to 2 inches below soil surface is below 65 °F or above 85 °F.
- Provide continuous agitation in the spray tank or feeder tank to ensure proper mixing and uniform distribution of nematodes during application.
- Use high volume of water to prevent nematodes from drying out before post-application watering is initiated.
- Remove all screens and filters from the sprayer to prevent clogging prior to application. If you must use screens, use screens that are 50 mesh or coarser.
- Do not subject nematodes to pump pressures in excess of 200 PSI.
- Apply at least 1/4 inch of irrigation immediately following application to wash nematodes off the foliage and facilitate penetration through the thatch and into the soil.

- Maintain soil moisture by irrigating as frequently as possible for the first 10 days after nematode application. If possible, break the normal irrigation schedule of 1 inch per week into 4 to 5 equal portions.

The majority of nematode applications in cranberries are made through the chemigation system. While chemigation parameters such as rinse out time or concentration are consequential for this kind of nematode application, all other practices that ensure uniform distribution of the injected product are very important. In addition to the guidelines listed above, the following points should be followed when nematodes are applied through the chemigation system:

- Mix the required amount of product in at least 4 gal of water per acre for uniform injection of mixture. In general, longer injection times than used for insecticides and fungicides are recommended for nematode applications.
- Pressure at the pump should be in the range of 50 to 55 PSI. Pressure losses in the range of 5 to 10 PSI can result over the length of the line. Pressures below 40 PSI are not recommended.
- Sprinkler head pressure should be between 40 to 55 PSI at the farthest point.

Evaluation of Results

Under optimal environmental conditions and application methods, nematode infected target pest stages should be found within about 5 to 7 days after application. Pest mortality is temperature dependent. Cooler soil temperatures may slow nematode activity and delay pest mortality, whereas higher optimal soil temperatures may hasten mortality. Roll back cranberry vines in suspected areas and look for nematode infected target pest stages. Cadavers containing heterorhabditid nematodes are usually red or reddish brown in color (Fig. 2). Cadavers infected with Steinernema are either yellow, brown, or dark gray depending on pest and nematode species. After initial application, nematodes will develop and reproduce within infected cadavers and new generations of infective juveniles will emerge to seek out additional hosts over the next few weeks. Thus, the full impact of nematode applications might not be realized for several weeks or more after the application.

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