# Biological Control of Conifer Root Aphids in Christmas Trees: An Update

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**Fig. 1.** Canaan fir tree with symptoms of aphid infestation.

**The Problem:** Root aphids are an emerging though intermittent pest problem for Christmas tree growers. Infested seedlings are stunted, have yellowing needles and are susceptible to root rot (Fig. 1). The aphids feed on the root, sucking sap with their piercing-sucking mouthparts. This slows tree growth, delays maturity and costs growers money in production costs. Growers commonly apply chemical pesticides to control them, with mixed results. Imidacloprid is commonly used, which has a negative impact on pollinators such as bees. Growers need alternatives to chemical pesticides.

**Program Goals:** Develop and assess cost-effective biological control options for managing conifer root aphids in Christmas tree plantations. We are testing the efficacy of a soil-dwelling predatory mite (*Hypoaspis miles*, now known as *Stratiolaelaps scimitus*, Stratos for short) and an insect-killing fungus (*Beauveria bassiana*, Mycotrol-O) to reduce root aphid populations. To achieve these goals, we also need to confirm the identity of the aphids and to develop suitable methods for estimating population levels.

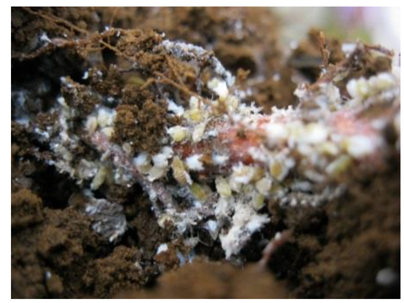

**Fig. 2.** Conifer root aphid infestation.

**Research Activities:**

***Aphid identification.*** Several specimens of root aphids, aphids on the trees and ants associated with the aphids were sent to specialists for identification. It was conclusively determined that the aphids found infesting Christmas trees at our research sites are *Prociphilus americanus* (Walker 1852) (Fig. 2). Aphids found on the branches are *Cinara confinis* (Koch 1856) (Fig. 3). Several ant species have been found associated with the aphids, *Brachymyrmex depilis* (Emery), the little hairless ant; *Camponotus novaeboracensis* (Fitch), the New York carpenter ant; *Formica incerta* (Emery), the uncertain ant; and *Lasius neoniger* (Emery), the Labor Day ant and *Tetramorium bicarinatum* Nylander (Fig. 4). All tend aphids and coccids and *B. depilis* is known to specifically tend root aphids.

**Fig. 3.** *Cinara confinis* aphid.

**Fig. 4.** Ant commonly found with root aphids.

***Population estimation.*** We evaluated a simple, rapid system for estimating root aphid populations adapted from methods developed previously in Europe. It involves digging up the tree to expose the roots, placing a grid over the roots and counting the number of white flecks within 25 squares (Fig. 5). All of the aphids on the entire root system of a few trees were then counted to correlate the relationship between the number of infested squares and the aphid population on the entire root system. A formula was developed based on these data to correlate the number of white flecks with the total number of aphids, providing a rapid yet reliable method to estimate aphid population size.

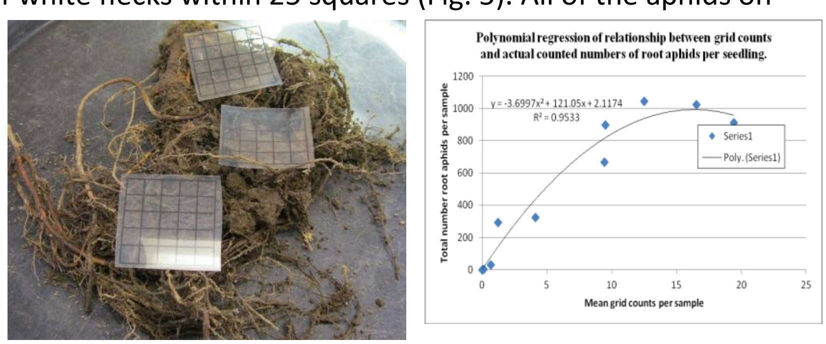


**Fig. 5.** Grid system to estimate aphid populations (left) and polynomial regression equation to estimate root aphid populations from grid counts.

***Biological controls.*** Two biocontrol agents are being tested against conifer root aphid, predatory mites and an insect-killing fungus. *Stratos* is a commercially-available predatory mite that feeds on a wide range of soil pests, including thrips pupae, nematodes, springtails, fungus gnat larvae, and hibernating spider mites (Fig. 6). It is commonly used in greenhouse crops and ornamentals. Though it occurs in this region and may play a role in reducing root aphid populations, it doesn't reach high enough population size naturally to keep root aphids at low levels. For this trial, *Stratos*, supplied by Applied Bio-nomics, a Canadian company that produces several species of natural enemies, are released around the base of small trees at a rate of around 375-500/tree. They are shipped in a mixture of peat and bran, and 25 ml is applied to each tree (Fig. 7). Single releases were made to the trees in the fall and the spring. This will provide information on the best time of year to make a release. Later this year the trees will be dug up to count the aphid populations (Fig. 8).


**Fig. 6.** *Stratos* predatory mite feeding on a mold mite.


**Fig. 7.** Predatory mite application to aphid-infested tree.

Mycotrol-O, an organically certified formulation of the insect-killing fungus, *Beauveria bassiana*, is also being tested for efficacy against conifer root aphid (Fig. 9). This fungus is found throughout the environment, naturally infecting insects. This fungus is applied as millions of spores. The spore attaches to the outside of the aphid, germinates, and then grows into the body, consuming the body contents and killing the pest. The insect does not need to eat the fungus to become infected. It is used extensively in production of greenhouse ornamentals to manage aphids, thrips and whiteflies (Fig. 10). Two drench applications of this product were made at 1 week intervals in early June.


**Fig. 8.** Removal of tree to inspect for aphids.


**Fig. 10.** Aphids infected with fungi.

The average number of root aphids on the mite-treated trees was 114 compared to 174 aphids per tree on the control trees (t= -2.587, df=430, $p$=0.03). This suggests that 1 year after releasing the predatory mites, root aphid populations were reduced. We will sample aphid populations again in 2015 to see if the impact of the predatory mite release will increase over time. Results from the fungal trials will also be evaluated in 2015.

**Fig. 9.** Organically certified liquid formulation of the fungus *B. bassiana*.

**Support for this work from:** VT Agency of Agriculture, Food & Markets; USDA Specialty Crops Block Grant; NE Sustainable Agriculture Research & Education Program; Univ. of VT College of Agric. & Life Sciences; Applied Bio-nomics and local cooperating growers.

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# General Facts About Conifer Root Aphids and Management Considerations

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**Fig. 2.** Conifer root aphid on roots of a Fraser fir tree.

**Scientific Name:** *Prociphilus americanus* (Walker). There are around 50 species in the genus *Prociphilus*, all with different primary host plants, but the same secondary host, i.e., conifers.

**Biology.** The primary host of conifer root aphid is thought to be ash trees (*Fraxinus* sp.). They are believed to reproduce sexually on this host. Root aphids at this stage form dark brown or black colonies that gather on terminal shoots causing them to become deformed and curled. They can also form on tender suckers that grow around the base of the tree. It is believed that in late April - June they fly to the secondary host—conifers. This stage moves to the roots where they feed underground, reproducing asexually over the summer until late August – October when they are believed to move back to ash trees. Though *P. americanus* is said to move to ash trees for part of its life cycle, we have yet to observe this migratory behavior in our Vermont test sites. Winged aphids were seen in the fall coming out of the soil but were not found when ash trees adjacent to the infested plantation were inspected. The literature reports that some colonies may reproduce continually on conifer roots. Therefore, removing ash from around Christmas tree plantations will not eliminate the aphid problem.

**Fig. 2.** Ant transporting aphid (top). Ant tunnels, infested with aphids (bottom).

Conifer root aphids feeding on the roots produce a waxy substance around them, secreting a sugary substance called honeydew. Ants feed on the honeydew, and aggressively defend the aphids from predators. The ants are likely responsible for spreading an aphid population around the plantation. They make tunnels throughout the tree root systems and can be seen carrying aphids to new locations (Fig. 3).

**Tree Susceptibility.** It is believed that tree species vary in their susceptibility to conifer root aphids. Nordmann fir is the least susceptible, followed by Douglas fir, Noble fir and the most susceptible being Fraser fir.

**Fig. 3.** Infested seedling planted adjacent to stump of old tree (bottom).

**Symptoms of Infestation.** The general symptoms of a conifer root aphid infestation are stunted new growth, yellowish needles, and decline and death of the leader and tips of branches. These symptoms are similar to those of nutrient deficiencies and environmental problems (flooding, drought, etc.). Therefore it is difficult to confirm that a tree is infested with conifer root aphid without digging it up and inspecting the roots, or looking for evidence of ants around the base of the tree.

**Management.** The best approach is to try to keep the aphids out. Therefore, the roots of seedlings should be inspected before they are planted to ensure they are free of root aphids. Infested seedlings should be discarded and if the infestation is widespread, it may be necessary to contact the supplier to ask for a new shipment.

Several commercial formulations of insect-killing fungi are registered for soil-dwelling pests or for aphids. These fungi occur naturally throughout the environment. They specifically infect insects and mites, not plants or mammals. These commercial strains are selected for their particular pathogenicity to the pest. While most are general pathogens, they do not usually negatively impact the natural enemies that contribute to reducing pest populations. Therefore insect-killing fungi are considered environmentally-friendly.

Several chemical insecticides are registered for conifer root aphids. A systemic pesticide, imidacloprid, is often used. This is a neurotoxin which acts on the central nervous system of insects. It is the most widely used insecticide in the world, and can be applied as a drench, spray, injection or granular. To minimize impact on bees, it is commonly applied as a drench to the soil. It should be noted that sometimes growers observe a secondary outbreak of spider mites following treatment. This may be caused by the negative effect of the pesticide on other non-target beneficial predators. Always read the pesticide label before making an application to ensure the dosage is correct. In addition, because of its widespread use, insect pests readily become resistant to it, so that it loses its effectiveness. If it is used, it should be included in rotation with other insecticide classes to minimize the potential for resistance to develop.

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