Integrated Pest Management of Conifer Root Aphids in Christmas Tree Plantations

Bruce L. Parker, Donald Tobi, and Margaret Skinner
The University of Vermont Entomology Research Laboratory
661 Spear Street, Burlington, VT 05405-0105
Tel: 802-656-5440 Email: bparker@uvm.edu

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The Problem: Root aphids (*Prociphilus americanus* Walker 1852) (Fig. 1) are an emerging, though intermittent, pest problem for Christmas tree growers in the Northeast. Infested seedlings are stunted, have yellowing needles and are susceptible to root rot. The aphids feed on the roots, sucking sap with their piercing-sucking mouthparts. This slows tree growth, delays maturity and costs growers money in production costs. Growers sometimes apply chemical pesticides to control them, but report mixed results. Imidacloprid, a systemic neonicotinoid insecticide, is commonly used, which has a negative impact on pollinators, in particular honey bees. Growers should consider other integrated pest management (IPM) options before resorting to the application of chemical pesticides.

Fig. 1. Conifer root aphid infestation.

IPM. The first line of defense against this pest is to try to keep the aphids out of the plantation. 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. If an infestation is detected in the nursery, biological control could be a viable option, particularly if pest populations are low.

Biological controls. We conducted field trials in a Vermont Christmas tree plantation to assess the effectiveness of two commercially available biological control agents against conifer root aphid: the predatory mite, *Stratiolaelaps scimitus* (formerly known as *Hypoaspis miles*), and an insect-killing fungus, *Beauveria bassiana*. *Stratios* feeds on a wide range of soil pests, including thrips pupae, nematodes, springtails, fungus gnat larvae, and hibernating spider mites (Fig. 2). It is widely used by growers of 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 populations naturally to keep root aphids at low levels.

Fig. 2. *Stratios* predatory mite feeding on a mold mite.

Several *B. bassiana*-based biopesticides are registered for use in ornamentals against aphids and other pests. This fungus occurs naturally in the environment, infecting insects, but does not infect plants or mammals. This and other commercial fungal strains are selected for their pathogenicity to the pest. They do not usually negatively impact the natural enemies that contribute to reducing pest populations. Therefore, insect-killing fungi are considered environmentally-friendly. The fungus is applied as a drench of millions of spores. The spores attach to the outside of the aphid, germinate, and then grow 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 the production of greenhouse ornamentals to manage aphids, thrips and whiteflies.

Chemical control. A systemic pesticide, imidacloprid, is often used in Christmas tree plantations to combat root aphids. 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. Growers should always read the pesticide label before making an application to ensure the dosage and timing is correct. In addition, because of its widespread use, insect pests readily become resistant to it, so that it loses its effectiveness. If used, this pesticide should be included in rotation with other insecticide classes to minimize the potential for resistance to develop.

Fig. 3. Predatory mite application to aphid-infested tree.

Our trials. Four treatments were tested, predatory mites, Mycotrol-O, Imidacloprid soil drench, and an untreated control. We applied *Stratios* (predatory mite), supplied by Applied-bionomics, around the base of small trees at a rate of approximately 375-500 predatory mites/tree. They are shipped in a mixture of peat and bran, and 25 ml was applied to each tree with a spoon (Fig. 3). The mites were released twice, once in the fall (Oct.) and once in the spring (May). Two drench applications of Mycotrol-O, an organically certified formulation of *B. bassiana* (Fig. 4), were made at 1-week intervals in early June. Trees were dug up at the end of the trial and visual assessments of the roots were made to determine the number of mites/tree.

Fig. 4. Organically certified liquid formulation of the fungus *B. bassiana*.

Significantly fewer conifer root aphids were observed on trees treated with predatory mites, the insect-killing fungus or imidicloprid than on the untreated (control) trees (Table 1). When averaged among plots, fewer aphids were found on trees treated with imidacloprid than on those with the mite or fungal treatments, but differences were not significant due in part to the large variation in aphid populations among plots. This may be offset though by the possible residual persistence of the mites or fungus, which could remain active in the soil for several months.

Table 1. Average number of root aphids /tree by treatment

	Average number of aphids/tree			
Plot	Predatory mites	Insect killing fungus	Control	Imidacloprid
1	21.26	21.68	88.87	21.68
2	21.68	15.16	45.70	14.75
3	53.39	77.06	146.63	2.12
Trt. average	**32.11**[A]	**37.97**[A]	**93.73**[B]	**12.85**[A]

Averages followed by the same letter are not significantly different. f=4.53, df=41, p<0.001

Our results show that the biological control treatments tested provided a suppressive effect on the root aphid populations similar to that obtained for the traditional chemical treatment. Therefore, growers may want to consider replacing their insecticide applications with one of these more environmentally-friendly biological control options. This will also minimize the potential secondary pest outbreak by spider mites.

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To learn more, contact:

Bruce L. Parker or Donald Tobi, UVM Entomology Research Laboratory, 661 Spear St., Burlington, VT 05405-0105

Tel: 802-656-5440 Email: bparker@uvm.edu Website: http://www.uvm.edu/~entlab/