

Balsam Woolly Adelgid in Michigan

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Established infestations of balsam woolly adelgid (BWA) (*Adelges piceae*), an invasive sap-feeding insect, were identified in lower Michigan in fall 2023. This tiny native European insect has probably been introduced into North America multiple times. It was first reported in Maine in 1908, after arriving around 1900 on nursery stock imported from Europe. Infestations were subsequently reported from Nova Scotia, Canada in 1910, California in 1928, Virginia in 1957 and Idaho in 1983. As of 2020, this pest was known to be established in at least 12 US states in the eastern, Pacific Northwest and Intermountain regions, as well as eight Canadian provinces. However, it was not previously known to be established in the Great Lake region.

Photo 1. – Different BWA life stages (overwinter nymph (bottom, black and white) and crawler (top, red-brown)) Credit: USDA Forest Service - Coeur d'Alene Field Office, Bugwood.org



Photo 2: White wax (“wool”) surrounds overwintering BWA nymphs on infested balsam fir trees in December in Missaukee County, Michigan. Photos by Max Ferguson.

In September 2023, approximately 50 balsam fir trees infested with BWA were found on forested land in southern Missaukee County. Since then, more infestations of BWA have been identified on balsam fir in forests in Missaukee and Clare Counties. In addition, BWA was detected on Fraser fir trees at a Christmas farm in Oceana County in October 2023. Surveys to assess the distribution and extent of BWA infestations were launched in December 2023 and will continue in 2024.

What trees are hosts for BWA? Although all true firs can be colonized by BWA, vulnerability differs among species. Unfortunately, balsam, Fraser and Caanan fir are very vulnerable to BWA damage. Concolor fir (white fir) can be colonized, but appears to tolerate BWA better than most other fir species. Douglas-fir is not a true fir and is not a host of BWA. Fir species in the native range of BWA in Europe, which co-evolved with BWA, are much more resistant to BWA feeding than most North American fir species.

How do BWA reproduce and what is the life cycle of BWA?

In North America, all BWA are females and reproduction is parthenogenetic. In other words, there are no males and no mating occurs. Eggs are genetically identical to each other and to the mother. Unfortunately, this means that even a single BWA can start a new infestation.

Two BWA generations occur annually in eastern Canada, the northeastern US and high elevation areas with short growing seasons in western North America, while three BWA generations per year occur in warmer climates. We expect to see two and possibly three generations of BWA per year in Michigan. In southern Nova Scotia, the first BWA generation matures and lays eggs between mid May and early June, while the second generation of adults lays eggs in September. Not all BWA develop at the same rate in any location. Life stages and generations may overlap during the growing season, which can complicate scouting and management.

Immature BWA nymphs (Photo 1) overwinter on infested trees. Overwintering nymphs are black with a line of white wax that runs down the middle of their back and around the edges of their bodies. In spring, these nymphs feed and develop, maturing (in 4-8 weeks) into plump, purplish-black adults. As nymphs and adult adelgids feed, filaments of white wax (“wool”) are secreted from pores on their bodies. This wax accumulates around the adelgids, providing protection from harsh weather and predators (Photo 2). Each BWA adult can lay about 100 eggs.

Eggs hatch in 2-4 weeks, producing reddish-brown crawlers (Photo 1), the only mobile BWA life stage. Crawlers move about on the tree but can be blown by wind or carried by birds, potentially landing a few feet or many miles away from the





Photo 3: Overwintering BWA nymphs on the trunk and branches of Fraser fir trees in a Christmas tree field in Oceana County in October. Note the dead needles on infested branches. Photos by R. Miller

original location. Crawlers eventually settle in bark crevices on tree trunks and large branches, or on current-year shoots near the buds. Once a crawler selects a feeding site and settles, it will pierce the outer bark with its mouthparts called “stylets” and remain attached to that specific location for the remainder of its life. After embedding their mouthparts, the insects transform (without molting), becoming flatter and producing a fringe of white wax around their body. Crawlers aestivate (remain dormant) for 3 to 6 weeks before they begin to feed and develop.

After completing three instars, the adelgids mature into adults, usually in mid summer. Those adults lay eggs and the cycle repeats; eggs hatch within a few weeks, crawlers settle, aestivate, feed, mature and lay eggs that will become the overwintering nymphs. A third BWA generation may occur in late summer and early fall depending on summer temperatures.

How does BWA affect fir trees?

Saliva injected by BWA as they feed triggers a defensive response by cells in the xylem, phloem and cambium. These tissues transport water, nutrients and drive radial growth. “Gouting,” a unique symptom (Photo 4) that develops as BWA feed near buds, refers to abnormal swelling and stunted growth of buds and nodes. Needles on gouty shoots can die while needles that drop in autumn are not replaced. As foliage is lost, photosynthesis declines, affecting tree growth and vigor.

Collectively, the changes resulting from BWA feeding restrict and reduce the ability of trees to transport water from the roots up the trunk and into canopy branches and foliage. Functionally, the trees are severely drought-stressed, regardless of soil moisture levels. Tree vigor and growth decline. Mortality may occur, especially if trees experience multiple stresses.

What are the symptoms of infested trees? Detection of BWA in a new area usually occurs when the white wax-covered BWA adults or nymphs are observed on the grey bark of the trunk (Photo 2). When scouting for BWA, check the base and lower portion of tree trunks as well as any large branches that extend down near the ground.

Other symptoms include gouty twigs (Photo 4), wilted or curled shoots and drooping branches. Apical dominance may be lost as shoots in the upper canopy die or curl outwards, causing fir trees to have a flat top or a weak terminal leader growing at a 45 ° angle. Flagging – shoots with dead red needles (Photo 3) – may be present on live trees. As trees die, needles fade from green to bronze to red to brown, usually progressing from inner to outer needles and from the lower to the upper canopy.

BWA natural enemies and biological control: No parasitoids attack any BWA life stage. Generalist insect predators such as spiders occasionally feed on BWA eggs or



Photo 4: Characteristic gouty shoots on Fraser fir trees with BWA. Photos by N. Zoller

other life stages but do not affect BWA population densities. Substantial effort and money were allocated over many years for classical biocontrol of BWA but with little success. At least 33 species of predatory insects, most from the native range of BWA in Europe, along with species from India or Pakistan, were introduced between 1933 and 1969 into the US and Canada. However, there remains no evidence that any predators, alone or collectively, can reduce BWA densities below damaging levels or slow BWA population growth, spread or the rate at which infested firs decline and die.

What are the options for managing BWA?

Prevention:

As with other adelgids, it helps to be aware of time periods when crawlers are likely to be active. Unfortunately, BWA crawlers could be active throughout the growing season from May-October! When working in an infested field, avoid transporting crawlers on clothing, shoes or equipment. Inspect stock prior to planting for signs of BWA.

Like other sap-feeding insects, such as aphids and scales, nitrogen fertilization benefits adelgids and can increase the number of eggs produced per female. Avoid applying high rates of nitrogen fertilizer to infested trees.

Chemical control:

Excellent spray coverage is critical for effective control of BWA. Spray must thoroughly cover the bark all the way

around the trunk and down to the base of the tree. Growers may need to reduce the number of rows they treat at one time, increase spray volume per acre, and treat trees from multiple directions. High pressure sprayers are the most effective option, but air-blast sprayers can be effective. Reducing planting density, minimizing weed pressure, and butt-pruning trees are other options to facilitate spray penetration and improve coverage.

Several contact insecticides, particularly synthetic pyrethroids such as esfenvalerate (e.g., Asana™), bifenthrin (e.g., Talstar™) and cyfluthrin (Tempo®) should effectively control BWA crawlers and early stage nymphs. Crawlers have no protective wax and are especially vulnerable to sprays of insecticides, as well as sprays of horticultural oil or insecticidal soap. Young nymphs are also relatively vulnerable because they have not yet produced much of the white wax. However, older nymphs and mature adults are protected by the abundant wax that accumulates around their bodies. Eggs are laid underneath adults and are also well protected. During the growing season, life stages of BWA can overlap which means that adults, eggs and nymphs can be present on the same trees. This can complicate efforts to target vulnerable BWA life stages with cover sprays.

Systemic insecticides such as imidacloprid, flupyradifurone, or dinotefuran may – or may not – be effective on BWA. Trees transport these insecticides in vessels that conduct water

(xylem tissue) up the trunk and into canopy branches and foliage. If trees have only recently become infested, systemic products should be effective, although it can take many weeks before BWA in the canopy are controlled. However, when trees have been infested for multiple years, BWA-caused changes in the xylem cells impede water transport, which also limits systemic insecticide movement and efficacy.

Unfortunately, some insecticide sprays to control BWA on fir Christmas trees may lead to problems with *spruce spider mite*. Information from North Carolina indicates bifenthrin (Talstar) will control spruce spider mite, as well as BWA. If other compounds are used for BWA, monitor treated trees to control mite populations early before damage accumulates.

To evaluate the effectiveness of any insecticide application, look for fresh white wax on treated trees, indicating BWA adults. Poking live adelgids inside the wax with the tip of a pocketknife will cause dark, purplish liquid to ooze out and mashing the adelgid will leave a purplish smear on the white wax. In contrast, dead adelgids simply desiccate (dry up) and produce no purplish liquid.

How can I report a suspect BWA infestation? Suspect BWA infestations in Michigan can be reported through the Midwest Invasive Species Information Network (MISIN) online reporting tool – <http://www.misin.msu.edu/report/>.

Please include a few photos of the suspect tree(s), ideally with a close-up or two of the white “woolly” adelgids, when you submit your report. You will need to provide the date of your observation and the location of the suspect trees (ideally GPS coordinates or a street address).

Reports can also be submitted to the Michigan Department of Agriculture and Rural Development at MDA-Info@michigan.gov or by calling the MDARD Customer Service Center, (800) 292-3939. For those outside of Michigan, contact your local state Department of Agriculture. 🌲



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