RESEARCH LABORATORY TECHNICAL REPORT

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Beech Leaf Disease

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Beech leaf disease (BLD) is an emerging disease caused by a foliar-feeding nematode, or microscopic roundworm, known as *Litylenchus crenatae mccannii* (*Lcm*). All cultivars of American and European beech are susceptible. Beech are ecologically important trees in eastern North America and are common feature trees in landscapes. Beech leaf disease was first observed in Lake County, Ohio (Cleveland area) in 2012. Since its initial detection, the disease has spread from the mid-Atlantic region through New England, and to Ontario. Movement in the Midwest is occurring, but more slowly. The species was described initially on Japanese beech in Japan where it causes mild symptoms. In eastern North American, however, healthy beech trees have been observed dying within five to seven years from the onset of symptoms. The progression of BLD over time compromises tree health and often results in secondary pests and disease incidence.

Symptoms

Symptoms of BLD typically progress from the lower canopy upward but may be randomly scattered throughout the canopy. Early symptoms include distinct striping between the leaf veins and darkening and/or chlorosis of the infested area (Figure 1). Symptoms can be confused with leaf galls caused by erineum mites or discolored sections from aphid feeding damage. From the top of the leaves, the interveinal discoloration may appear cupped or puckered (Figure 2).

Figure 1: Leaf striping/banding symptoms of BLD seen from the underside of the leaf. Bands are usually thick and dark green but may turn yellow or necrotic

Figure 2: Interveinal leaf cupping or puckering symptom of BLD

After successive years of infestation, high numbers of nematodes causing damage within overwintering buds result in emerging new leaves that are increasingly deformed, chlorotic, and have a thickened, leathery texture (Figure 3). By this stage, the photosynthetic capacity of these distorted leaves is greatly reduced, and trees are unable to produce adequate amounts of carbohydrates. Bud death and twig dieback increases. The resulting lack of vigor and resources stresses the tree and predisposes it to other secondary invaders, such as insect borers, *Phytophthora*, and fungal cankers. Based on current knowledge, this nematode only infests leaf and bud tissue and has not been detected in woody tissues or root.

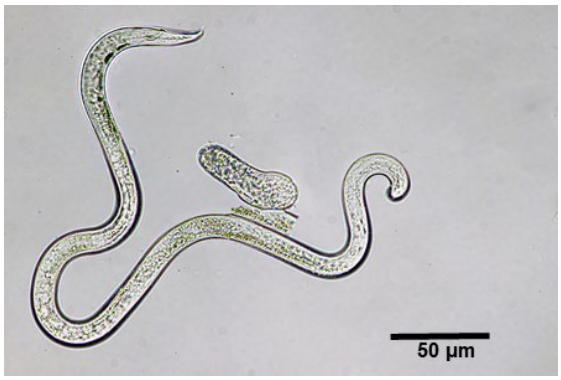
Figure 3: Severe leaf deformation and thickening

Causal Agent

The causal agent of BLD is the foliar-feeding nematode *Litylenchus crenatae mccannii* (*Lcm*) [1]. *Lcm* is currently considered a subspecies of *Litylenchus crenatae*, which was described in 2018 from Japanese beech in Japan and is thought to be native to the region. Mounting research demonstrates the profound physiological changes the nematode induces to young leaf tissues, later disrupting functionality [2].

This nematode has an egg stage, several juvenile stages, and an adult stage where both male and female nematodes are present (Figure 4). Late in the growing season, nematodes exit infested leaves and migrate to vegetative buds. Over the winter months, they feed and reproduce within the buds, inducing gall-like cell malformation between the leaf veins. Once the buds open in spring, BLD symptoms are immediately evident on infested leaves.

Figure 4: *Litylenchus crenatae mccannii* adult male and egg



At leaf expansion, numerous *Lcm* eggs may be dispersed by wind and rain splash. As the summer progresses, populations rapidly increase with activity peaking from late summer to early fall. *Lcm* nematodes move in shallow films of water (from irrigation or precipitation) on the surface of leaves and bark. In addition to wind-driven rain as a likely source of local spread, there have been reports of *Lcm* nematodes "hitching a ride" on arthropods (e.g. mites, insects). It is still unclear how the nematodes are moving long distances, but birds have been implicated and research is underway. Movement of infested nursery stock from areas with known BLD has resulted in long distance spread and should be avoided.

Management

Bartlett research staff and others have been investigating potential treatment options for several years. Based on two major discoveries, followed by numerous field trials and lab studies, Bartlett scientists have developed two separate and distinct management programs shown to effectively suppress BLD symptoms and *Lcm* populations [3, 4].

A program consisting of foliar applications is intended for small to medium sized beech, including hedges. This program begins in mid-summer and continues through the peak nematode activity season, mid-to-late summer through early fall.

The other program consists, intended for medium to large beech (including those near water), is a root flare injection implemented by mid-summer (Figure 5). Research indicates a single injection treatment can provide significant BLD suppression for a minimum of two seasons.

Both programs are intended to reduce nematode populations at a critical stage of their life cycle and minimize migration into developing vegetative buds. Cultural treatments and soil care remain important aspects of beech health management, as BLD can negatively impact mycorrhizal root associations [5].

Other diseases, particularly Phytophthora root rot and canker, are common secondary stressors.

Soil applications of potassium phosphite-based products are included in a standard beech health program. These products, applied early and late in the growing season, have been shown to slow disease progression and severity of symptoms by enhancing resistance within the tree.

Figure 5: Root flare injection treatment on beech

Interpreting Results

BLD management remains a novel challenge and we are continuing to fine-tune these programs. Our ongoing research trials aim to make management tactics more environmentally conscious and economically feasible. The goals of current programs are nematode population reduction, symptom suppression, and tree stress alleviation. For example, a treated tree showing mild leaf banding in spring may indicate a significant reduction in nematodes that reached buds to cause damage if the tree had more severe symptoms the previous year. Program timing is very important. If the optimal window has passed, waiting until the following season is advised. Other challenges include the need to achieve full canopy coverage with the foliar and root flare injection management programs and the risk of *Lcm* spread from heavily infected, nearby beech. If trees are too large to achieve full coverage, results will not be as desirable. Similarly, if trees have conditions such as girdling roots or basal decay, movement of the root flare injection product will be reduced or uneven.

Founded in 1926, The Bartlett Tree Research Laboratories is the research wing of Bartlett Tree Experts. Scientists here develop guidelines for all of the Company's services. The Lab also houses a state-of-the-art plant diagnostic clinic and provides vital technical support to Bartlett arborists and field staff for the benefit of our clients.

References for further information

[1] L. K. Carta *et al.*, "Beech leaf disease symptoms caused by newly recognized nematode subspecies *Litylenchus crenatae mccannii* (Anguinata) described from *Fagus grandifolia* in North America," *Forest Pathology*, vol. 50, no. 2, 2020. doi: https://doi.org/10.1111/efp.12580

[2] C. D. McIntire, "Physiological impacts of beech leaf disease across a gradient of symptom severity among understory American beech," *Frontiers in Forests and Global Change*, vol. 6, Mar. 2023, doi: https://doi.org/10.3389/ffgc.2023.1146742.

[3] A. L. Loyd, *et al*., "Exploring Novel Management Methods for Beech Leaf Disease, an Emerging Threat to Forests and Landscapes," *Journal of Environmental Horticulture*, 42:1-13, 2024, doi: https://doi.org/10.24266/0738-2898-42.1.1.

[4] A. L. Loyd, Borden, M. A., Littlejohn, C. A., Rigsby, C. M., Brantley, B., Ware, M., McCurry, C., and K. Fite. "Thiabendazole as a therapeutic root flare injection for beech leaf disease management," *Journal of Arboriculture & Urban Forestry*, publication pending, 2024.

[5] C. Bashian-Victoroff, A. Brown, A. L. Loyd, S. R. Carrino-Kyker, and D. J. Burke, "Beech Leaf Disease Severity Affects Ectomycorrhizal Colonization and Fungal Taxa Composition," *Journal of Fungi*, vol. 9, no. 4, pp. 497–497, Apr. 2023, doi: https://doi.org/10.3390/jof9040497.

During the 2022 season, estimated 70% of canopy on four European beech hedges in Ohio showed moderate BLD symptoms

Program included potassium phosphite fertilizer soil application, followed by a foliar treatment program from summer through fall

A field trial site in New Jersey evaluating Arbotect 20-S injection treatments.

The tree on the right retains much more canopy the season following treatment, compared to an untreated neighboring tree.