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BOXWOOD BLIGHT—A NEW DISEASE FOR CONNECTICUT AND THE U. S.

In October 2011, samples of boxwoods with unusual symptoms were submitted to The Plant Disease Information Office of the Experiment Station for diagnosis. Symptoms included leaf spots and blights, rapid defoliation, distinctive black cankers on stems, and severe dieback (Figure 1).

Figure 1. Symptoms of boxwood blight on a boxwood from a landscape planting.

After extensive microscopic examination and a search of the literature, the disease was tentatively identified as boxwood blight, caused by the fungus *Cylindrocladium buxicola (*syn. *C. pseudonaviculatum)*. Since this fungus had not been reported in the U.S., samples of infected plants were sent to national mycologists at the United States Department of Agriculture-Animal Plant Health Inspection Service-Plant Protection and Quarantine (USDA-APHIS-PPQ) for identification. They confirmed the fungus as *C. pseudonaviculatum.*

HISTORY:

Boxwood blight, also called box blight and boxwood leaf drop, was first described in the United Kingdom (UK) in the mid-1990s, although the fungus was not formally identified at that time. However, in 2002, boxwood blight was found in New Zealand and the causal agent was described and formally named as a new species, *Cylindrocladium pseudonaviculatum.* Later that same year, the boxwood fungus from the UK was named *Cylindrocladium buxicola*. They are now known to be synonyms for the same fungus. Since those first reports, boxwood blight has been reported throughout Europe. This disease was included in the European Plant

Protection Organization (EPPO) Alert List from 2004-2008, but was removed, since no international action was requested during that period. Boxwood blight is widespread throughout the UK and, although not regulated, is considered a disease of great concern.

The geographic origin of the fungus is not known, nor is it known how the pathogen was introduced into the U.S. Boxwood blight has also been confirmed from North Carolina and Virginia. At the time of this writing, boxwood blight has been found in some Connecticut landscapes, garden centers, and nurseries in Fairfield, Hartford, Middlesex, and New London Counties.

HOSTS:

Boxwood blight has been reported to occur on all *Buxus* species to date, although some species and cultivars appear to be more susceptible than others. *Buxus sempervirens* 'Suffruticosa' (English boxwood) and *B. sempervirens* (American or common boxwood) appear to be highly susceptible. Other species of boxwood grown in Connecticut that have been found to be infected include many cultivars of *Buxus sinica* var. *insularis* (Korean boxwood), *Buxus microphylla* (little leaf boxwood), *Buxus microphylla* var. *japonica* (Japanese boxwood), and *Buxus sinica* var. *insularis* X *B. sempervirens* hybrids (Table 1). Experimental inoculations have revealed that *Sarcococca*, another member of the boxwood family (Buxaceae), is also susceptible. The complete host range of this pathogen is not known. However, published reports have not shown evidence of substantial resistance, since no boxwood species challenged with *C. pseudonaviculatum* have demonstrated any immunity.

Table 1. Some species and cultivars of boxwood on which boxwood blight has been identified in Connecticut.

Host	Cultivar
Buxus microphylla var. *japonica*	'North Star' 'Green Beauty' 'Baby Gem'
Buxus sempervirens	'Suffruticosa' 'Elegantissima' 'Arctic Emerald' 'Jade Pillar' 'Graham Blandy'
Buxus sinica var. *insularis*	'Winter Gem' 'Winter Green'
Buxus sinica var. *insularis* X *B. sempervirens* hybrid	'Green Mountain' 'Green Gem' 'Green Velvet' 'Chicagoland' 'Green Ice' 'Big Leaf Gordo'

SYMPTOMS AND DISEASE CYCLE:

Cylindrocladium pseudonaviculatum infects all aboveground portions of boxwood, but does not appear to infect the roots (Figure 1). Initial symptoms appear as dark or light brown spots or lesions on the leaves (Figure 2). These lesions often have dark borders. Spots enlarge and then coalesce, often with a concentric pattern or a zonate appearance (Figure 3). Infected leaves then turn brown or straw colored, so infected plants look "blighted" (Figure 1). Defoliation often occurs very quickly after foliar symptoms first develop.

The fungus also infects the stems, which results in distinctive and diagnostic dark brown to black lesions, sometimes with an angular, diamond-like pattern (Figure 4). Many black lesions can be found along a stem, from the soil line to the shoot tips (Figure 5). Heavily infected plants drop most of their leaves. Although the plant

attempts to regrow, repeated infection and defoliation can weaken the root system and lead to plant death, especially for young plants or new transplants.

Figure 2. Initial symptoms appear as dark or light brown spots on the leaves.

Figure 3. Blighting of leaves. Lesions often have a concentric pattern or a "zonate" appearance (arrow).

Figure 4. Diagnostic young, developing black cankers on stems (arrows).

Figure 5. Dieback on stems girdled by coalesced, black cankers (arrow).

Boxwood blight can spread very rapidly under warm and humid conditions. For example, in 2011 we have seen several examples of established boxwood plantings in Connecticut landscapes that were apparently killed in one season following the introduction of infected plants—2011 was a particularly cool, wet year that included several violent rain events (Figures 6 and 7).

Figure 6. Seven-year-old planting of boxwood infected with blight.

Figure 7. Established planting of boxwood with symptoms of boxwood blight.

Boxwood blight can also be a very serious problem in commercial production settings, because the conditions are highly favorable for infection—many susceptible plants are grown in close proximity in a field or pot-to-pot in a hoop house, levels of humidity are often high, plants are often watered overhead, and leaf debris is abundant (Figures 8, 9, 10, 11, and 12).

The boxwood blight fungus readily forms fruiting structures on infected plants (Figure 13). These structures, called sporodochia, can be seen on the undersides of infected leaves (Figures 14 and 15) and on the black lesions on stems (Figure 16). Details are visible with a hand lens.

Figure 8. Hoop house of symptomatic, off-colored boxwoods in various stages of decline. Note leaf debris in walkway.

Figure 9. Boxwood blight symptoms in container-grown plants. Note extensive leaf debris in the pots and on landscape fabric.

Figure 10. Boxwood blight symptoms in a propagation flat.

Figure 11. Field-grown boxwood plants with symptoms of boxwood blight (note leaf debris, arrow).

Figure 12. Close-up of dieback and defoliation associated with black stem cankers.

Sporodochia contain large numbers of sticky, cylindrical spores (conidia), which give the sporodochia an angular or crystalline appearance (Figure 17). Structures of the fungus called vesicles form in the sporodochia and protrude from the main fruiting body (Figures 17 and 18). Spores (conidia) are cylindrical and hyaline, and usually have one septation (Figure 19).

Boxwood blight spores are splash-dispersed and can be carried by wind or wind-driven rain over short distances. Longer distance spread is thought to occur through the activities of humans (e.g., contaminated boots, clothing, and equipment), animals, and birds, since the spores are sticky.

Figure 13. Sporulation of the fungus on undersurfaces of symptomatic leaves (arrows).

Figure 14. Upper leaf surface with lesion (left) and sporulation on lower leaf surface (right).

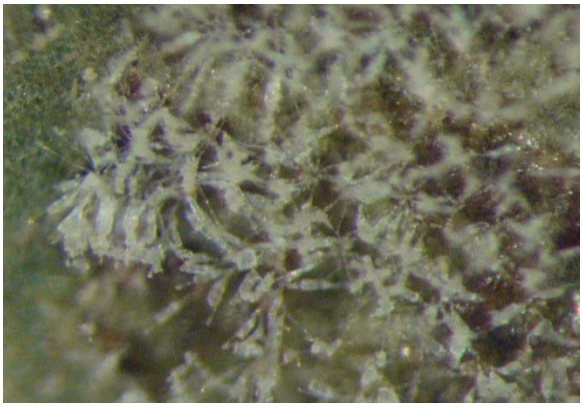

Figure 15. Sporulating colonies have an angular, “blocky” appearance.

Infected plant material is the primary means for long-distance spread. The key factor for unintentional spread of this disease is movement of apparently "healthy" boxwoods (infected, but asymptomatic or having very limited outward symptoms) or boxwoods treated with fungicides that suppress, but do not kill or eradicate the fungus, to nurseries and landscapes. This method of disease transmission is often called the "Trojan horse" or "Typhoid Mary" syndrome.

Figure 16. Numerous fruiting bodies (sporodochia, arrow) emerging from black stem cankers.

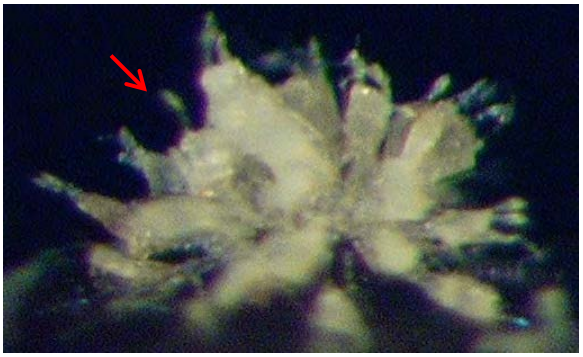

Figure 17. Angular appearance of spore clusters with many protruding vesicles (arrow).

The boxwood blight pathogen has a rapid disease cycle that can be completed in one week. It has a temperature range of 41-86 ºF. The optimum temperature for growth is 77 ºF. The fungus is sensitive to high temperatures and is killed after 7 days at 91 ºF. Infections can occur very quickly under warm (64-77 ºF), humid conditions.

Figure 18. Photomicrograph of distinctive protruding vesicles (arrow) and cylindrical spores.

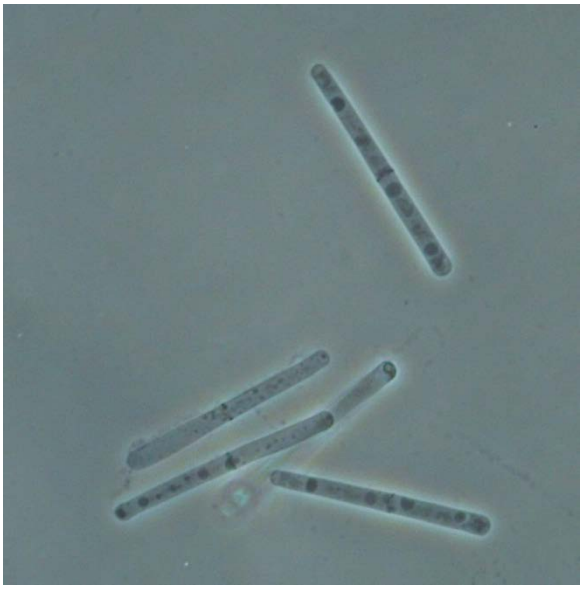

Figure 19. Photomicrograph of cylindrical, two-celled spores of the boxwood blight pathogen.

The boxwood blight fungus does not require a wound to infect, since it can penetrate directly through the plant cuticle or can enter the leaf through stomata. High humidity levels or free water on plant tissues are necessary for successful infection.

Cylindrocladium pseudonaviculatum has been reported to survive as mycelium in cankers on infected plants and in leaf debris (fallen, infected leaves) (Figures 9 and 11). It has been reported to survive for at least 5 years on decomposing boxwood leaves. Resting structures called microsclerotia and chlamydospores have been reported to form in culture, but have not been observed to form in plant tissues.

OTHER BOXWOOD DISEASES:

Boxwoods in production and landscapes are susceptible to several diseases that can be confused with boxwood blight. These include Volutella blight, Macrophoma leaf spot, boxwood decline, and winter injury and sunscald. In addition, boxwoods can be infected by more than one pathogen—we have commonly found boxwood blight along with Volutella canker and/or Macrophoma leaf spot.

Volutella blight (also called canker and leaf blight) is caused by the fungus *Volutella buxi (Pseudonectria rousseliana).* Symptoms are usually evident in spring, as individual shoots or entire plants exhibit poor growth. Leaves on affected shoots turn from green to a distinctive straw-tan color. Diagnostic, salmon-colored, somewhat waxy pustules of the fungus develop on the undersurfaces of infected leaves and stems (Figure 20). These are readily visible with a hand lens. The bark of infected shoots may be loose and peel to reveal gray or blackened, discolored wood underneath. Extensive dieback and leaf drop can occur, especially under wet conditions.

Macrophoma leaf spot is caused by the fungus *Macrophoma candolleri***.** Leaves turn yellow or straw-colored and diagnostic fruiting structures of the fungus appear as small, black dots on the symptomatic leaves (Figure 21). This disease can result in extensive leaf drop.

Figure 20. Diagnostic, salmon-colored fruiting bodies of Volutella blight.

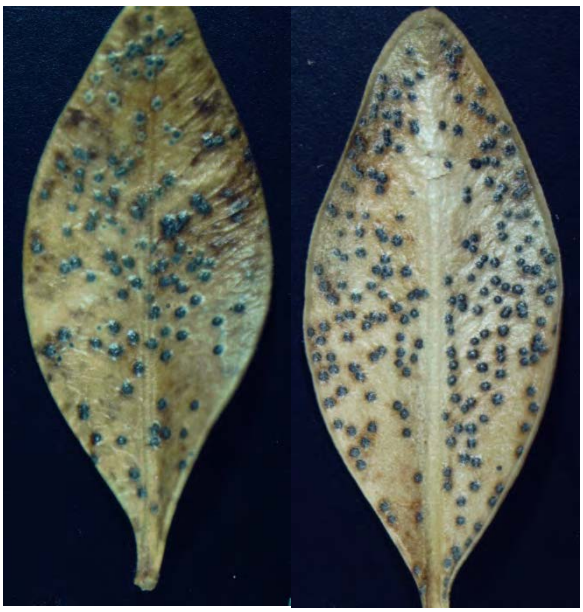

Figure 21. Diagnostic symptoms of Macrophoma leaf spot (left, upper leaf surface, right, lower leaf surface).

Boxwood decline is associated with root damage by root-knot nematodes *(Meloidogyne* and *Pratylenchus).* Plants often undergo progressive decline over a period of several years. Symptoms include stunting, wilting, loss of vigor, and chlorosis. Some bronzing of internal foliage can occur. Depending upon the nematode, root symptoms include formation of swollen

galls or lesions. Disease severity is influenced by nematode populations and other environmental factors that impair root function such as drought. Diagnosis requires soil samples from the vicinity of symptomatic plants to test for the presence of and populations of nematodes.

Winter injury or sunscald is associated with damage to the cambium and sapwood. Many species of boxwood are only marginally hardy in Connecticut. This type of injury results in dieback of leaves, twigs, and even entire plants. Leaves often develop a brown to reddish-brown, bronze color. Bark splitting and peeling on stems and branches is common and may also result in dieback.

MANAGEMENT STRATEGIES:

Whether in the nursery, garden center, or landscape, management of boxwood blight requires aggressive measures that include combined use of culture, scouting, sanitation, and when appropriate, fungicide sprays. Boxwood blight is generally considered a serious disease affecting the quality and aesthetics of plants, although in many cases it can lead to plant death. Since this disease has only recently been found in the U.S., we are not certain of any long-term implications on plant health, especially with regard to the role that repeated, defoliation might have on weakening plants and predisposing them to winter injury, insects, and opportunistic pathogens.

1. It is very important to start with pathogen-free material, by purchasing from reputable suppliers, nurseries, or garden centers. Plants and cuttings should be carefully inspected for symptoms.
2. Newly purchased plants or rooted cuttings should be isolated from existing boxwood plantings or production areas in nurseries for at least one month, but preferably, for several months.
3. Adequate spacing between plants can help to maximize air circulation and minimize conditions favorable for disease development.
4. Since water is important for the spread and development of boxwood blight, it is beneficial to avoid overhead watering. It also helps to avoid working with plants when they are wet, since this pathogen can be spread during these types of activities.
5. Sanitation, accomplished by raking and removing leaf debris, is critical for eliminating and reducing inoculum, since the fungus can survive in plant debris for up to five years. In commercial situations with field plantings, burning the plant debris with a propane torch might be an option.
6. Scout and inspect all boxwood plants daily or weekly. **As soon as boxwood blight symptoms are detected, immediately pull and remove whole plants and place them in a plastic bag to avoid carrying the infected material through the nursery or landscape. Infected plant material should NOT be composted.**
7. If you observe suspicious symptoms on boxwoods, it is important to have the disease accurately identified by a specialist. An image gallery of boxwood blight can be found at: http://www.ct.gov/caes/pdio.
8. Planting less susceptible species of boxwood or alternatives to boxwood can reduce the potential for disease. Examples of alternative plants include some dwarf cultivars of *Ilex crenata, Pieris japonica, Rhododendron* spp., and *Taxus baccata.*
9. The final strategy for managing boxwood blight involves selection, timing, and application of fungicide

sprays. Reports on fungicide efficacy from countries that have been dealing with this disease for many years are not encouraging, since fungicides have not been found to be particularly effective. However, they can be used in conjunction with other management strategies previously outlined, especially when weather is favorable for disease. When there is a risk of boxwood blight occurring, fungicide applications need to be used on a regular preventive schedule. Because of the tight nature of the boxwood canopy, thorough coverage with fungicides is difficult. However, all parts of the plant need to be covered so any sprays should be applied until run-off. Because this is a new disease for the U.S., boxwood blight will not be on any fungicide labels. However, fungicide labels of products that can be used on boxwood will contain information on dosage rates, reentry intervals (REI), and safety precautions. FUNGICIDES ARE NOT CURATIVE.

a. For Connecticut homeowners, the fungicides chlorothalonil and mancozeb are registered for use. Since these are protectant materials, they should be applied before symptoms are observed and repeated as necessary when conditions are favorable for disease development and spread.
b. Commercial nursery growers should follow a preventative fungicide program that includes different products with different modes of action (FRAC groups). Among the fungicides registered for use are azoxystrobin, boscalid + pyraclostrobin, chlorothalonil, fludioxonil, kresoim-methyl, and mancozeb. These products differ significantly in their mode of action (e.g., some are more effective in inhibiting spore germination; others are more effective at inhibiting mycelial growth).

10. Please contact the Experiment Station for the most current information on control.

For answers to questions or assistance with diagnosing boxwood blight, please contact the Experiment Station's
Plant Disease Information Office
Phone: 203.974.8601
Statewide Toll-Free: 877.855.2237
Website: www.ct.gov/caes/pdio

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