Boxwood Blight

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Boxwood blight is caused by two fungal species, *Calonectria pseudonaviculata* (syn. *Cylindrocladium pseudonaviculatum, C. buxicola*) and *C. henricotiae.* As of yet, only *C. pseudonaviculata* is known to be present in the United States (Gehesquière et al. 2016), where it was first identified on boxwood in nurseries and landscape plantings in North Carolina and Connecticut in 2011 (Ivors et al. 2012). Since that time boxwood blight has been confirmed in 22 additional states (Alabama, Delaware, Florida, Georgia, Illinois, Kansas, Kentucky, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Virginia, Washington and West Virginia) and the District of Columbia in the United States. *Buxus* spp. (boxwood), *Sarcococca* spp. (sweet box) (Henricot et al. 2008, Malapi-Wight et al. 2016) as well as *Pachysandra terminalis* (Japanese spurge) (LaMondia et al. 2012), *P. procumbens* (Allegheny spurge) (LaMondia and Li 2013) and *P. axillaris* (Windcliff Fragrant) (LaMondia 2017), have been reported as hosts to this pathogen (*P. procumbens* and *P. axillaris* by inoculation). Variations in boxwood blight disease susceptibility occur within *Buxus* (Table 1) and *Pachysandra* species and cultivars (Table 2).

The pathogen can infect all growth stages of boxwood plants and make plant production economically unacceptable. This fungus spreads rapidly over short distances and defoliates most of the plants in the *Buxaceae* family. Warm, humid, and shady conditions favor disease development. Infection is favored at 64-77˚F.

The pathogen can spread a short distance via rain or irrigation water, wind, plant debris, contaminated tools and equipment (such as pruning tools), workers (contaminated boots and clothing), and animals (pets, insects, birds etc.). But, The main mechanism for long distance spread, however, is thought to be movement of contaminated plants and cuttings, including boxwood greenery used for holiday decorations (confirmed on boxwood greenery in Warren Co., TN in 2016). The pathogen may persist as mycelium in infected leaves left on the soil surface or on those buried in the soil for at least 5 years (Henricot et al. 2008). While conidia of *C. pseudonaviculata* can remain viable in soil for 3 weeks, microsclerotia were shown to survive for at least 40 weeks at optimal conditions (Dart et al. 2015). Extremes of heat and cold may kill the pathogen in plant debris but, at moderate temperatures, it may remain in soil for long periods (Shishkoff and Camp 2016). When the environmental conditions are favorable, microsclerotia produce new mycelium and new lesions can be observed within one week.

Initially, reddish-brown to brown concentric circular spots with tan to light brown centers are visible on infected leaves (Figure 1), and angular diamond-shaped dark brown to black lesions (Figure 2) can be found on stems from the base to the shoot tip. Later, whole leaves will turn brown and defoliation will begin from the lower branches and spread to the upper canopy (Figure 3 and 4). During favorable conditions, the fungus sporulates and produces white spore masses on the underside of the leaves and stem that are visible to the naked eye (Figure 6 and 7). The pathogen does not initially attack the roots; so large plants can survive by producing new leaves even while the plant is attacked by the pathogen. With repeated cycles of defoliations and die back under disease-conducive conditions, though, large plants and rooted cuttings in the nurseries may get destroyed.


Figure 1 and 2 . Leaf spots of boxwood blight.


Figure 3 and 4. Leaf spots and defoliation caused by *Calonectria pseudonaviculata* on boxwood.

Figure 5. Black stem canker caused by *Calonectria pseudonaviculata* on boxwood.

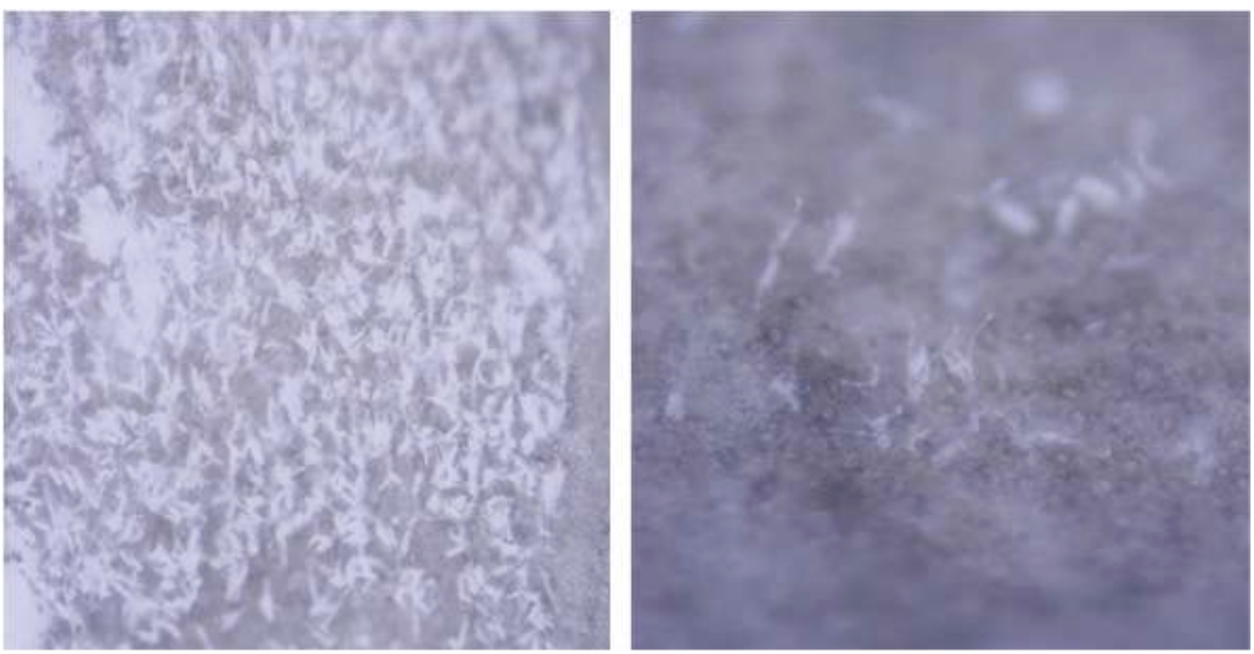

Figure 6 and 7. Underside of infected boxwood leaf showing white-colored spore masses.

The black cankers or streaks develop on the green stems of the boxwood blight disease infected plants (Figure 5). This is the major symptom that can be used to differentiate this disease from other boxwood diseases such as Volutella blight (Figure 8) and Macrophoma leaf spot (Figure 9); boxwood pests such as boxwood leaf miner (Figure 10 and 11); or boxwood abiotic disorders such as winter injury or sunscald (Figure 12).

Figure 8. Volutella blight on boxwood.

Figure 9. Macrophoma leaf spot on boxwood.

Figure 10 and 11. Boxwood leaf miner damage.

Figure 12. Abiotic disorder on boxwood.

Management Strategies

Scouting and early diagnosis of infected plants is critical for the avoidance of boxwood blight disease spread and the implementation of effective disease control strategies. If you would like to confirm that boxwood blight has infected your plants, you can submit a sample to your local university's plant diagnostic laboratory.

Since boxwood blight can be introduced via contaminated plants and cuttings, careful inspections need to be done prior to and also after the purchase of host plant material. Newly purchased plants should be isolated from existing boxwood, sweet box or spurge plantings or production areas in nurseries for at least one month. During this isolation period fungicide applications are not recommended since the fungicide treatments can suppress symptom development and mask proper diagnosis. In particular, moderately tolerant or tolerant cultivars need to be inspected carefully during this period since they may carry the pathogen without obvious symptoms. Using boxwood greenery for holiday decorations is not recommended in close proximity to landscape boxwood plantings or boxwood production areas. Homeowners who had holiday decorations using boxwood should, dispose them in sealed double bags in a landfill; boxwood greenery should not be placed in a compost pile. Once infected plants are detected, they should be destroyed immediately to reduce the potential for spread of the disease. Along with the plants, leaf and stem debris should be removed from the landscape or nursery because the pathogen can survive for a long time (up to five years) in plant debris. Before leaf debris has been blown by wind, buried by erosion or begun to decompose, flaming the soil surfaces with a propane push flamer can significantly reduce levels of inocula of *C. pseudonaviculata* in the upper layer of soil.

Sanitation of tools, equipment, and hard surfaces is critical for boxwood blight management. Different types of disinfectants containing sodium hypoclorite, hydrogen dioxide, hydrogen peroxide + peroxyacetic acid + octanic acid, phenolic compounds (O-benzyl-p-chlorophenol), and alcohol as active ingredients are helpful. To improve the effectiveness of disinfectants, surfaces need to be cleaned and free of soil and other organic matter before using disinfectants (Baysal-Gurel 2016). At least 5 minutes of contact time with the disinfectant is suggested for tools; 10 minutes is suggested for pots or other surfaces. If there is a field or landscape area where boxwood are suspected to be affected by boxwood blight, do not work in those areas when the plants are wet, and wear clean disposable booties and coveralls and dispose of the booties and coveralls before entering other boxwood areas. Do not go from areas of known infections to areas where infections have not been seen.

Proper irrigation can reduce disease spread as well. Drip irrigation is better than overhead irrigation, as it supplies water to the root system of the plant without the potential of spreading the disease through splashing.

Fungicides can be used to prevent this disease in conjunction with other management strategies previously mentioned. When there is a risk of boxwood blight occurring, repeated applications (at 7- or 14-day intervals) of fungicides may be necessary. A spray program that includes fungicides with different modes of action is ideal for fungicide resistance management (Table 3).

Table 1. Susceptibility of boxwood species and cultivars (as container grown plants or unrooted cuttings) to boxwood bight disease.

***Buxus* species**	**Cultivar**	**Highly Susceptible**	**Susceptible**	**Moderately Susceptible**	**Moderately Tolerant**	**Tolerant**
B. sempervirens	‘Aurea-pendula’	○				
B. sempervirens	‘Pendula’	★				
B. sempervirens	‘Justin Brouwers’	+				
B. sempervirens	‘Suffruticosa’	+ ★	■○			
B. sempervirens	‘Vardar Valley’	■		★		
B. sempervirens	‘Scupi’	★			■	
B. sempervirens	‘Rotundifolia’	★			○	
B. sempervirens	‘Northland’	★				■
B. sempervirens		★				■
B. sempervirens	‘Denmark’	★	○	■		
B. sempervirens	‘Handsworthiensis’	★	○			■
B. sempervirens	‘Elegantissima’		+			
B. sempervirens	‘American’		+			
B. sempervirens	‘Jensen’		+			
B. sempervirens	‘Asheville’		○			
B. sempervirens	‘Rochester’		○			
B. sempervirens	‘Aurea Maculata’		○			
B. sempervirens	‘Latifolia Maculata’		○			
B. sempervirens	‘Latifolia Aurea Maculata’		○			
B. sempervirens	‘Route 50’		○			
B. sempervirens	‘Newport Blue’		★			
B. sempervirens	‘Gordo’			+		
B. sempervirens	‘Myosotifolia’			○		
B. sempervirens	‘Pier Cove’			○		
B. sempervirens	‘Henry Shaw’			○		
B. sempervirens	‘Liberty’			○		
B. sempervirens	‘Ohio’			★		
B. sempervirens	‘Decussata’			★		
B. sempervirens	‘Marginata’		+ ★		■	
B. sempervirens	‘Graham Blandy’		★		■	
B. sempervirens	‘Fastigiata’				+	
B. sempervirens	‘Dee Runk’		★		+	
B. sempervirens	‘Angustifolia”				○	
B. sempervirens	‘Longwood’				○	
B. sempervirens	‘Northern New York’		○★			■
B. sempervirens	‘Arborescens’ 31793		★			■
B. sempervirens	‘Arborescens’ 57953		★			■

***Buxus* species**	**Cultivar**	**Highly Susceptible**	**Susceptible**	**Moderately Susceptible**	**Moderately Tolerant**	**Tolerant**
B. sempervirens	‘Edgar Anderson’		★			■
B. sempervirens	‘Myrtifolia’			★		■
B. sempervirens	‘North Star’					○
B. microphylla	‘Green Pillow’			+		
B. microphylla	‘Grace Hendricks Phillips’		★	+		
B. microphylla	‘Sprinter’			○		
B. microphylla	‘Hohman’s Dwarf’				○	
B. microphylla	‘Golden Dream’					+
B. microphylla	‘John Baldwin’			★	+	■
B. microphylla	‘Baby Gem’					■
B. microphylla	‘Wedding Ring’					○
B. microphylla var. *japonica*	'Morris Midget'		+			
B. microphylla var. *japonica*	‘Morris Dwarf’		+			
B. microphylla var. *japonica*	‘National’			★	■	
B. microphylla var. *japonica*	‘Jim Stauffer’			+ ★		
B. microphylla var. *japonica*	‘Gregem’			★		
B. microphylla var. *japonica*	‘Green Beauty’					+ ○
B. microphylla var. *japonica*	‘Winter Gem’				+	■ ★
B. sinica var. *insularis*	‘Wintergreen’				○ ★	
B. sinica var. *insularis*	‘Nana’					+ ○
B. sinica var. *insularis*	‘Pincushion’					■ ★
B. sinica var. *insularis*	‘Winter Beauty’					★
B. sinica var. *insularis* x *B. sempervirens* hybrids	‘Chicagoland Green’ ‘Glencoe’		+	★		
B. sinica var. *insularis* x *B. sempervirens* hybrids	‘Green Velvet’		★		○	
B. sinica var. *insularis* x *B. sempervirens* hybrids	‘Green Mountain’			+ ★		

Buxus species	Cultivar	Highly Susceptible	Susceptible	Moderately Susceptible	Moderately Tolerant	Tolerant
B. sinica var. *insularis* x *B. sempervirens* hybrids	‘Green Gem’			★	+	
B. sinica var. *insularis* x *B. sempervirens* hybrids	‘Green Mound’			+		■★
B. koreana x B. sempervirens hybrids	‘Green Ice’			★		
B. harlandii			★			+■
B. harlandii	‘Richard’				○	
B. bodineiri				★		■
B. wallichiana				★		
Buxus sp.	‘Franklin’s Gem’				○	
Buxus sp.					★	■
Buxus sp.	‘Northern Emerald’					○

+ Ganci et al. 2012. Susceptibility of commercial boxwood varieties to *Cylindrocladium buxicola*. http://americanhort.theknowledgecenter.com/library/Americanhort/docs/government%20relations/boxwood%20blight/NCSU_boxblight_tolerance.pdf

○ Ganci et al. 2013. Susceptibility of commercial boxwood cultivars to boxwood blight. https://plantpathology.ces.ncsu.edu/wp-content/uploads/2013/05/final-Cult-trials-summary-2013.pdf?fwd=no

■ Miller et al. 2016. Evaluation of boxwood cultivars for resistance to boxwood blight, 2015.

★ Shishkoff et al. 2015. Evaluating boxwood (*Buxus* spp.) susceptibility to *Calonectria pseudonaviculata* by inoculating cuttings from the national boxwood collection at the US National Arboretum. Plant Health Progress 16:11-15. Plant Health Progress doi:10.1094/PHP-RS-14-0033.

Table 2. Susceptibility of *Pachysandra* species and cultivars to boxwood blight disease (LaMondia 2017).

Pachysandra species	Cultivar	Highly Susceptible	Susceptible	Moderately Susceptible	Moderately Tolerant	Tolerant
P. terminalis	‘Common’	X				
P. terminalis	‘Crinkled’				X	
P. terminalis	‘Green Carpet’					X
P. terminalis	‘Green Sheen’			X		
P. terminalis	‘Variegated’		X			
P. axillaris	‘Windcliff’				X	

Table 3. Active ingredients with effectiveness against boxwood blight in US trials.

Active ingredient	FRAC Code	Reference
Azoxystrobin	11	Ivors et al. 2013
Benzovindiflupyr + azoxystrobin	7 +11	LaMondia 2016 Baudoin et al. 2015
Boscalid + pyraclostrobin	7 + 11	Baudoin et al. 2015 LaMondia 2015
Chlorothalonil	M5	Baudoin et al. 2015 Ivors et al. 2013 LaMondia 2015
Cyprodinil + fludioxonil	9 + 12	Ivors et al. 2013 LaMondia 2015
Fludioxonil	12	Ivors et al. 2013
Fluoxastrobin + chlorothalonil	11 + M5	Ivors et al. 2013
Fluxapyroxad + pyraclostrobin	7 + 11	Maurer and LaMondia 2016 LaMondia and Maurer 2017
Mancozeb	M3	LaMondia 2014
Metconazole	3	Ivors et al. 2013
Myclobutanil	3	LaMondia 2015
Polyoxin D zinc salt	19	Ivors et al. 2013
Propiconazole	3	LaMondia 2015
Propiconazole + chlorothalonil	3 + M5	Ivors et al. 2013
Pyraclostrobin	11	Ivors et al. 2013
Tebuconazole	3	Ivors et al. 2013
Thiophanate-methyl	1	LaMondia 2016 Ivors et al. 2013
Thiophanate-methyl + chlorothalonil	1 + M5	Ivors et al. 2013
Trifloxystrobin	11	Ivors et al. 2013
Trifloxystrobin + triadimefon	11 + 3	Palmer and Shishkoff 2014

NOTE: Before applying ANY disease management product, be sure to: 1) read the label to be sure that the product is allowed for the crop and the disease you intend to control; 2) read and understand the safety precautions and application restriction.

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For additional information, contact your local nursery specialist office at:

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