



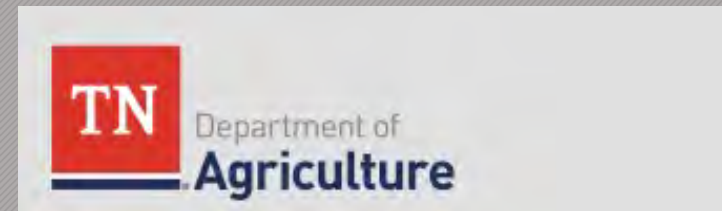
Boxwood Blight

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Tennessee State University

Otis L. Floyd Nursery Research Center, McMinnville, TN

Dixon Gallery and Gardens, Feb 18, 2022



Boxwood Blight

- Potential impact
- Hosts
- Pathogen spread
- Pathogen biology
- Symptoms and signs
- Management



Devastated boxwood crops in production (left) and plantings in Tudor Place (right)
PC: Chuan Hong

Boxwood Blight

Two fungal species:

- *Calonectria pseudonaviculata*
- *C. henricotiae* (Six countries in Europe- Belgium, the Czech Republic, Germany, the Netherlands, Slovenia and the United Kingdom)

Landscapes, gardens and nurseries



Boxwood Blight



Lewis and Clark College, Portland,
Oregon
<http://www.landscapeeast.com>



Boxwood Blight

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Ensuring the Longevity of Our Boxwood

By Katie Mobley, on January 12, 2021

share    

While we nurture each and every plant across our Gardens with the utmost care, it is with solemnity that we must say goodbye to a portion of our tree boxwood in the eastern part of our Gardens due to boxwood blight infection. We are especially saddened to

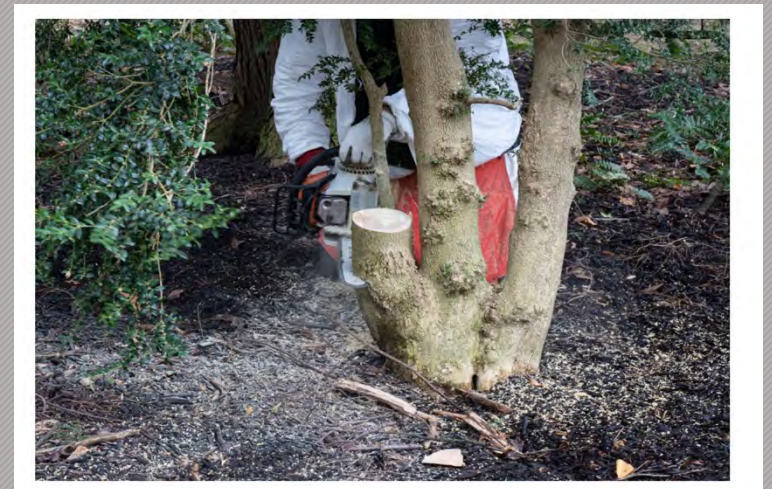


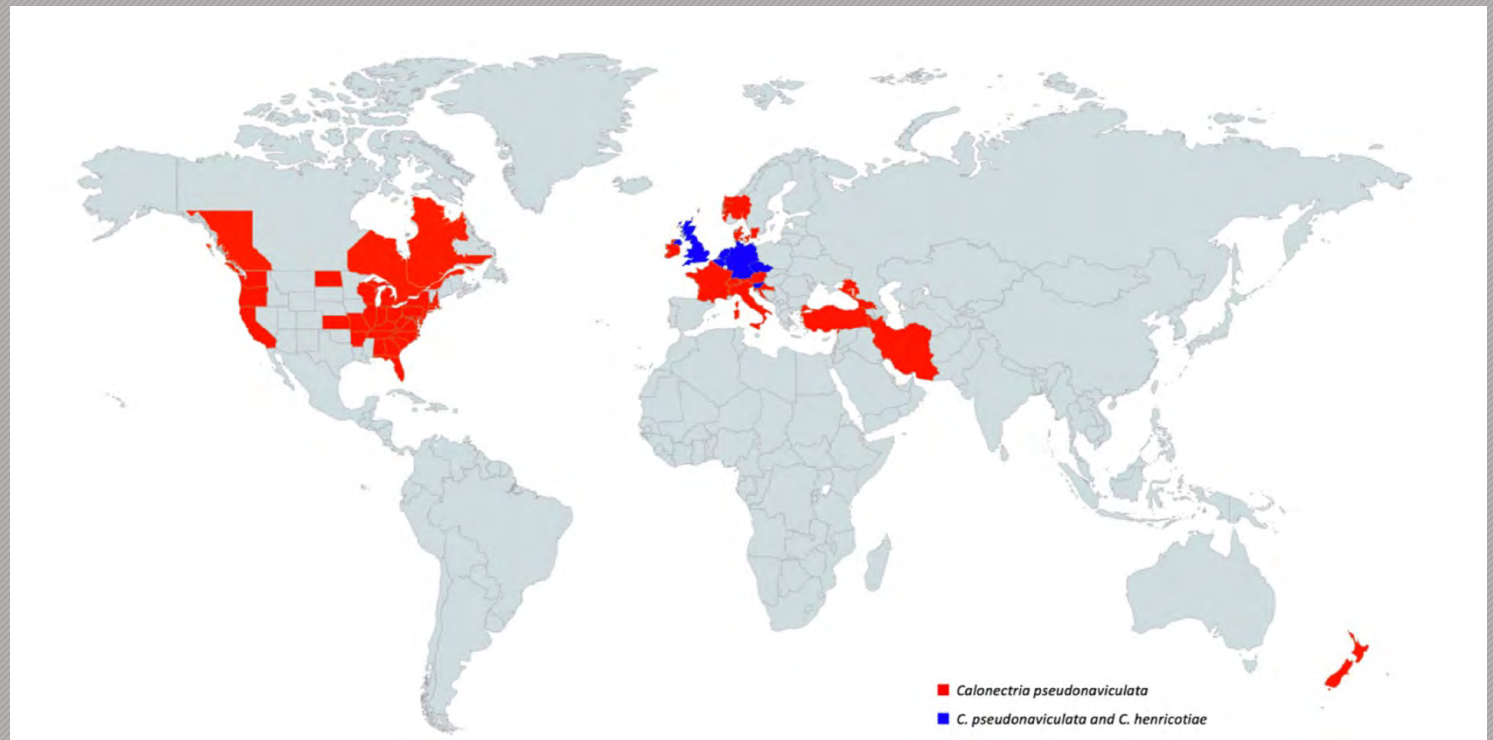
Photo by Carol Gross

Boxwood Blight

- The pathogen can infect all growth stages of boxwood plants and the disease results in defoliation and decline of susceptible boxwood.
- This fungus spreads over short and long distances.
- Once introduced to a nursery/landscape, boxwood blight is very difficult and costly to manage.

Distribution of Boxwood Blight

- 1994: First identified in the United Kingdom
- 2011: First identified on boxwood in nurseries and landscape plantings in North Carolina and Connecticut.
- 2022: Confirmed in 28 additional states and the District of Columbia in the United States.



PC: Vanina et al. 2020- Plant Health Progress



Department of
Agriculture

TN's blighted timeline

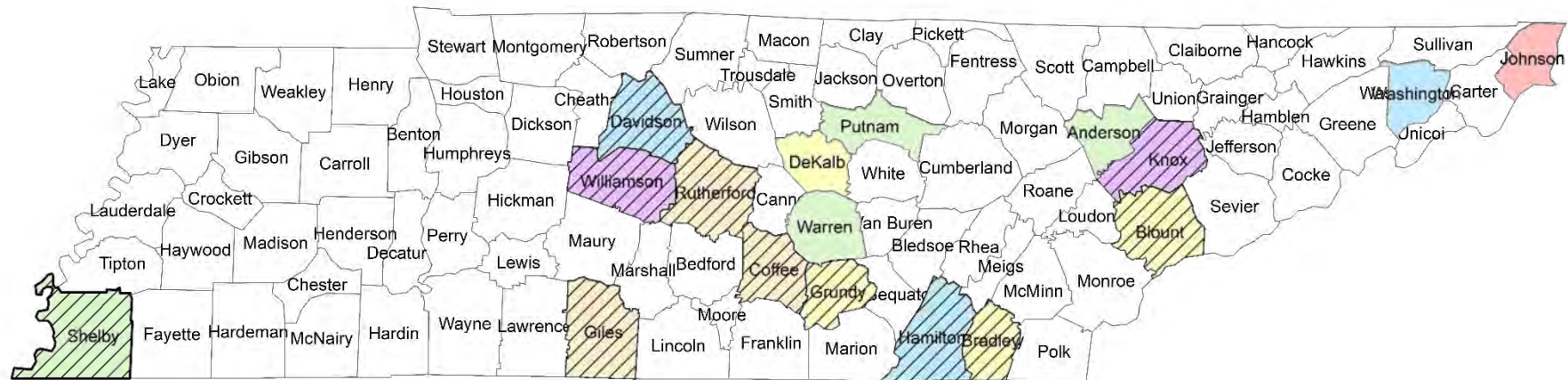
and quarantine

Katy Kilbourne, Plant Pathologist

02/18/22



TN's Timeline



Quarantine

Quarantine became effective on February 4th 2018

- Exterior Quarantine

Regulated Material:

- Boxwood and Sarcococca plants and any material containing these plants, e.g. compost, mulch, soil, cuttings, greenery or waste; and,
- Any equipment, shipping material, compost, mulch, soil, or waste exposed to boxwood or Sarcococca plants.



Quarantine requirements

3 Parts

- Production
- Inspection
- Notification



Quarantine Requirements: Production

All regulated material entering the state must be sourced from a participant in the boxwood blight nursery cleanliness program or equivalent.

Cleanliness Program:

- Exclusion
- Water Management
- Sanitation
- Inspection
- Training
- Record keeping/traceability



Cleanliness Program

Exclusion:

- Purchase from clean sources and inspect new material
- Isolate new or returned material for 30 days
- 3 meters or more from existing plants
- No treatment while in isolation



Cleanliness Program

Water Management:

- Avoid overhead irrigation
- Watch for runoff and plant placement



Sanitation:

- Clean tools
- Clean staff
- Clean pots
- Remove debris



Cleanliness Program

Inspection:

- Know the symptoms
- Inspect plants

Record keeping/traceability:

- Incoming plants including quantity and sources
- Shipping records
- Fungicide applications
- Personnel training


Training:

- Train the staff on sanitation and inspections



Quarantine Requirements: Notification

All parties or firms receiving shipments of regulated material from outside of TN are required to give the department shipment notification within three days of the arrival date.

	
TENNESSEE DEPARTMENT OF AGRICULTURE Consumer and Industry Services, Plant Certification P.O. Box 40627, Nashville, TN 37204 Phone (615) 837-5137 FAX (615) 837-5246 www.tn.gov/agriculture/pe-acc-summary/cis.html	
Boxwood Shipping Notification	
Receiver:	Shipper:
Signature _____	
Receiver Address:	Shipper Address:
Receiver Phone:	Shipper Phone:
Receiver Fax:	Shipper Fax:
Receiver Email:	Shipper Email:
County/State of Origin:	
Varieties and Quantities (or attach invoice):	
Expected Delivery Date:	
Shipper Certificate Number:	
Shipper Boxwood Compliance Number:	
Invoice Number:	
<small>TA-0562017</small>	
Return: Email to plant.certification@tn.gov or Fax (615) 837-5246 or mail to Plant Certification, PO BOX 40627, Nashville, TN 37204	

Blight found

- Infected plants should be destroyed as well as plants touching or in close proximity
- Destruction by bagging, burning or burial
- Other plants on site should be sampled and scouted



Boxwood blight- Hosts

- *Buxus* spp. (Boxwood)
- *Sarcococca* spp. (Sweet box)
- *Pachysandra terminalis* (Japanese spurge)(Virginia 2016)
 - *P. procumbens* (Allegheny spurge)(by inoculation)
 - *P. axillaris* (Windcliff fragrant)(by inoculation)



(a) Japanese pachysandra (*Pachysandra terminalis*) showing necrotic leaf lesions. (b) Necrotic lesions on sweet box (*Sarcococca hookeriana*). Panel a courtesy of Yonghao Li. Panel b courtesy of Chuan Hong.

Boxwood blight- Hosts

Groundcovers and companion plants commonly associated with boxwood plantings: boxwood blight infection and sporulation were observed on twelve plant species:

- *Alchemilla mollis* (Lady's Mantle)
- *Arctostaphylos uva-ursi* (Bearberry)
- *Brunnera macrophylla* (Siberian bugloss)
- *Epimedium youngianum* (Bishop's hat)
- *Galium odoratum* (Sweet woodruff)
- *Geranium sanguineum* (Bloody geranium)
- *Phlox subulate* (Moss phlox)
- *Tiarella cordifolia* (Foam flower)
- *Callirhoe involucrate* (Purple poppy mallow)
- *Iberis sempervirens* (Candytuft)
- *Mazus reptans* (Mazus)
- *Vinca minor* (Dwarf periwinkle)

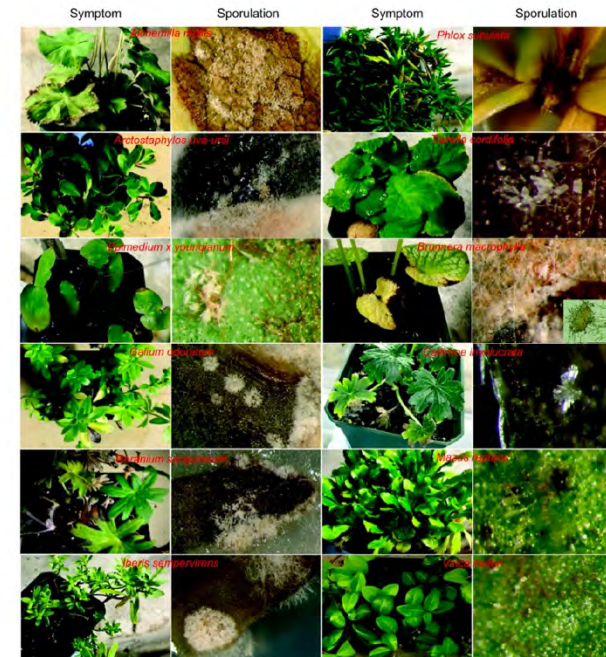


Fig. 1. Characteristic disease symptoms and sporulation of *Calonectria pseudonaviculata* on twelve non-Buxaceae, with lady's mantle, phlox, epimedium, mazus and vinca sporulation photos from inoculations of detached leaves and remaining photos from whole plant inoculations

Boxwood blight- Pathogen spread

- Short distance:

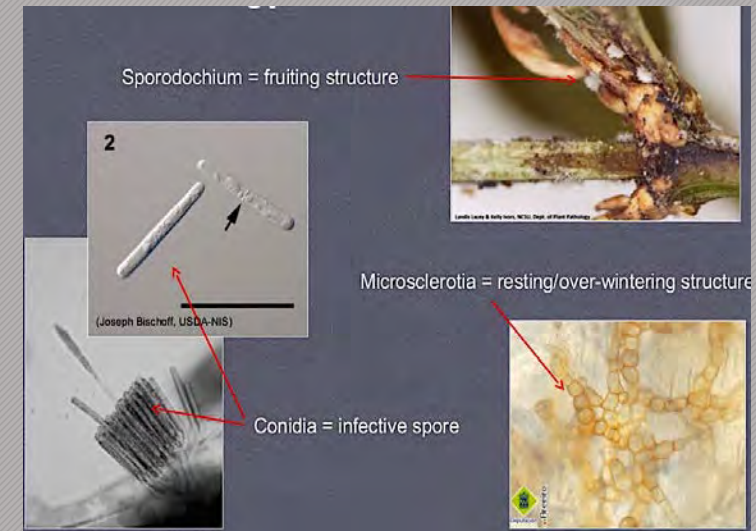
- Rain or irrigation water
- Wind
- Plant debris
- Contaminated tools and equipment (such as pruning tools)
- Workers (contaminated boots and clothing) and
- Animals (pets, insects, birds etc.)

- Long distance:

- Movement of contaminated plants
- Cuttings, including boxwood greenery used for holiday decorations

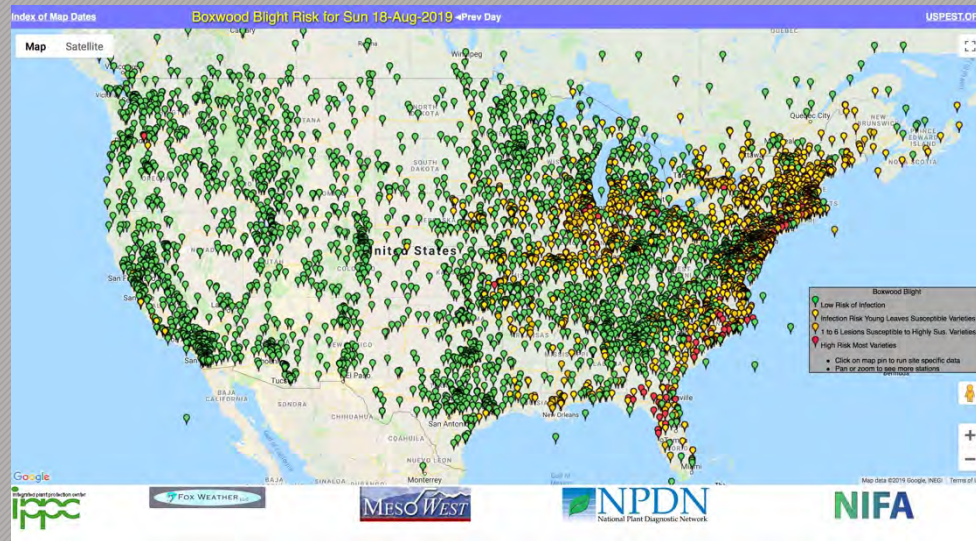
Boxwood blight- Pathogen biology

- Persist as mycelium in infected leaves left on the soil surface or on those buried in the soil for at least 5 years.
- 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 in soil.
- When the environmental conditions are favorable, microsclerotia produce new mycelium and new lesions can be observed within one week.
- The fungal pathogen gains leaf entry through stomatal openings and not by direct penetration of the cuticle.



Boxwood blight- Pathogen biology

- Warm, humid, and shady conditions favor disease development.
- Infection is favored at 64-77°F.



http://uspest.org/risk/boxwood_map

This website brings together US weather data and plant pest and disease models to serve many decision support needs in agriculture.

Boxwood blight forecasting model is available as an Android or iOS app and also as a mobile-friendly web version (https://uspest.org/risk/boxwood_app) and a full web version (http://uspest.org/risk/models?mdl=bxwd_s)

Boxwood Blight Symptoms

- Reddish-brown to brown concentric circular spots with tan to light brown centers are visible on infected leaves



Boxwood Blight Symptoms

- Leaf spots and defoliations



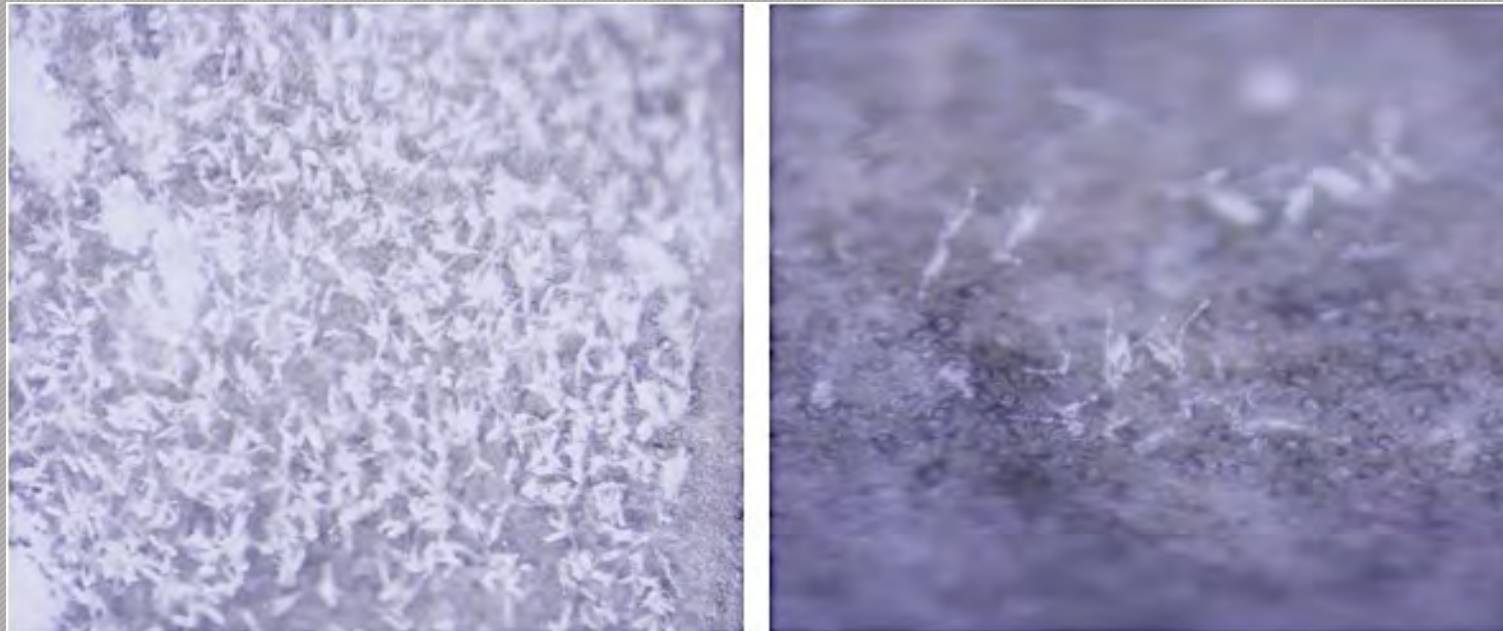
Boxwood Blight Symptoms

- Leaf spots and defoliations



Boxwood blight signs

- 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.



Boxwood blight signs

- Sporulation of the fungus



Boxwood blight signs

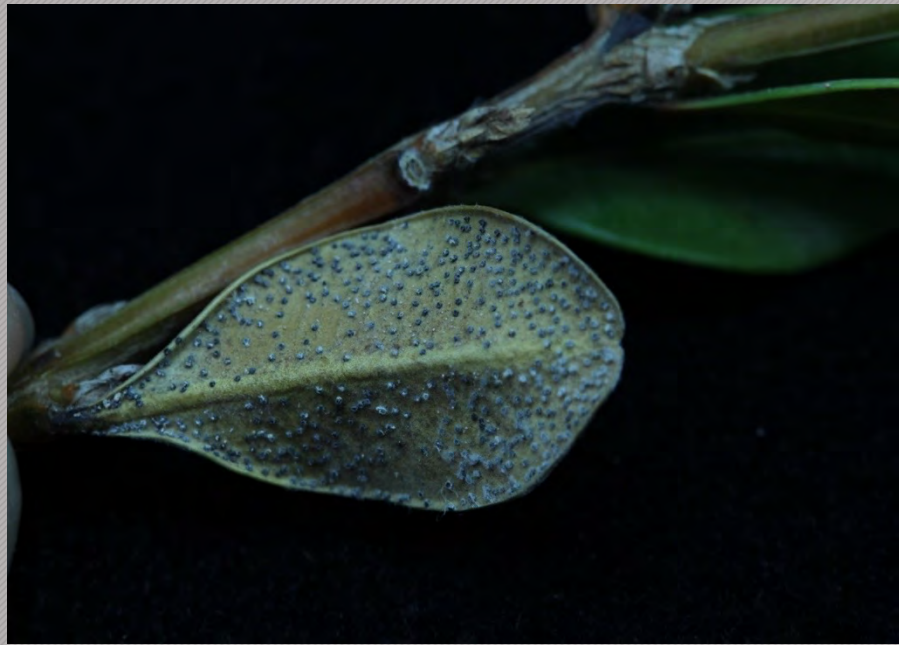
- Sporulation on a twig



Boxwood- Volutella blight



Boxwood- Macrophoma leaf spot



Boxwood Dieback (*Colletotrichum theobromicola*)



Louisiana, North Carolina, New York, Virginia, Indiana, South Carolina and Texas

Boxwood- Phytophthora root and crown rot



Winter and salt injury



Boxwood-leaf miner injury



Boxwood blight management

- **Purchase boxwood plants** from the suppliers or nurseries that have **been inspected by the state's department of agriculture** and found to be apparently free from boxwood blight and hold a **boxwood blight cleanliness program compliance agreement**.

Boxwood blight management

- Careful inspections need to be done prior to and also after the purchase of host plant material.
- **Scouting and early diagnosis** of infected plants are critical for the avoidance of boxwood blight disease spread and the implementation of effective disease control strategies. **If the plant is symptomatic, contact TN Department of Agriculture.**

Boxwood blight RISK management

- Newly purchased plants should be isolated from existing boxwood, sweet box or spurge plantings or holding or production areas for at least one month by a minimum of 10 ft. (isolation area).
- 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.

Boxwood blight RISK management

- Blocking the plants using 10 ft. distance between the blocks or separating the boxwood blocks with another non-host plant is critical.



Boxwood blight RISK management

- Good drainage system in the holding or production area.
- Prevent runoff from the one holding or production block to another.
- Proper irrigation can reduce disease spread. 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.
- Gardening experts recommend that boxwood be shaped with a convex rather than a flat top to aid the canopy in shedding water

Boxwood blight RISK management



- Right planning for the landscape design
- Mulching at the base of plants reduces reinfection from dropped leaves
- Ensure good air circulation in plantings by providing adequate spacing between plants in landscape

Boxwood blight management

- 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.



Boxwood blight management

- Once infected plants are detected, they should be destroyed immediately to reduce the potential for spread of the disease.
- Along with the plants (including roots), leaf and stem debris should be removed from the landscape because the pathogen can survive for a long time (up to five years) in plant debris.



Boxwood blight management

- Before leaf debris has been blown by wind, buried by erosion or begun to decompose, **flaming the soil surfaces with a propane push flamer (1 m/45 sec)** and using **leaf vacuum** can significantly reduce levels of inocula of boxwood blight in the upper layer of soil.



Following removal, Senior Horticulturist Pandora Young flames the ground to kill remaining spores and help prevent the spread of blight. Photo by Carol Gross.

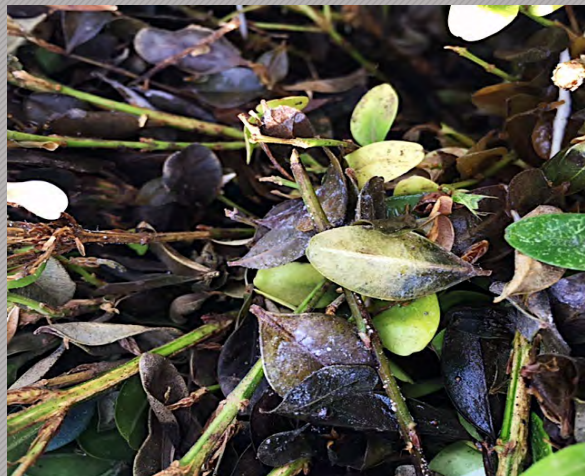


During removal, staff wear protective shoe coverings, which are removed when leaving the infection site. Staff also spray their shoes and coverings with ethanol when leaving the site as an additional precaution and to ensure blight does not travel past the remediation site. Photo by Carol Gross.



Boxwood blight management

- Do not work in boxwood blight suspected 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.



Boxwood blight management

- Sanitation of tools, equipment, and hard surfaces is critical (spray hoses, pruning tools, wheelbarrows, tarps, vehicles etc.) for boxwood blight management.

Different types of disinfectants containing;

- Sodium hypochlorite (Clorox- 10%)
- Hydrogen dioxide (OxiDate, ZeroTol)
- Hydrogen peroxide + peroxyacetic acid + octanic acid (Xeroton-3 (X3))
- Phenolic compounds (O-benzyl-p-chlorophenol) (Lysol Brand Concentrate Disinfectant) (2.5 oz/ 1 qt)
- Ethanol

Boxwood blight management



Boxwood blight management- Fungicides

- 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.

Boxwood blight management- Fungicides

Fungicide	Active ingredient	FRAC Code	Rate (per 100 gal)	Reference
Daconil WeatherStik 54FL	Chlorothalonil	M5	22 fl oz	Baudoin et al. 2015 Ivors et al. 2013
Mural 45WG	Benzovindiflupyr + Azoxystrobin	7 +11	4 - 7 oz	LaMondia 2016 Baudoin et al. 2015
Pageant 38WG	Boscalid + pyraclostrobin	7 + 11	14 oz	Baudoin et al. 2015
Orkestra Intrinsic SC	Fluxapyroxad + Pyraclostrobin	7 + 11	6- 10 fl oz	Maurer and LaMondia 2016 LaMondia and Maurer 2017
3336 F	Thiophanate-methyl	1	16 fl oz	LaMondia 2016 Ivors et al. 2013
Spectro 90WDG	Thiophanate-methyl + Chlorothalonil	1 + M5	1.5 lb	Ivors et al. 2013
Disarm C	Fluoxastrobin + Chlorothalonil	11 + M5	11 fl oz	Ivors et al. 2013
Concert II	Propiconazole + Chlorothalonil	3 + M5	35 fl oz	Ivors et al. 2013
Medallion WDG	Fludioxonil	12	4 oz	Ivors et al. 2013
Palladium 62.5WG	Cyprodinil + Fludioxonil	9 + 12	6 oz	Ivors et al. 2013
Heritage 50WG	Azoxystrobin	11	8 oz	Ivors et al. 2013
Tourney 50WDG	Metconazole	3	4 oz	Ivors et al. 2013
Compass O 50WDG	Trifloxystrobin	11	2 oz	Ivors et al. 2013
Affirm WDG	Polyoxin D zinc salt	19	0.5 lb	Ivors et al. 2013
Torque	Tebuconazole	3	10 fl oz	Ivors et al. 2013

Boxwood blight management- Fungicides

Treatment and rate (Application dates)	Application interval	Application method	Boxwood blight			Plant height increase (in)
			Disease severity (%) (13 Jan)	AUDPC	Defoliation (%) (13 Jan)	
<u>Broadform SC 2 fl oz/100 gal (1,3,5)</u>	<u>21 day</u>	Drench	21.2 abc ^{**}	608.4 bcd	15.0 ab	0.47 a
<u>Broadform SC 2 fl oz/100 gal (1,4,6)</u>	<u>28 day</u>	Drench	13.7 c	508.1 cd	14.2 ab	0.51 a
<u>Broadform SC 4 fl oz/100 gal (1,3,5)</u>	<u>21 day</u>	Drench	18.3 c	582.8 bcd	14.2 ab	0.39 a
<u>Broadform SC 4 fl oz/100 gal (1,4,6)</u>	<u>28 day</u>	Drench	22.5 abc	712.3 abc	17.5 ab	0.87 a
<u>Daconil Weatherstik 22 fl oz/100 gal (1,2,4)</u>	<u>14 day</u>	Spray	16.3 c	434.0 cd	10.3 b	0.59 a
<u>Daconil Weatherstik + KleenGrow 22 fl oz/100 gal + 0.25 fl oz/1 gal (1,2,4)</u>	<u>14 day</u>	Spray	15.3 c	500.5 cd	8.7 b	0.98 a
<u>KleenGrow 0.25 fl oz/1 gal (1,2,4)</u>	<u>14 day</u>	Spray	13.7 c	454.4 cd	10.8 b	0.67 a
<u>Medallion SC 1 fl oz/100 gal (1,4,6)</u>	<u>28 day</u>	Drench	20.0 bc ^{**}	449.8 cd	14.2 ab	0.59 a
<u>Pageant Intrinsic 12 oz/100 gal (1,2,4)</u>	<u>14 day</u>	Drench	30.0 ab	887.8 ab	22.5 a	0.31 a
<u>Pageant Intrinsic 12 oz/100 gal (1,4,6)</u>	<u>28 day</u>	Drench	22.0 abc	625.3 a-d	17.5 ab	1.18 a
<u>Terraguard SC 6 fl oz/100 gal (1,2,4)</u>	<u>14 day</u>	Drench	14.5 c	365.8 d	12.5 ab	0.98 a
Non-treated, inoculated control			30.8 a	937.4 a	21.7 a	0.39 a

Boxwood blight management- Susceptibility of boxwoods to boxwood blight disease

<i>Buxus</i> species	Cultivar	Highly Susceptible	Susceptible	Moderately Susceptible	Moderately Tolerant	Tolerant
<i>B. sempervirens</i>	'Aurea-pendula'	○				
<i>B. sempervirens</i>	'Pendula'	★				
<i>B. sempervirens</i>	'Justin Brouwers'	+				
<i>B. sempervirens</i>	'Suffruticosa'	+★	■○			
<i>B. sempervirens</i>	'Vardar Valley'	■		★		
<i>B. sempervirens</i>	'Scupi'	★			■	
<i>B. sempervirens</i>	'Rotundifolia'	★			○	
<i>B. sempervirens</i>	'Northland'	★				■
<i>B. sempervirens</i>		★				■
<i>B. sempervirens</i>	'Denmark'	★	○	■		
<i>B. sempervirens</i>	'Handsworthiensis'	★	○			■

+ 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
 c 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?fw=no>
 n 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.

Boxwood blight management- Susceptibility of boxwoods to boxwood blight disease

<i>Buxus</i> species	Cultivar	Highly Susceptible	Susceptible	Moderately Susceptible	Moderately Tolerant	Tolerant
<i>B. microphylla</i> var. <i>japonica</i>	'Green Beauty'					+★○
<i>B. microphylla</i> var. <i>japonica</i>	'Winter Gem'				+	■★
<i>B. sinica</i> var. <i>insularis</i>	'Wintergreen'				○★	
<i>B. sinica</i> var. <i>insularis</i>						+★○
<i>B. sinica</i> var. <i>insularis</i>	'Nana'					
<i>B. sinica</i> var. <i>insularis</i>	'Pincushion'					■★
<i>B. sinica</i> var. <i>insularis</i>	'Winter Beauty'					★
<i>B. harlandii</i>			★			+■
<i>B. harlandii</i>	'Richard'				○	
<i>B. bodineiri</i>				★		■
<i>B. wallichiana</i>				★		
<i>Buxus</i> sp.	'Franklin's Gem'				○	
<i>Buxus</i> sp.					★	■
<i>Buxus</i> sp.	'Northern Emerald'					○

Boxwood blight management- Susceptibility of Sarcococca to boxwood blight disease

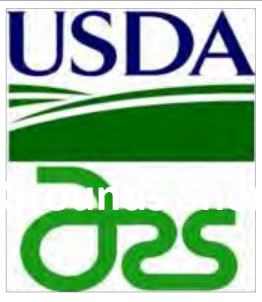
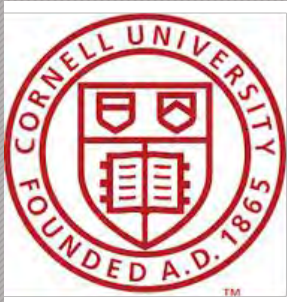
Taxon	Mean Spots per Leaf ^z	Group ^y	Source ^x
Sarcococca confusa	37.7	a	SBG
S. confusa	33.2	ab	GPN
S. confusa	28.5	abc	HF
S. orientalis	24.8	a-d	HF
S. hookeriana	21.4	a-e	HF
S. vagans	21.3	a-e	FRF
S. humilis 'Sarsid2'	18.5	a-e	RFN
S. ruscifolia	16.1	a-e	SBG
S. sp.	15.0	a-e	ABG
S. saligna	13.7	b-e	JCN
S. wallichii	12.3	b-e	FRF
S. humilis 'Sarsid1'	11.2	b-e	NC
S. humilis	9.8	b-e	SBG
S. orientalis	8.9	c-e	HF
S. ruscifolia	8.1	c-e	JCN
S. ruscifolia	7.2	c-e	SBG
S. hookeriana 'Purple Stem'	7.0	c-e	PDN
S. humilis	6.0	c-e	WH
S. ruscifolia var. chinensis	5.9	c-e	PDN
S. orientalis	5.9	c-e	SBG
S. ruscifolia	5.4	c-e	WH
S. sp.	5.3	c-e	ABG
S. saligna	5.0	de	WH
S. sp.	4.4	de	HF
S. hookeriana	2.2	de	FRF
Buxus sempervirens 'Suffruticosa'	1.5	de	SFN
B. 'Green Gem'	0.9	e	HF
S. ruscifolia	0.05	e	ABG
S. ruscifolia var. chinensis 'Dragon Gate'	0.05	e	FRF

This is highly important to the green industry because *S. confusa* is among the most popular sweet boxes in cultivation.

Sources

- HRI- <https://www.hriresearch.org/Boxwood>
<https://www.hriresearch.org/article/hri-oan-boxwood-health-workshop-recap>
<https://www.hriresearch.org/sites/default/files/BoxwoodBlight/HRIBoxwoodHealthBMPs-V3-2020.pdf>
- Factsheets- http://www.tnstate.edu/extension/publication_index.aspx
- Facebook updates-
<https://www.facebook.com/TSUNurseryResearchCenter>
- Quarantine Link: <https://publications.tnsosfiles.com/rules/0080/0080-06/0080-06-07.20180204.pdf>

Together we save boxwood crops and plantings!



**Horticultural
Research Institute**
The AmericanHort Foundation



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Public Gardens
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Acknowledgements

This work was supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, SCRI grant, under award number 2020-51181-32135 and TDA.



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

THANK YOU

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