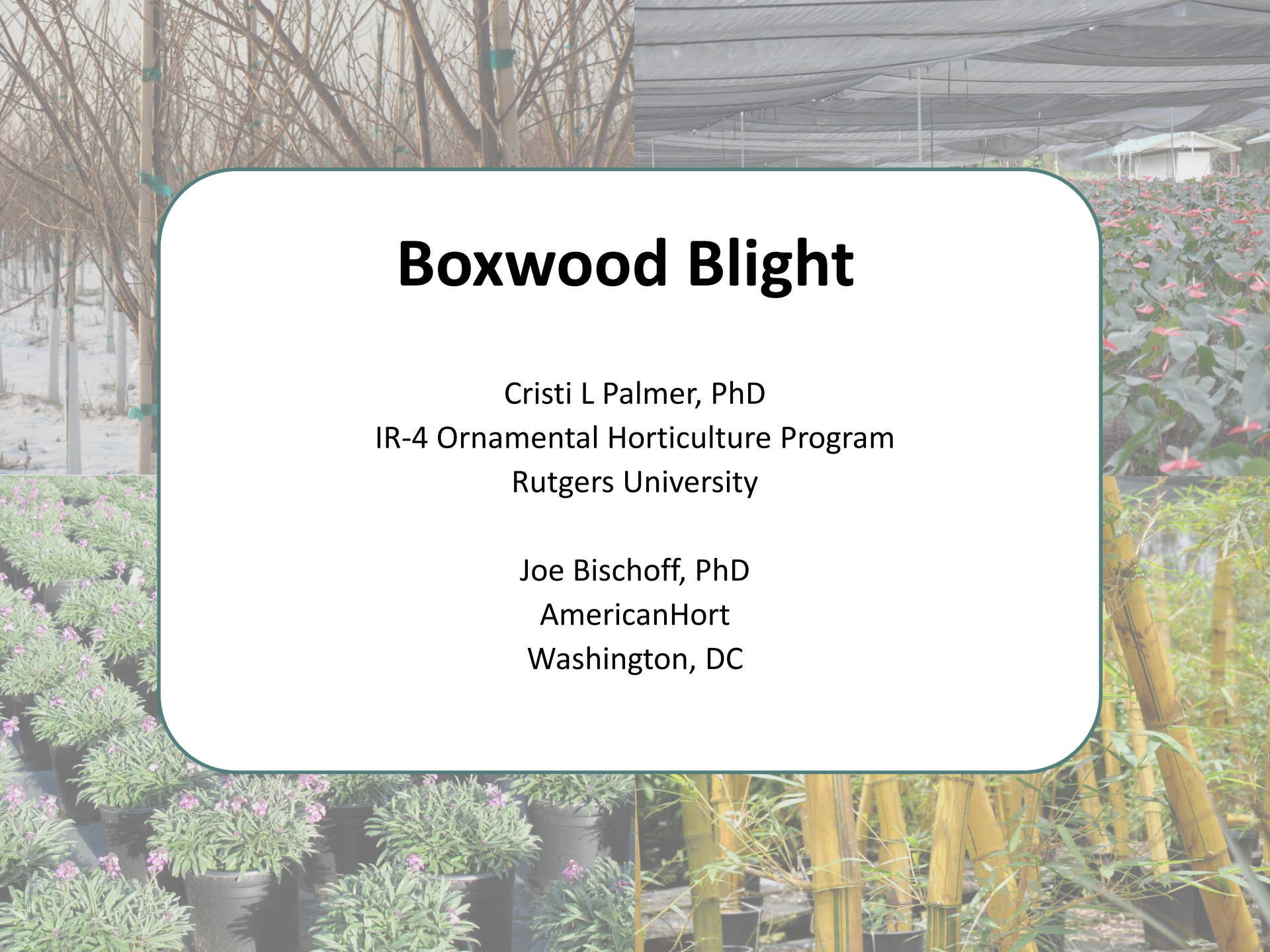




Boxwood Blight

Cristi L Palmer, PhD
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Rutgers University

Joe Bischoff, PhD
AmericanHort
Washington, DC



Photo by Cristi Palmer



Photo by Cristi Palmer



Photo by Cristi Palmer



Photo by Cristi Palmer



Photo by Cristi Palmer





Photo by Cristi Palmer

Boxwood blight — CT production nursery



Boxwood blight — CT commercial property



Boxwood blight — CT residential property





Helping to Coordinate a Response

BoxwoodBlight.org

Knowledge Center :: OnDemand Back to AmericanHort.org



OnDemand » Boxwood Blight » (1 thru 2 of 2)



Directory

» Boxwood Blight Update: Where we are and where we hope to be.



Where We Are and Where We Want To Be.

» Boxwood Blight: A Year of Research

Latest from ANLA Today » Boxwood Blight

Two New State Records for Boxwood Blight July 24, 2013
In recent weeks boxwood blight has been confirmed from Delaware and New Jersey. These findings mark the first new state reports since March 2012. Many growers and landscapers have...

NCSU Reports New Preventative Treatment Recommendations for Boxwood Blight	July 24, 2013
Boxwood Blight Tolerant Cultivars Capable of Spreading Pathogen	July 03, 2013
Boxwood Blight shown to be Pathogenic on Allegheny Spurge	March 12, 2013
Recording Of Boxwood Blight Research Update Available	March 06, 2013
ANLA Will Host Boxwood Blight On February 25th	February 06, 2013
Boxwood Blight and IDM Proposals Submitted to USDA	December 18, 2012
Soil Surface Flaming Kills Boxwood Blight Resting Structures	November 07, 2012
Some Boxwood Varieties Show Tolerance to Blight	October 17, 2012
The Boxwood Blight Working Group adds Pachysandra to BMPs	August 01, 2012

Additional Resources

Access to some or all of these resources may be restricted.

- » BBWG recommended BMPs for Boxwood Blight
Industry Recommended Best Management Practices for the prevention and eradication of Boxwood Blight within a nursery
- » Shoot blight of boxwood-Calonectria pseudonaviculata
A diagnostic fact sheet from ARS-USDA
- » Boxwood Blight - a New Disease for Connecticut and the U.S.
An introduction to the disease from The Connecticut Agricultural Experiment Station (www.ct.gov/coes)
- » An Online Guide to Plant Disease Control: Boxwood Blight
An overview provided by Oregon State University Extension
- » Prevention and Management of Boxwood Blight
North Carolina State University reviews the prevention and management of Boxwood Blight.
- » The Box Blight Pathogen
Information from the Rhode Island Department of Environmental Management

BMPs



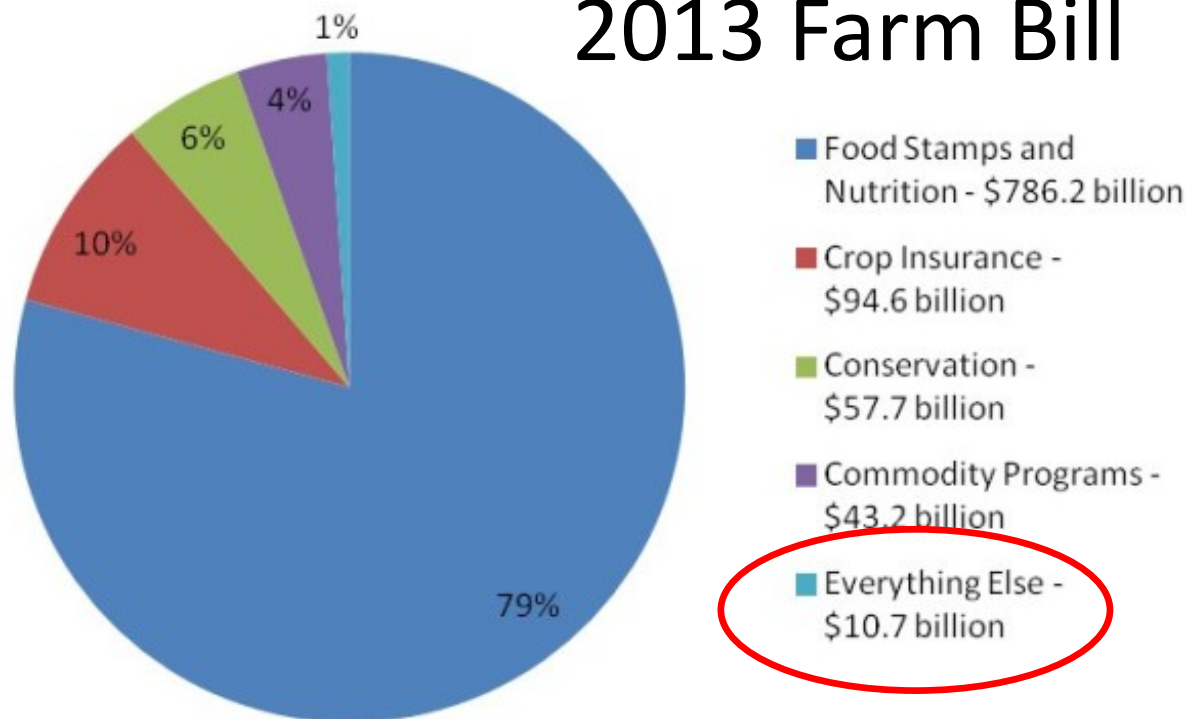
Funded Research



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2013 Farm Bill



\$1.8 Billion

- 10201 – Pest & Disease Management
- NCPN – National Clean Plant Network
- SCRI – Specialty Crop Research Initiative
- SCBG – Specialty Crop Block Grants

- Legislative advocacy
- Regulatory representation
- Research into tools and solutions



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ROSE ROSETTE DISEASE

AmericanHort News Friday, January 17th 01:59 PM ET

First Report of Rose Rosette Disease in Florida

On January 15th the Florida Division of Plant Industry confirmed the presence of rose rosette virus in three Florida counties (Gadsden, Alachua, and Levy). The... [Read more](#)

Congress and Horticulture -...

 The second session of the 113th Congress is now underway. Soon enough, most...

First Report of Rose Rosette Disease...

 On January 15th the Florida Division of Plant Industry confirmed the...

For H-2B Employers, "B" Stands for...

 H-2B is the temporary non-farm visa program many green industry employers...

Federal Regulations on Plant Imports...

 Last spring USDA's Animal and Plant Health Inspection Service (APHIS) began...

AmericanHort News [READ MORE AmericanHort News](#)



LEGISLATIVE

Washington Impact
Congress and Horticulture - AmericanHort's 2014 Agenda
The second session of the 113th Congress is now underway. Soon enough, most attention will turn to the November 4 elections. The midterm elections will decide the fate of all 435... [Read More](#)

Pest & Diseases
[First Report of Rose Rosette Disease in Florida](#)

Washington Impact
[For H-2B Employers, "B" Stands for "Battleground"](#)

Pest & Diseases
[Federal Regulations on Plant Imports are Tightening](#)

Association & Member News
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CHARLIE'S ANGLE

Breaking Down the Shutdown, Debt Ceiling, and What to Expect in the Future

Charlie's Angle
Breaking Down the Shutdown and Debt Ceiling Impacts

Washington Impact
Episode 4: Putting Pressure on the House of Representatives

Washington Impact
Washington Politics: Are You At the Table or On the Menu?

Power Up
Sid Raisch: Are You Selling Stuff or a Solution?

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Regulatory & Legislative Affairs
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Email: JoeB@AmericanHort.org



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Boxwood Blight

The following slides were compiled from presentations and information provided by Dr. Sharon Douglas, Dr. Jim LaMondia, Dr. Bob Marra, Dr. JoAnne Crouch, Dr. Nina Shishkoff, Dr. Kelly Ivors, Dr. Mike Benson, and Ms. Margery Daughtrey.

Photo by Cristi Palmer

Location: Williamsburg, VA

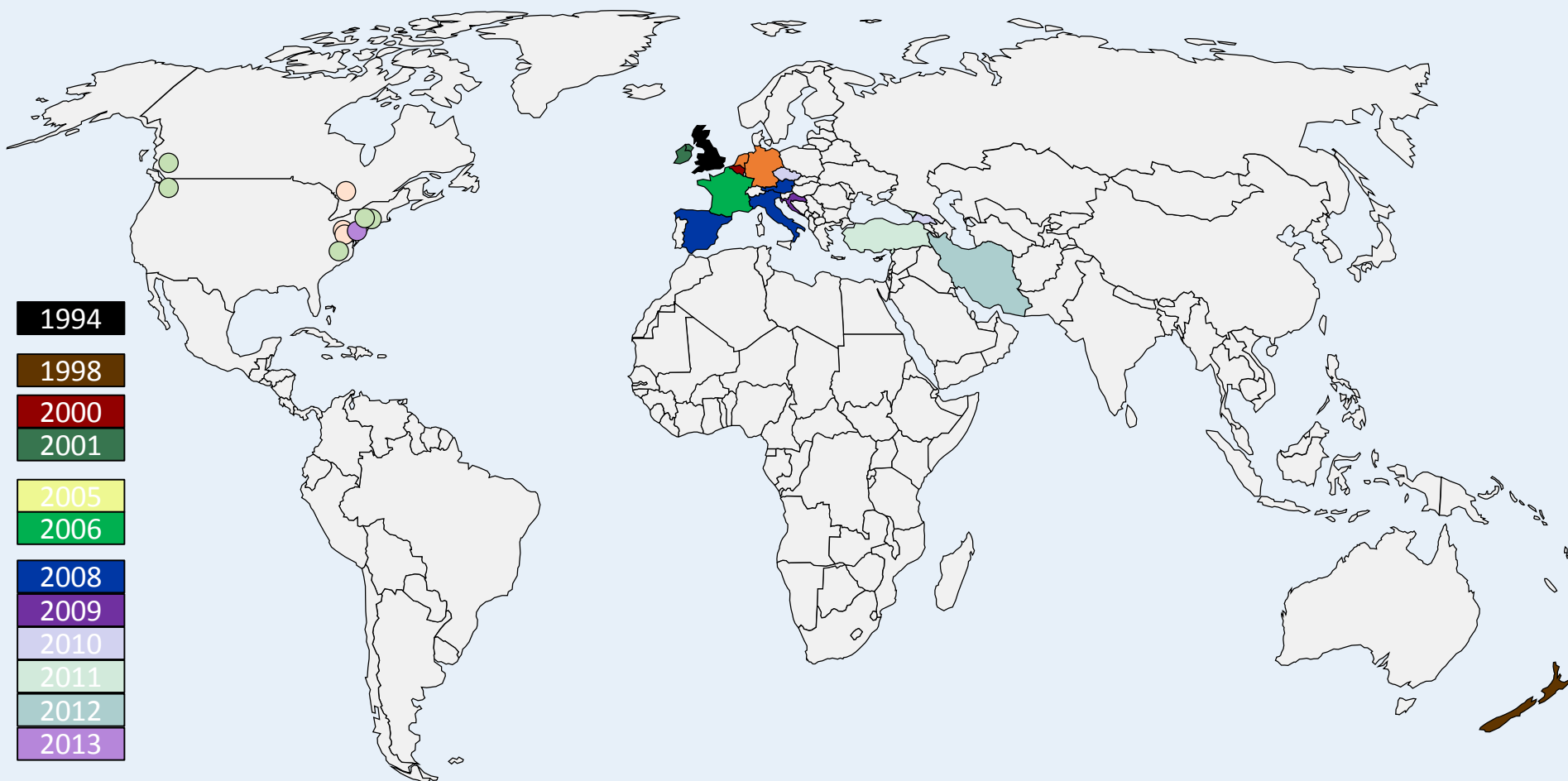
Date: 9/5/2014



Boxwood Blight Disease in the U.S.

- Caused by the fungus *Calonectria pseudonaviculata*
 - also referred to as *Cylindrocladium pseudonaviculata* or *Cylindrocladium buxicola*
- First identified in October 2011
- Current known range in North America
 - NC, CT, MD, VA, RI, MA, OR, NY, PA, DE, and NJ, USA
 - Canada

Temporal Geographic Distribution



World map by www.freeworldmaps.net

Boxwood Blight-Pathogen Biology

- Disease cycle completed in one week
- Temperature range: 41-86°F (optimum 77°F)
- Moisture necessary for infection
- Wound not necessary for infection



Photo by Greg Parra

Boxwood Blight-Pathogen Biology (cont'd)

- How the pathogen spreads:
 - Infected plant material
 - Wind, wind-driven rain, and splashing irrigation water
 - Contaminated equipment, tools, vehicles, and shipping containers
 - Contaminated shoes and clothing
 - Potentially via animals

Boxwood Blight-Pathogen Biology (cont'd)

- Isolated from symptomless plants
- Abundant spores (**conidia**) in a slimy matrix
- Survives in leaves and cankers of infected plants and in leaf debris (fallen, infected leaves)



Photos by Cristi Palmer

Symptoms



Photos by Cristi Palmer

Sporulation on undersurfaces of leaves



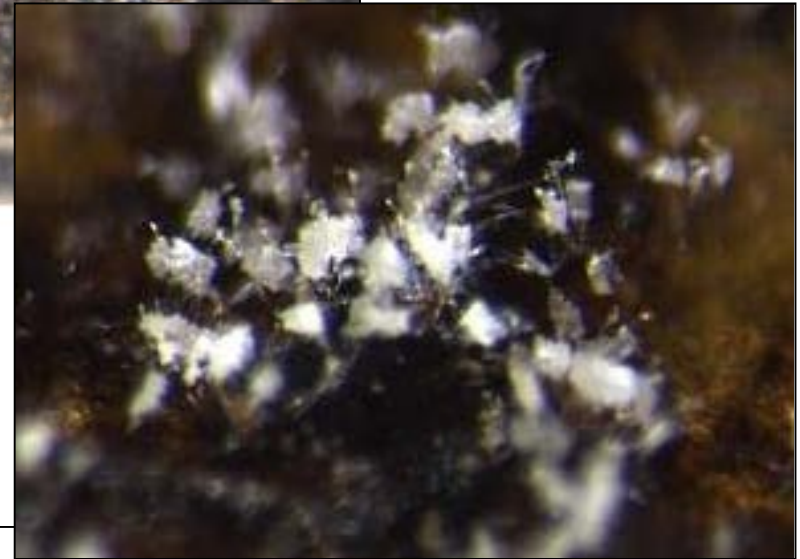
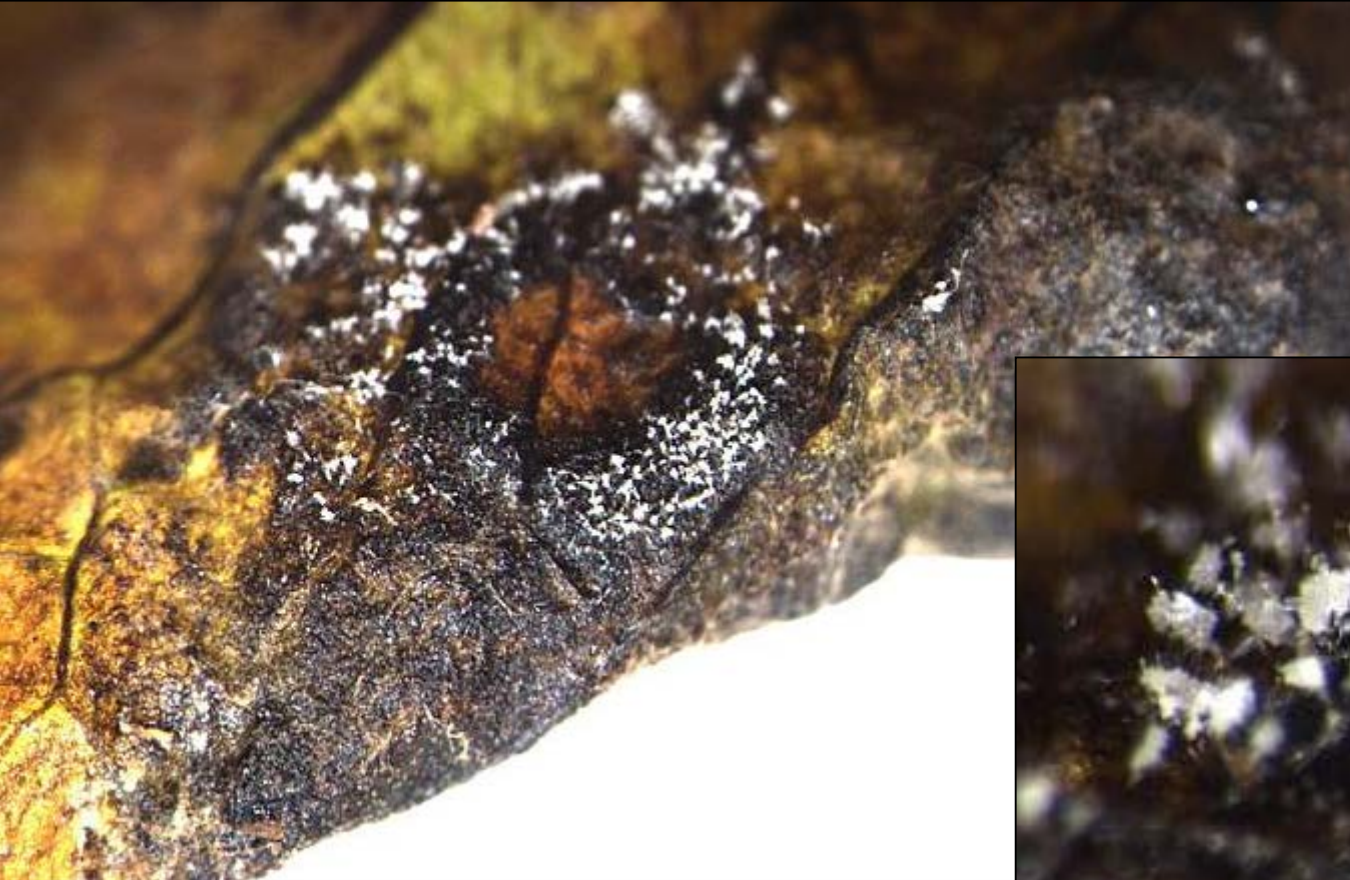
Photo by Sharon Douglas

Spore-producing bodies on stem lesion

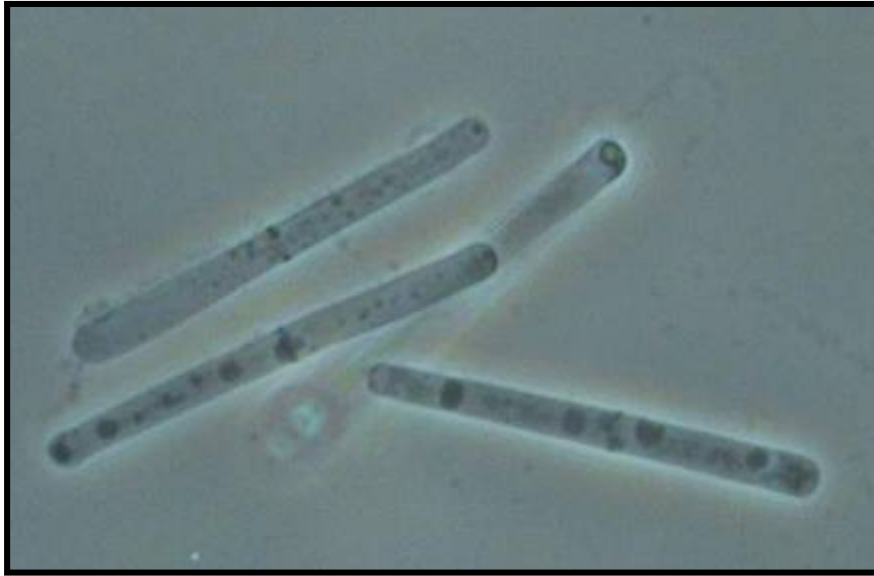


Photo by Sharon Douglas

Sporulation on leaves



Boxwood Blight Fungus



Individual spores

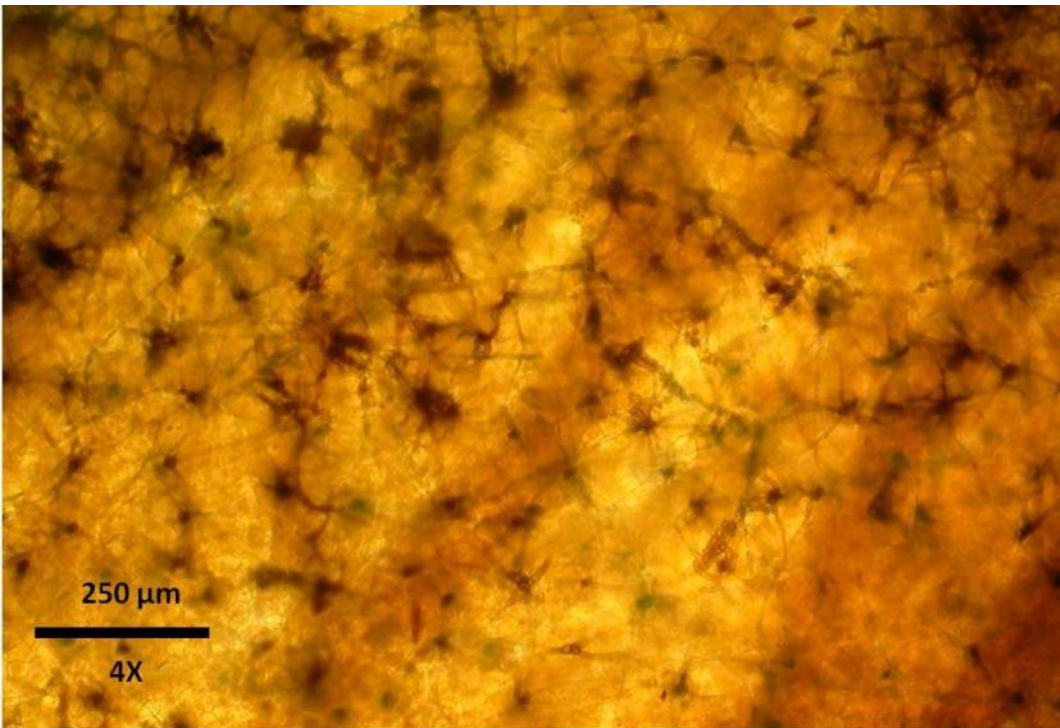
Photos by Sharon Douglas



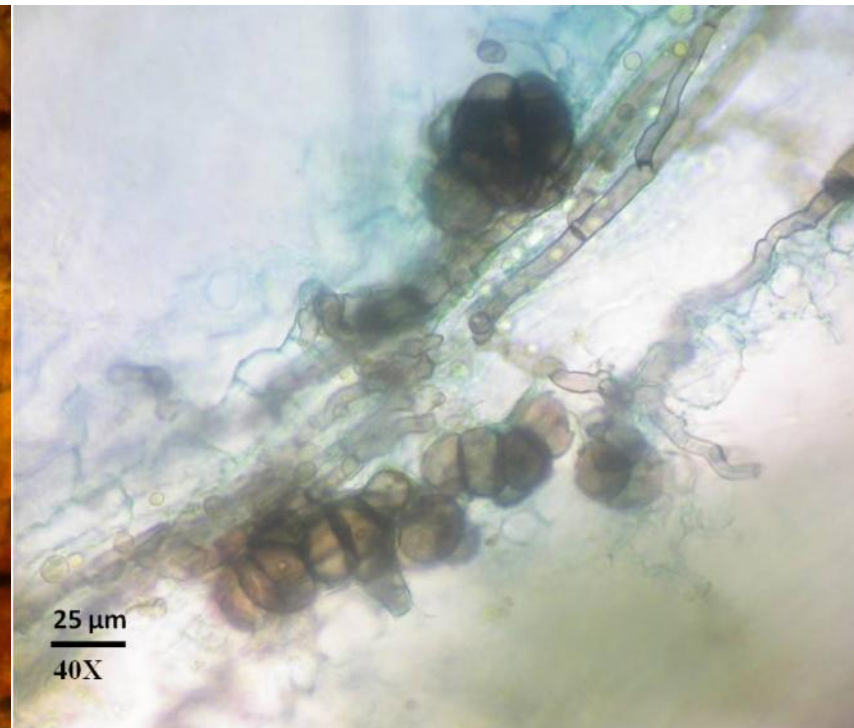
Cluster of spores in a slimy matrix

Microsclerotia: An adaptation for surviving and dispersing in soil

Cylindrocladium microsclerotia in stained and cleared leaf



Closer view of *Cylindrocladium* microsclerotia



Host Range of *C. ps.*

- Boxwood (*Buxus*)
- Japanese Spurge (*Pachysandra*)
- Sweet Box (*Sarcococca*)



Photos by Cristi Palmer



Photo by Jim LaMondia



Buxus cultivar susceptibility to box blight



Other Common Problems on Boxwood



Volutella blight. Photo: K. Ivors, NCSU

Phytophthora Root Rot



Phytophthora root rot (often *P. nicotianae*). Photo: NCSU slide collection

Phytophthora Root Rot



Phytophthora root rot (often *P. nicotianae*).
Photos: PDIC at NCSU

Root Lesion Nematodes



Root lesion nematodes-
Pratylenchus spp. Photo:
NCSU slide collection

Root Lesion Nematodes



Root lesion
nematodes-
Pratylenchus spp.
Photos: PDIC at NCSU

Boxwood Leaf Miner



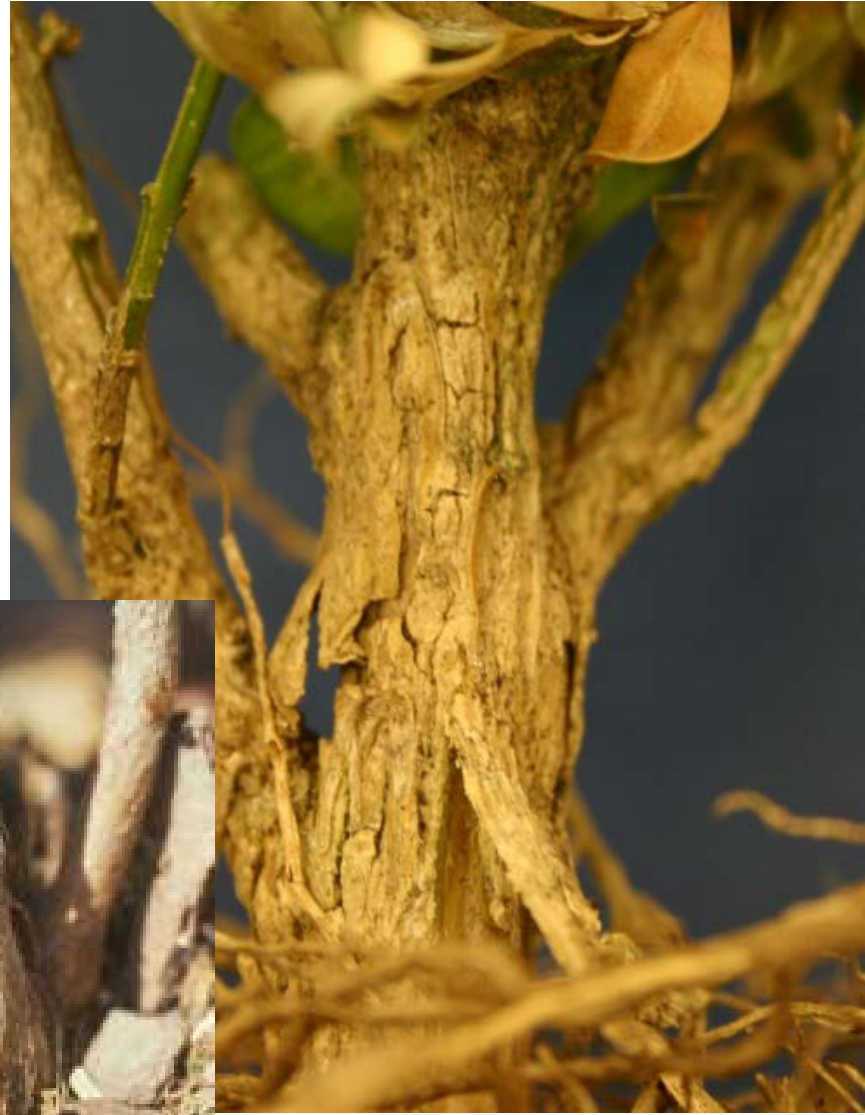
Photo: Dave Stephan, PDIC at NCSU

Undetermined root rot and stress from low pH (3.4)



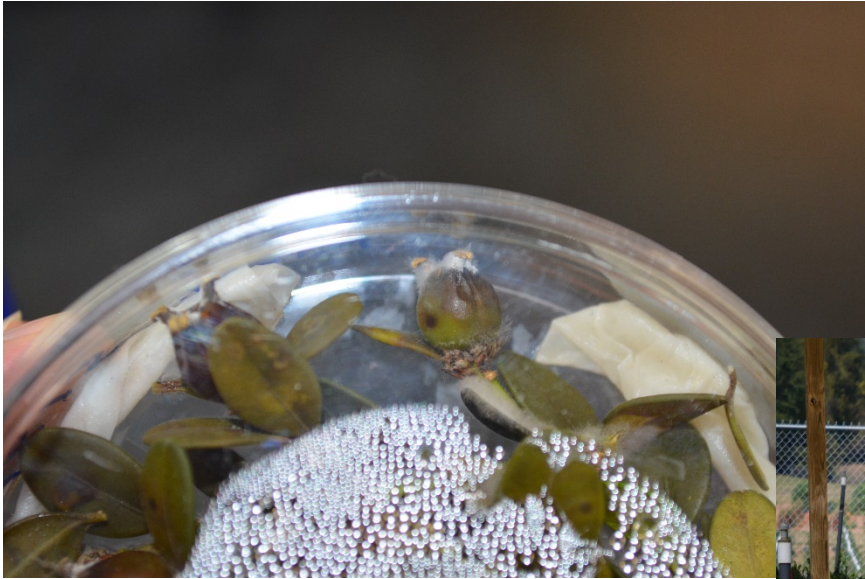
Photo: PDIC at NCSU

Cold Injury



Photos: PDIC at NCSU

Boxwood Blight Efficacy Research



Photos by Cristi Palmer



Fungicides tested for efficacy against *C. ps.*

Active Ingredient	Product Trade Name	FRAC Code
Azoxystrobin	Heritage 50WG, Ortiva 250SC, Amistar	11
Boscalid *	Edura 70WG	7
Boscalid + pyraclostrobin	Pageant 38WG, Signum	7 + 11
Carbendazim *	Delsene 50 Flo	1
Carbendazim + flusilazole *	Harvesan	1 + 3
Chlorothalonil	Daconil WeatherStik, Daconil 54F, Bravo 500	M5
Cyprodinil + fludioxanil	Palladium WG, Switch	9 + 12
Difenconazole + azoxystrobin	Alibi Flora SC	3 + 11
Epoxiconazole + kresoxim-methyl + pyraclostrobin *	Opponent	3 + 11 + 11
Epoxiconazole + pyraclostrobin	Opera	3 + 11
Etridiazole **	Truban 25EC	14
Famoxadone + cymoxanil *	Tanos DF	11 + 27
Fenhexamid *	Elevate 50WG	17
Fludioxonil	Medallion 50WDG	12

* Not available in the U.S.

** Not expected to be efficacious based on MOA & activity on similar fungi

Fungicides tested for efficacy against *C. ps.*

Active Ingredient	Product Trade Name	FRAC Code
Fluoxastrobin + chlorothalonil	Disarm C	11 + M5
Hydrogen peroxide	ZeroTol 2.0	--
Hymexazole **	Technical	32
Iprodione	OHP 26019	2
Kresoxim-methyl *	Cygnus 50WG, Stroby WG	11
Mancozeb	Dithane 75DF, Protect DF, Dithane NeoTec	M3
Mandestrobin *	S2200	11
Mandestrobin + metconazole *	S2200 + Tourney 50WDG	11 + 3
Metconazole	Tourney 50WDG	3
Myclobutanil	Rally 40WP	3
Penconazole *	Fungus Clear	3
Polyoxin D zinc salt	Affirm WDG	19
Potassium phosphite	ProPhyt, Vital	--
Prochloraz *	Mirage 45EC, Scotts Octave	3
Propiconazole	Banner MAXX, Procon-Z 14.3L, Tilt 250EC	3

* Not available in the U.S.

** Not expected to be efficacious based on MOA & activity on similar fungi

Fungicides tested for efficacy against *C. ps.*

Active Ingredient	Product Trade Name	FRAC Code
Propiconazole + chlorothalonil	Concert II	3 + M5
Pyraclostrobin	Insignia SC, Insignia 20WG	11
Quinoxifen **	Quintec 22.58EC	13
Tebuconazole	Torque 3.6SC Torque 38.7SC	3
Thiophanate-methyl	3336 F, 3336 50WP. Cercobin FL	1
Thiophanate-methyl + chlorothalonil	Spectro 90WDG	1 + M5
Tolyfluanid *	Euparen M WG	M6
Triadimefon + trifloxystrobin	Strike Plus 50WDG, Armada 50WDG	3 + 11
Trifloxystrobin	Compass O 50WDG, Flint 50WG	11
Triflumizole	Terraguard, Procure 480SC	3
Triticonazole	Trinity 2SC	3

* Not available in the U.S.

** Not expected to be efficacious based on MOA & activity on similar fungi

Laboratory Efficacy: Conidial Germination & Mycelial Growth



C. ps. Laboratory Efficacy - Conidia

FRAC Mode of Action Group	Active Ingredient	Conidial Germination		
		EC ₅₀ ug/ml Isolate RHS PT25, genotype G1 Henricot, 2008	EC ₈₅ ug/ml Isolate CT-L1, genotype G1 LaMondia, 2014	EC ₁₀₀ ug/ml Brand, 2006
1	Thiophanate-methyl	--	> 50	500
3	Myclobutanil	> 50	> 50	--
3	Propiconazole	--	> 50	>30
3	Tebuconazole	--	> 50	--
3	Triflumizole	--	> 50	--
7 + 11	Boscalid + pyraclostrobin	0.23	0.18	--
9 + 12	Cyprodinil + fludioxanil	-- ^z	0.19	37.5 + 25
11	Azoxystrobin	2.39	4.60	25
11	Kresoxym-methyl	0.07	0.07	--
11	Pyraclostrobin	--	0.11	--
11	Trifloxystrobin	--	0.12	--
12	Fludioxonil	--	0.20	--
14	Etridiazole	--	> 50	--
M3	Mancozeb	0.70	1.26	15 (1.5 was greater than 90% reduction)
M5	Chlorothalonil	0.44	0.33	1 (0.1 was greater than 90% reduction)
M6	Tolyfluanid	--	--	0.1616

C. ps. Laboratory Efficacy - Mycelia

FRAC Mode of Action Group	Active Ingredient	Mycelial Growth		
		EC ₅₀ ug/ml Isolate RHS PT25, genotype G1 Henricot, 2008	EC ₈₅ ug/ml Isolate CT-S1, genotype G1 LaMondia, 2014	EC ₁₀₀ ug/ml Brand, 2006
1	Thiophanate-methyl	--	3.18	5
3	Myclobutanil	0.50	1.21	--
3	Propiconazole	--	0.43	3
3	Tebuconazole	--	0.87	--
3	Triflumizole	--	0.58	--
7 + 11	Boscalid + pyraclostrobin	0.33	6.07	--
9 + 12	Cyprodinil + fludioxanil	--	0.70	> 375 + 250 (37.5 + 25 was greater than 90% reduction)
11	Azoxystrobin	1.65	> 50	> 250
11	Kresoxym-methyl	0.09	1.77	--
11	Pyraclostrobin	--	5.28	--
11	Trifloxystrobin	--	22.7	--
12	Fludioxonil	--	5.88	--
14	Etridiazole	--	> 50	--
M3	Mancozeb	2.70	4.91	1,500
M5	Chlorothalonil	2.48	2.31	> 1,000
M6	Tebuconazole	--	0.43	> 1,616

***C. ps.* Field Efficacy Studies**



Boxwood Blight Preventative Efficacy

FRAC MOA Group	Active Ingredient	Rate (ug ai per ml)	AUDPC (Percent Control)	
			Ivors et al 2012 Preventive	Ivors et al 2013a Preventive
--	Hydrogen peroxide	2,939	-- ^z	2,922.8 (0%) a
--	Potassium phosphite	2,513	--	1,302.9 (54%) c
1	Thiophanate-methyl	598	0.5 (97%) d	254.1 (91%) fghi
1 + M5	Thiophanate-methyl + chlorothalonil	324 + 1,294	0.0 (100%) d	0.2 (99%) i
2	Iprodione	1,197	6.4 (74%) cd	--
3	Metconazole	150	0.9 (96%) d	39.1 (98%) hi
3	Propiconazole	159	12.7 (48%) bc	--
3	Tebuconazole	366	0.5 (97%) d	1.0 (99%) i
3	Triflumizole	651	14.4 (41%) ab	--
3	Triticonazole	206	14.4 (41%) ab	--
3 + 11	Triadimefon + trifloxystrobin	292 + 58	--	47.7 (98%) ghi
3 + M5	Propiconazole + chlorothalonil	1,316 + 99	0.0 (99%) d	15.5 (99%) i
7 + 11	Boscalid + pyraclostrobin	264 + 134	0.7 (97%) d	156.1 (94%) fghi
9 + 12	Cyprodinil + fludioxanil	169 + 113	0.0 (100%) d	209.5 (92%) fghi
11	Azoxystrobin	300	0.4 (98%) d	664.0 (76%) de
11	Pyraclostrobin	150	0.6 (97%) d	322.6 (88%) efghi
11	Trifloxystrobin	75	0.5 (98%) d	116.0 (95%) fghi
11 + M5	Fluoxistrobin + chlorothalonil	25 + 407	0.0 (100%) d	15.6 (99%) i
12	Fludioxonil	150	0.0 (99%) d	32.7 (98%) ghi
19	Polyoxin D zinc salt	68	0.6 (97%) d	1,648.7 (42%) b
M3	Mancozeb	1,920	--	404.8 (85%) efg
M5	Chlorothalonil	1,256	0.0 (100%) d	6.8 (99%) i
	Non-inoculated negative control		--	744.7 (--) d
	Non-treated inoculated control		24.6 (0%) a**	2,876.7 (0%) a

Boxwood Blight Curative & Preventative Efficacy

K. Ivors, NCSU, 2013

Inoculation 1 DAT Preventive/6 DAT Curative,

Treatments applied on 14 d schedule except Zerotol

FRAC MOA Group	Active Ingredient	Rate (ug ai per ml)	AUDPC (Percent Control) Ivors et al 2013b	
			Preventive	Curative
1 + M5	Thiophanate-methyl + chlorothalonil	324 + 1,294	18.3 (99%) e	1,198.0 (37%) c
3	Metconazole	150	502.8 (73%) b	1,239.3 (35%) c
3	Tebuconazole	366	341.8 (82%) bc	1,216.7 (36%) c
3 + 11	Triadimefon + trifloxystrobin	292 + 58	5.4 (99%) e	1,175.5 (38%) c
3 + M5	Propiconazole + chlorothalonil	1,316 + 99	12.8 (99%) e	1,196.3 (37%) c
11 + M5	Fluoxistrobin + chlorothalonil	25 + 407	26.5 (98%) de	1,526.0 (20%) ab
12	Fludioxonil	150	230.4 (87%) cd	1,459.0 (23%) b
M5	Chlorothalonil	1,256	5.4 (99%) e	1,198.0 (37%) c
	Non-inoculated negative control		21.6 (--) de	21.6 (--) de
	Non-treated inoculated control		1,916.8 (0%) a	1,916.8 (0%) a

ZeroTol

Sanidate

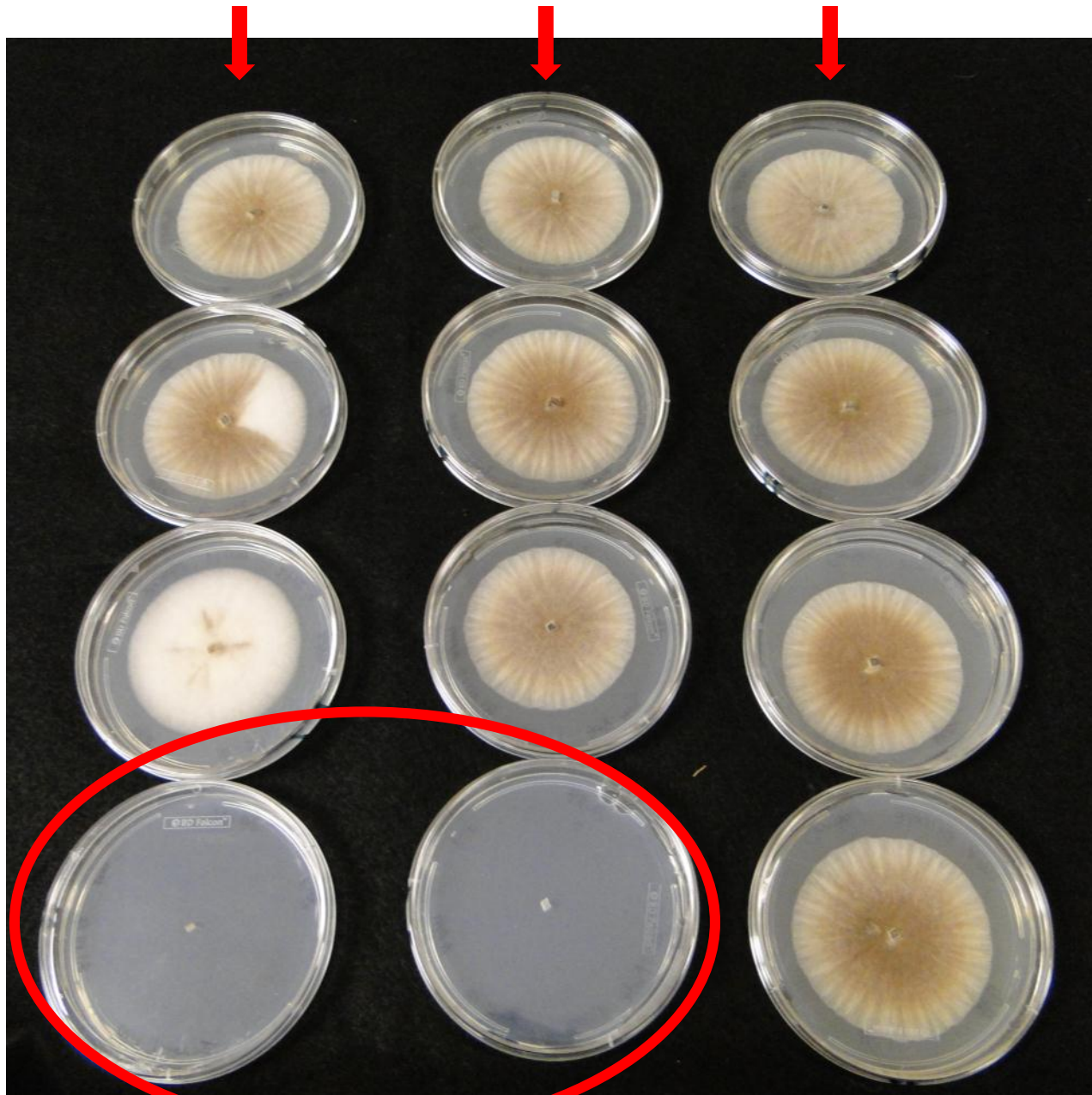
Water Control

1: 10,000

1: 1,000

1: 100

1: 10



Recommendations for Growers:

- Be very careful sourcing new boxwood or pachysandra plants; sequester new plants in one part of the nursery away from existing stock
- Sanitize all trimming tools frequently, especially if you see disease symptoms
 - Quaternary ammonia, chlorox
- Scout both boxwood and pachysandra for symptoms
- If you do find symptoms of boxwood blight:
 - Send samples to Rutgers Diagnostic Clinic for confirmation
 - Do not visit another property with boxwoods until clothes, shoes, etc are cleaned/sanitized
 - Sanitize truck beds and any equipment used to move infected plants
 - Carefully dispose of plants in waste stream, burning, or burying several feet under soil (do not compost)
 - Make sure all litter is removed
 - Treat any remaining plants with preventative fungicides

Recommendations for Landscape:

- Be very careful sourcing and installing new boxwood or pachysandra plants next to existing landscape plantings
- Visit properties with boxwoods later in the day
- Sanitize all trimming tools frequently, especially if you see disease symptoms
 - At the very least, sanitize between properties
 - Quaternary ammonia, chlorox
- Scout both boxwood and pachysandra for symptoms
- If you do find symptoms of boxwood blight:
 - Send samples to Rutgers Diagnostic Clinic for confirmation
 - Do not visit another property with boxwoods until clothes, shoes, etc are cleaned/sanitized
 - Carefully dispose of plants in waste stream, burning, or burying several feet under soil (do not compost)
 - Make sure all litter is removed
 - Replace with other plants with similar characteristics
 - Treat any remaining plants with preventative fungicides

Current and Future Research

- Developing genetic diagnostic tools using loop-mediated isothermal amplification
- Assessing *C. ps.* genetic variability and mating types
- Examining putative biocontrol organisms for impact on *C. ps* infections
- Determining whether fungicides can prevent or delay microsclerotium formation
- Correlating real time rainfall and temperatures with disease incidence and severity to develop a disease forecasting model
- Identifying boxwood species and cultivars at the U.S. National Arboretum with reduced susceptibilities

Resources

- AmericanHorts's website
www.boxwoodblight.org
- Connecticut Ag Experiment Station
- North Carolina State University

Thank you !



Funding for IR-4 Research:

USDA-NIFA

USDA-ARS

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Researchers:

All the fine researchers throughout the US and in cooperating countries



Rethink Tomorrow

Nichino America, Inc.

novozymes®



Growers:

Who donate time to complete the biennial survey and all those plant materials!

IR-4 Personnel:

Michelle Foo

Mika Pringle-

Diane Infante

Tolson

Edith Lurvey

Becky Sisco

Satoru Miyazaki

Ely Vea



Thank you