



Newsletter

(November 2020)

Specialty Crop Research Initiative Project #: 2020-51181-32135



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National Institute
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FEATURED NEWS

Together We Save Boxwood Crops and Plantings

Boxwood blight caused by *Calonectria pseudonaviculata* is an emerging disease that has decimated many boxwood crops in production and historic plantings on both sides of the Atlantic Ocean. This disease was first reported for England and New Zealand in mid and late 1990s, respectively. In the United States, this disease was first observed and confirmed in North Carolina and Connecticut late 2011. As of November 1, 2020, this disease has spread to 28 other states.

To save the nation's #1 evergreen shrub crop and iconic landscape plant from the blight, fourteen transdisciplinary scientists from thirteen labs of seven institutions have teamed up and formed a Boxwood Blight Insight Group (BBIG) with a shared vision and mission – Improving boxwood blight mitigation through innovation, economic analysis and education. The BBIG is sponsored by the USDA Institute of Food and Agriculture – Specialty Crop Research Initiative (SCRI).

The BBIG includes: 1) five USDA Agricultural Research Service (ARS) labs with **Doug Luster** and **Nina Shishkoff** at the Foreign Disease and Weed Science Research Unit in Ft Detrick, MD, **Jerry Weiland** at the Horticultural Crop Research Unit in Corvallis, OR, plus **Fred Gouker** at the Floral and Nursery Plants Research Unit and **Jo Anne Crouch** at the Mycology and Nematology Genetic Diversity and Biology Laboratory, both in Beltsville, MD; 2) two labs each of Cornell University with **Margery Daughtrey** in Riverhead and **Karen Snover-Clift** in Ithaca, NY, and 3) Oregon State University with **Jay Pscheidt** in Corvallis and **Luisa Santamaria** in Aurora, OR; and 4) one representative of Connecticut Agricultural Experiment Station (**James LaMondia**) in Windsor, CT, 5) Tennessee State University (**Fulya Baysal-Gurel**) in McMinnville, TN, and 6) Texas A&M University (**Charlie Hall**) in College Station, TX—with 7) the Virginia Tech lab (**Chuan Hong** and **Ping Kong**) in Virginia Beach, VA leading.

The Research Team, headed by **Luster**, consists of four groups with each having clear targets. Two groups focus on immediate project impacts – preventing blighted plant materials from entering the nursery trade (Group A) and better managing the disease at sites of contamination (Group B). The A Group develops on-site commercial strip kits for pathogen detection (Luster), conducts Oregon nursery surveys (Weiland), bridges several major knowledge gaps in the blight epidemiology - latent infection under Oregon climatic conditions (Weiland), pathogen colonization, latency and phenotypic diversity (Crouch), cultivar and relative humidity impact on pathogen sporulation (Shishkoff), and field epidemiology (Hong), and identifies critical control points at production nurseries (Baysal-Gurel). The B Group evaluates the potential of antidesiccants as a physical barrier for blight mitigation (Hong), further develops biological control agents already identified into final products (Hong), enhances boxwood self-defense through systemic acquired resistance inducers and selective fertilization (Daughtrey), silicon treatment and UV radiation (Gouker), and integrates several recently developed technologies including more resistant cultivars, mulching and disease forecasting into model-directed fungicide protection (LaMondia) —as well as working to prevent less susceptible boxwood cultivars from becoming ‘Trojan horses’, while encouraging their adoption (Shishkoff). Group C aims to build resilience into boxwood production and plantings by developing more resistant boxwood cultivars (Gouker), cataloging boxwood microbiome then devising cultural practices to enhance their crop health and production benefits (Kong), and by consumer perception analysis to facilitate adoption of more resistant cultivars (Hall). Group D makes sure

DELIVERABLES (this quarter)

Research

- 9 Research articles
- 2 Seminars

Extension & Outreach

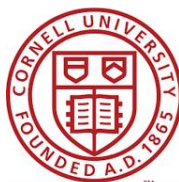
- 3 Field demonstrations
- 3 Webinars/virtual meetings
- 6 Extension presentations
- 1 Citizen science project
- 86 Samples diagnosed
- 215 Email/phone inquiries answered
- 2786 People reached with research publications

Education

- 1 Postdoctoral associate
- 1 Graduate student

Team Featured in Media

- 7 Newsletters
- 1 Multimedia



that all innovations and best management practices (BMPs) developed through this project are economically viable and sustainable by 1) developing baseline production models for both East Coast and West Coast, 2) analyzing cost/benefit of changes in blight mitigation practices, 3) partial budgeting – an economic engineering approach, 4) performing sensitivity tests, 5) determining the economic return of long investment in blight mitigation, and 6) assessing the overall project impact (Hall).

The Extension/Outreach Team, led by **Daughtrey**, also consists of four groups: 1) research translation, 2) technology transfer, 3) impact documentation, and 4) mentoring and training. All researchers are on this Team and they are mandated to translate their data into operational recommendations, protocols, products or practical knowledge. Several scientists carry more extension and outreach responsibilities, with Pscheidt leading multimedia material development, Santamaria leading bilingual material development and communication with Spanish-speaking stakeholders, and Snover-Clift the liaison to several national networks including National Plant Diagnostic Network, National Plant Board, and National Master Gardeners Association for expanded and expedited reach.

Additionally, this project features: 1) extensive collaboration with researchers at home and overseas, and 2) close partnerships with stakeholders as exemplified by the project's Advisory Panel (AP), representing different segments of environmental horticulture industry, public gardens, and the public, and thus serves as a platform for outreach programs of projects sponsored by other federal, state and private institutions while coordinating research and educational programming for max quality, productivity and impacts.

Rapid Diagnostic Kits to Help Combat Boxwood Blight by Xiao Yang and Doug Luster

Early and accurate detection is critical to better management of boxwood blight caused by *Calonectria pseudonaviculata* in the U.S.A., and to prevention of the second blight pathogen species – *Calonectria henricotiae* from entering this country. In the **Luster lab**, Dr. Xiao Yang is developing and testing rapid serological and isothermal amplification-based diagnostic assays for boxwood blight. For the serological approach, initial results from the first set of rabbit antibodies have showed promising results, while the isothermal amplification assays have demonstrated promising specificity and sensitivity in a recombinase polymerase amplification (RPA) assay which requires only a 25-minute amplification step and a 5-minute visualization step. Dr. Yang will further evaluate the specificity and sensitivity of both serological and RPA assays. We will also evaluate different boxwood extraction methods to find the best one to couple with each of the diagnostic assays. The goal is to develop affordable, robust field test kits, enabling growers, retailers, landscapers and gardeners to test their plants on-site when needed and have infected plant materials removed in a timely manner.

RESEARCH UPDATES by Doug Luster

Despite restrictions on staffing levels permitted in university, state and federal facilities, during the pandemic, considerable progress has been made in laboratory and field research during the first quarter of research funding.

Weiland Lab, USDA-ARS, Horticultural Crops Research Laboratory

Oregon Nursery Survey. We sampled 5 nurseries having from 15 to 120 acres in boxwood production, which produce 47,000 to 387,000 boxwood plants.

Latent Infection. Plants of Green Beauty (resistant) and common boxwood (susceptible) were inoculated with *Calonectria pseudonaviculata* spores seasonally from fall 2019 through summer 2020. Little to no disease developed in any season and most inoculated plants remained disease free through November 13, 2020. Disease developed on the new growth of Green Beauty during spring 2020 because those tissues were more succulent.

Baysal-Gurel Lab, Otis L. Floyd Nursery Research Center, Tennessee State University

Critical Control Points. Dr. Baysal-Gurel and PhD student Bhawana Ghimire are working on a comprehensive national list of boxwood nursery growers of varying sizes and also working on a survey questionnaire to determine growers' boxwood production flow; baseline knowledge of boxwood blight disease; and knowledge and practice of boxwood blight best management strategies. The developed survey will be shared with Dr. Charlie Hall to insert questions related to the estimation of the current economic impact of boxwood blight disease and management techniques.

Hong Lab, Hampton Roads Agricultural Research and Extension Center, Virginia Tech

Field Epidemiology. As detailed in the **Collaboration Corner**, we have officially launched joint investigations into the field epidemiology with Dr. Thomas Brand of Landwirtschaftskammer Niedersachsen, Oldenburg, Germany, and Matthew Cromey of the Royal Horticultural Society in Surrey, United Kingdom, using their data sets collected from field trials since 2007 and historic diagnostic records since 1998, respectively.

Antidesiccants. We treated container grown boxwood of four cultivars – Justin Brouwers, Green Beauty, Nana and Winter Gem – with six common antidesiccant products at three concentrations at the Research Center in Virginia Beach, VA in August and did not see any plant injury. One of these products has been used at a historic garden in Virginia while another used on a production nursery for several years, yet no plant injury was observed in either per personal conversation with the garden manager and grower. The treated plants were moved and placed in a field with history of boxwood blight in the western region of North Carolina in early September, to expose them to natural inoculum. We are currently monitoring the disease development on treated and nontreated control plants.

Biological Control. We have been working with Amanda Taylor, Nursery Specialist of North Carolina Cooperative Extension, in identifying a suitable boxwood farm with history of boxwood blight for the field study. We are also developing a Material Transfer Agreement to send biocontrol agents to Dr. Kurt Heungens Lab in the Research Institute for Agriculture, Fisheries and Food in Belgium for a parallel field study in continental Europe.

Microbiome. In addition to recruiting a new postdoctoral microbiome scientist, we secured additional funding from the College of Agricultural and Life Sciences at Virginia Tech (\$16,000) and other sources (\$2,360) to support this project with a state-of-art Data Science Workstation (Dell Precision 7920).

Daughtrey Lab, Cornell University, Long Island Horticultural Research & Extension Center

Self-Defense Enhancements. Treatments with WiltStop (antidesiccant), Vacciplant (SAR inducer), Actigard (SAR inducer), TopBuxus (fertilizer) and chlorothalonil (Daconil) were applied to container-grown boxwood ‘Green Mountain’ in an outdoor hoop house on November 6. Water-sprayed plants served as a non-treated check. Treatments with Daconil, Actigard, and Vacciplant were reapplied on November 20, after which cuttings will be harvested from treated plants and evaluated in the laboratory for their susceptibility to *Calonectria pseudonaviculata*. Inoculations will be done indoors in plastic containers sealed to provide high humidity, with cuttings held in Oasis foam blocks.

LaMondia Lab, Connecticut Agricultural Experiment Station

Tech Integration. We are evaluating environmental factors on the development of boxwood blight. To establish disease and initiate our landscape disease management experiment, we have inoculated and infected boxwoods in field plots. These diseased plants will be defoliated and additional diseased plant residue from plant resistance evaluations will be added to plots in the spring prior to planting new boxwood. This field experiment will be used to evaluate the effects of plant susceptibility, fungicides and mulch on blight development in a landscape replant situation. We have collaborated with boxwood breeders to screen approximately 150 cultivars, lines, or germplasm accessions for boxwood blight resistance.

Gouker Lab, USDA-ARS, Floral and Nursery Plant Research Unit

Resistance Breeding. Controlled crosses have been planned for early spring 2021 and we have initiated discussion with Kim Scheiber and Laura Lara from Star Roses and Plants about coordinating breeding efforts for the upcoming breeding season. Disease screenings for F1 hybrids using detached leaf assays are currently underway and we are also screening accessions from USNA germplasm.

Gene Discovery. We developed a new DNA extraction method for woody plant taxa and tested it using several boxwood species. Results show a 2-hour reduction in total extraction time but with the same quantity and quality as using commercial kits. The procedure will allow us to extract high quality DNA for future genetic studies.

Hall Lab, Department of Horticultural Sciences, Texas A& M University

Benefits of New BMPs. We have initiated 1) the literature search regarding attributes important to consumers when purchasing woody ornamentals, 2) conversations with Team Leaders to discuss the types of economic implications that can be modeled under each objective of the project, 3) the literature search regarding the economic dimensions of disease management in other ornamental crops, 4) data collection regarding the costs of key inputs used during boxwood production, and 5) data collection regarding BMPs of boxwood production practices on the West coast. We will start data collection of East coast practices in the next quarter.

EXTENSION & OUTREACH by Margery Daughtrey

The BBIG Extension team was busy during the first quarter of our SCRI grant. We met virtually August 24 to get organized and plan the newsletter and future coordinated educational offerings. As a result, we have decided to develop more video materials, in a short format and in English and Spanish, and to use BBIG-branded templates in our own PowerPoint presentations and in those posted for the use of other educators. Notably, Baysal-Gurel developed a training video for the TN Small Farms Expo on Boxwood blight disease and management that has had 91 views:

https://www.youtube.com/watch?time_continue=1&v=Xv91WAmYP8s, and Weiland and Pscheidt combined forces to develop a training video on scouting for boxwood blight in the nursery that will be posted soon.

We met with Jennifer Gray and her crew at the Horticultural Research Institute (HRI) on October 2 to discuss how our BBIG educational material can be presented at a distinct location within their website. We already have a draft design and scheme for the site, which is projected to be launched in January 2021. We have also discussed with Jennifer some tentative plans for showcasing boxwood research at AmericanHort's Cultivate'21. Another idea under development is to possibly use the HRI platform for hosting an International Seminar Series on Boxwood Blight.

The Team's extension efforts were of course shifted to virtual delivery owing to the COVID-19 pandemic cancelling most in-person meetings through summer and fall. *Calonectria pseudonaviculata*, however, did NOT stop. In the Northeast, for example, a droughty June, July and August was followed by disease-conducive fall rains. MacArthur Airport, Islip, Long Island, NY reported 2 inches of rain over September 11-12, and an upsurge of boxwood blight positive samples on Long Island followed that rain event. There were 86 samples of boxwood, pachysandra and sarcococca submitted for diagnosis to four labs in NY, TN and VA from September to November, most of them taken from symptomatic boxwood in the landscape. Homeowners, landscapers and arborists were advised on appropriate responses to blight detections. These represent only a portion of the total cases occurring during that time period—Snover-Clift and Daughtrey will be working with the Plant Diagnostic Network in the Northeast (NEPDN) on December 9 to discuss how more comprehensive boxwood blight reporting might be achieved with regional collaboration with diagnosticians.



Socially-distanced presentations were made to Master Gardeners in Painter, VA on November 12 (Hong) and to nurserymen at a field demonstration in Rock Island, TN on October 16 (Baysal-Gurel). Virtual presentations were made to nursery growers and landscapers at the Southern Region Green Industry Webinar hosted by the UGA Center for Urban Ag on November 12 (Baysal-Gurel); to nursery growers in South Carolina (Daughtrey in collaboration with Steve Jeffers, Clemson) at a Virtual IPM Symposium on October 22; to landscape gardeners on Long Island at a seminar sponsored by Cornell Cooperative Extension on October 14, to tree stewards in Dutchess Co., NY on October 9, to the Horticultural Alliance of the Hamptons on November 8, and to the members of the New York State Arborists Association on November 6 (Daughtrey).

PROJECT MEETING BRIEF

In addition to the Extension/Outreach meetings reported above, five project-wide meetings were held within the BBIG for further planning and ironing out details. The first quarterly project meeting was November 18.

Three project initiation meetings were held virtually via Zoom.

- June 29 – All Project Directors (PDs) and AP members met, to get to know one another and revisit the project goals, objectives, approaches, activities, anticipated deliverables and applications.
- July 13 – All PDs met to 1) introduce associates, 2) digest comments from the review panel and peer reviewers, 3) update proposed activities, and 4) further brainstorm on project strategies and methodology. Other topics included: 5) project logo and newsletter name, 6) addition of Citizen Science Projects to the SCRI project, and 7) project management tools – selecting Microsoft Teams for project management.
- July 22 – All PDs and AP members met again to 1) nominate and elect the AP chair - Dr. Jill Calabro was elected, 2) get AP feedback on proposed project activities, approach and management, 3) review five major proposals on project logo and 23 proposals on newsletter name, etc. The final winners were selected via follow-up Qualtrics surveys for both project logo and newsletter name.

Two meetings were held late July on Microsoft Teams via the Teams.

- July 20 – A training session on Microsoft Teams was conducted by Paige Ghra, Program Coordinator of Collaborative Computing Solutions at Virginia Tech for PDs and their associates as well as some Advisory Panel members as desired – very informative and practical, all participants got a jump start!
- July 27 – A follow-up meeting was held to discuss Teams/Channel structures for efficient internal communication and project management – we elected to have six Teams with one per objective and within each of these Teams one channel per subobjective. Also elected to have a general Team for project-wide matters.

First quarterly project-wide meeting– reviewing project progress, moderated by Luster on November 18,

- Keynote speaker – Drs. Xiao Yang/Doug Luster on development of diagnostic tools

- Teams highlighted major progress
- Open discussion – Template proposals for Word documents and PowerPoint presentations as well as an update on the BBIG Newsletter's format and contents.

NEW TEAM MEMBER



Dr. Xiaoping Li recently joined the SCRI Project Team as a Post-doctoral Microbiome Scientist at Virginia Tech's Hampton Roads Agricultural Research and Extension Center in Virginia Beach, VA. Xiaoping received a doctoral degree in biology from New Mexico State University in 2016. His graduate research was focused on characterization of a putative transcription regulator, CpVIB-1, mediating vegetative incompatibility in the chestnut blight fungus *Cryphonectria parasitica*. Prior to coming to Virginia Tech, he worked as a postdoctoral associate at Oregon State University, investigating the potato soil microbiome under different cultural management practices including soil fumigation.

Dr. Li's major focus on this project is to work with team members and collaborators to collect boxwood samples from different states and times of year, then use the latest DNA sequencing technology and the newest bioinformatics pipelines to determine their microbiome, better understand its roles in relation to boxwood blight, then devise cultural practices to enhance boxwood health and production benefits.

COLLABORATION CORNER

Horticultural Research Institute has been working with the Project Team in developing an outreach website – The Boxwood Blight Insight Group (BBIG) – for the project. The website is undergoing an internal review and will be released to the public soon. Major tabs of this site include: Project Vision & Mission, Objectives and Approach, Teams & Partners, Knowledge Center, Research Updates and a Calendar of Events to keep stakeholders informed and engaged in this important project. This outreach website will be hosted at HRI for continuing updates, maintenance and impacts beyond this project period.

Dr. Thomas Brand, Department Head of Landwirtschaftskammer Niedersachsen, Oldenburg, Germany, compiled a list of field trials that he and his colleagues have performed since 2007 to evaluate boxwood cultivars, fungicides and other control strategies, and shared it with the Field Epidemiology team. He also sorted through seven data sets of fungicide evaluation and one from a cultivar trial, and shared them through Microsoft Teams. Both teams are currently charting strategies for analyzing these data to better understand the epidemiology of this blight disease under northern Germany conditions.

Dr. Matthew Cromey, Principal Plant Pathologist at the Royal Horticultural Society in Surrey, United Kingdom (UK), has been working with the Field Epidemiology team in looking into the relationship between boxwood blight and weather in the UK gardens since 1998.

Dr. Matthew Taylor, Research and Conservation Director at Longwood Gardens in Kennett Square, PA worked with the Virginia Tech team and successfully established a local protocol to monitor the blight pathogen in soil at sites of contamination.

RECENT PUBLICATIONS

Striving to advance boxwood blight science and make innovations in disease mitigation, here PDs report on their latest research in plain English while providing details on individual publications and links to those set for open access.

Castroagudin, V.L., Yang, X., Daughtrey, M.L., Luster, D.G., Pscheidt, J.W., Weiland, J.E., and Crouch, J.A. 2020.

Boxwood blight disease: A diagnostic guide. Plant Health Progress 21:291-300.

Boxwood plants worldwide are threatened by a deadly fungal disease known as boxwood blight. Accurate diagnosis of boxwood blight is one of the best ways to reduce spread and reduce damage, but differences in symptoms or sometimes the lack of symptoms can make disease diagnosis difficult. To address this challenge, scientists from the USDA-ARS,

Cornell University and Oregon State University developed a guide for diagnosis of boxwood blight. This guide provides up-to-date information on how to diagnose and identify boxwood blight. It also offers an overview of methods used to isolate the fungus from infected plants, how to store fungal cultures and how to evaluate pathogenicity of the fungi that cause the disease. A free copy of the boxwood blight diagnostic guide can be downloaded at <https://doi.org/10.1094/PHP-06-20-0053-DG>.

Castroagudin, V.L., Weiland, J.E., Baysal-Gurel, F., Cubeta, M.A., Daughtrey, M.L., Ward Gauthier, N., LaMondia, J., Luster, D.G., Peduto Hand, F., Shishkoff, N., Williams-Woodward, J., Yang, X., LeBlanc, N., and Crouch, J.A. 2020. **One clonal lineage of *Calonectria pseudonaviculata* is primarily responsible for the boxwood blight epidemic in the United States.** *Phytopathology* 110:1845-1853.

Boxwood plants worldwide are threatened by boxwood blight. Early U.S. outbreaks of the disease (2011-2013) were previously characterized based on the DNA profiles of the blight fungi at several outbreak sites. However, the DNA profiles of the blight fungi as the disease expanded its range across the U.S. were unknown. Therefore, a nationwide research collaboration led by scientists at the USDA-ARS isolated 218 new samples of the boxwood blight fungus from disease outbreaks across the U.S. since 2014 and typed the fungi using custom DNA markers called simple sequence repeats. The study showed that just one major DNA type is responsible for the majority of U.S. boxwood blight outbreaks, although individuals from a second major DNA type are also present at low frequency. The U.S. blight population is significantly differentiated from the population of blight fungi in Europe. The research also showed that the boxwood blight fungi are multiplying in the U.S. by making clones of themselves, but new DNA types have also evolved from the original DNA types since their first introduction in 2011. This publication was selected by the journal's Editor in Chief as his "Editor's Pick" for the November issue of *Phytopathology*.

Gouker, F.E., Guo, Y., and Pooler, M.R. 2020. **Using acetone for rapid PCR-amplifiable DNA extraction from recalcitrant woody plant taxa.** *Applications in Plant Sciences* (In Press).

Research labs, botanic gardens, and arboreta that work on woody plant breeding, genetics, and conservation projects, often require extraction of DNA from hundreds if not thousands of samples, which requires a DNA extraction protocol that is effective across many plant species regardless of sample collection and storage conditions (for example, fresh, frozen, freeze-dried). Some current methods rely on a modification of protocols from commercial extraction kits or use additional chemicals which adds additional costs. This paper reports a new protocol that provides a low-cost and rapid alternative to extract DNA with yield and quality that are suitable for downstream genetic applications using fresh, frozen, oven-dried, or herbarium tissue samples across 16 plant families ranging from boxwood to oak to hemlock trees.

Hall, C.R., Hodges, A.W., Khachatryan, H., and Palma, M.A. 2020. **Economic Contributions of the Green Industry in the United States in 2018.** *Journal of Environmental Horticulture* 38(3):73–79.

The economic contributions of the green industry in the United States were estimated for 2018 using information on industry employment and wages, and economic multipliers from a U.S. IMPLAN economic model. Direct industry output for all sectors was estimated at \$159.57 billion (B), and total output contributions, including indirect and induced regional economic multiplier effects of export sales, were \$348.08 B. The total value-added contribution to the Gross Domestic Product (GDP) was \$190.98 B, including labor income contributions of \$121.55 B, other property income contributions of \$16.01 B and business taxes paid to local, state and federal governments of \$25.84 B. The industry had direct employment of 1,599,662 fulltime and part-time individuals, and total employment contributions of 2,315,357 jobs in the broader economy. The largest individual industry sectors in terms of employment and GDP contributions were landscaping and horticultural services (1,460,669 jobs, \$221.89 B), greenhouse, nursery and floriculture production (217,574 jobs, \$28.69 B), and lawn and garden equipment and supplies stores (292,614 jobs, \$43.80 B). The top ten states in terms of employment contributions were California (264,913 jobs), Florida (203,482), Texas (161,151), Ohio (90,406), Pennsylvania (90,075), New York (90,266), Illinois (87,595), North Carolina (78,766), Michigan (77,719), and Georgia (66,527). Since 2013, green industry contributions in 2018 increased by 16.2% for employment and 17.3% for GDP in inflation-adjusted terms. Growth in the industry was highest for wholesale and retail trade, while production and manufacturing declined. Although the green industry has grown slowly in recent years, it remains an important contributor to national, state and local economies. A full report of this open access article may be downloaded from <https://doi.org/10.24266/0738-2898-38.3.73>

Hall, C.R., and Knuth, M. 2020. **An update of the literature supporting the well-being benefits of plants: Part 4 Available resources and usage of plant benefits information.** *Journal of Environmental Horticulture* 38(2):68–72.

This paper provides an overview of the key resources available to green industry firms that provide evidence of the health and well-being benefits associated with plants and improved landscaped areas and how they influence the physiological, psychological, cognitive, and social well-being constructs affecting quality of life. These benefits may persuade reluctant residential homeowners to purchase plants and improve their landscapes, may aid municipal leaders

and policymakers in justifying green infrastructure-related funding decisions, and may provide grounds for the construction industry for using biophilic design principles to ensure the built environment offers opportunities for green space interactions. In this way, the green industry can play a pivotal role not only in providing plants of high quality for these applications, but in educating stakeholders regarding the benefits discussed herein. This research should also be strategically incorporated into both industry-wide and firm-specific marketing messages that highlight the quality-of-life value proposition in order to maintain the industry's sense of value and relevance to residential landscape consumers of the future. If done correctly, the demand for green industry products and services may be affected positively. A full report of this open access article may be downloaded from <https://doi.org/10.24266/0738-2898-38.2.68>.

LaMondia, J.A. 2020. **Curative fungicide activity against *Calonectria pseudonaviculata*, the boxwood blight pathogen.** Journal of Environmental Horticulture 38(2):44–49.

Boxwood blight caused by the fungal pathogen *Calonectria pseudonaviculata* has been a destructive disease affecting boxwood nursery production and valuable landscape plantings. Management of the disease has been heavily dependent on sanitation and protection with a number of fungicides. While pretreatment with fungicides is most efficacious against the boxwood blight pathogen, infectious periods may occur almost continuously over a long wet period and environmental conditions may limit the ability to apply protectant fungicides prior to infection. In both whole plant and detached leaf experiments we demonstrated that fungicides in FRAC groups 3 and 7 had curative post-infection activity up to 48 hours after inoculation. In those instances, the reduced incidence, lesion size and inhibition of sporulation demonstrated by post-infection treatment with propiconazole, fluxapyroxad and benzovindiflupyr fungicides should combine to slow the development of disease and significantly reduce epidemic development, aiding boxwood blight management. A full report of this open access article may be downloaded from <https://doi.org/10.24266/0738-2898-38.2.44>.

LaMondia J.A., and Maurer, K. 2020. ***Calonectria pseudonaviculata* conidia dispersal and implications for boxwood blight management.** Plant Health Progress 21:232-237.

This is the first direct demonstration that spores of the boxwood blight pathogen *C. pseudonaviculata* were not released and not wind dispersed by winds as high as 44 mph directed across leaves covered with spores. The sticky spores were only moved from infected leaves after they were detached and moved by rain, rain splash or irrigation water. A fine mist was not enough to either detach spores or move them. If water drops containing the sticky spores dry, spores will likely remain attached to a surface and not be wind distributed, even after re-wetting. In the absence of other means of spread such as moving infected boxwood, movement of infected plant parts like diseased leaves, contact distribution while shearing/pruning, physical movement by contact with animals or by other means, models of rain intensity on splash dispersal of spores can be developed and used to estimate water splash distances to aid with management decisions. We determined that most defoliated boxwood leaves in our experiments had the bottom of the leaf (where spores are produced) facing up. The curved surface of leaves in that orientation may aid in retention of water films to wet and release spores and further, contribute to splash dispersal biomechanics. This is consistent with observations of increased disease severity in lower boxwood canopies and suggestions for best management practices that include mulching and pruning lower branches of plants to reduce infection.

LeBlanc, N.R., Cubeta, M., Crouch, J.A. 2020. **Population genomics trace clonal diversification and intercontinental migration of an emerging fungal pathogen of boxwood.** Phytopathology at <https://doi.org/10.1094/PHYTO-06-20-0219-FI>.

Boxwood blight was first reported in Europe in the 1990s, prior to its recent colonization of North America, where it continues to have significant negative impacts on the ornamental horticulture industry. Due to near genetic uniformity in the fungi that cause the disease, understanding of historical disease emergence and ability to predict future outbreaks is limited. Because the boxwood blight pathogens have such similar DNA profiles, standard approaches to track their movement and predict new disease outbreaks are not always effective. Therefore, scientists at the USDA-ARS and North Carolina State University used a new strategy called population genomics, with the entire genome of DNA sequenced and analyzed from a large global sample of the boxwood blight pathogens. Using this population genomics approach, more than 2,000 differences in the pathogen's DNA were discovered, which is a significant increase from previous methods, where less than two dozen DNA differences were known. From these new DNA data, scientists learned that four different genetic groups of the pathogen are present worldwide: two groups with limited geographic distribution and two groups found globally including in the U.S. The two DNA groups currently found in the U.S. came from different sources: one from Europe and the other from a still unknown source. This research is important because it shows how spread of the blight fungus has occurred and suggests how it will continue to move in the U.S. and globally. Evidence for multiple introductions of this disease into the U.S. and intercontinental migration indicates that future introductions are likely to occur and should be considered in quarantine regulation.

Sacher, G.O., Weiland, J.E., Putnam, M.L., Crouch, J.A., and Castroagudin, V.L. 2020. **Confirmation of *Calonectria pseudonaviculata* causing boxwood blight of *Buxus* cultivars in Oregon.** Plant Disease 104:1862.

Boxwood blight threatens the Oregon nursery industry. This report confirms that the pathogen causing boxwood blight is still present in Oregon nurseries and in public parks and at private residences, eight years after it was originally discovered.

PROJECT DIRECTORS

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