

Project No. and Title:

NCERA 224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes, <https://nimss.org/projects/18875>

Year: 2024

Name: Vera Krischik, Chair, Moderator of the meeting, organized annual report

State: Minnesota

University and complete mailing address: 1980 Folwell Ave #219, Saint Paul, MN 55108

Phone number: 612.625.7044

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Period Covered: 10/01/2024 to 09/30/2025

Date of Report: December 21 2024

2024 meeting location: October 21 2024 NC State University, Department of Plant Pathology and Entomology, Raleigh, NC

2025 meeting location: December 8, 2025, Syngenta Vero Beach Research Center, Vero Beach, Florida

Summary

Currently in the Midwest we have one landscape and nursery oriented group, NCERA 224 "IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes", which is composed of mostly university extension and researchers in entomology and plant pathology. Learn more at NIMSS website <https://nimss.org/projects/18875>

We met October 21 2024 at North Carolina State University before the biannual IPM workshop. Below is the agenda for the meeting and the members. The state report are at the end.

On NIMMS site as approved (A) status, 14 members

- *Karla Adesso <kaddesso@tnstate.edu>
- *Janna LBeckerman<jbeckerm@purdue.edu>
- *Enrico Bonello <bonello.2@osu.edu>
- *Kyle Broderick <kbroderick2@unl.edu>
- *Gary Chastagner<chastag@wsu.edu>
- *LauraJesse<ljesse@iastate.edu>
- *William Kilingemn<wklingem@utk.edu>
- *Vera Krischik<krisc001@umn.edu>
- *Brian Kunkel <bakunkel@udel.edu>
- *Jill Pollok <jillp@udel.edu>
- *Ada Szczepaniec<A.Szczepaniec@colostate.edu>

*V. Joseph Shimat, svjoseph@uga.edu

*Chelsea Harbach, charbach@iastate.edu

*Zee Ahmed mahmed2@clermson.edu

New members not yet posted at NIMSS

Midhula Gireesh mgireesh@tennessee.edu

Other members, please contact Christima Hamilton to become an approved member

David Held <dwh0004@auburn.edu>

Rodriguez-Salamanca, Lina linar@vt.edu

Steven D. Frank <sdfrank@ncsu.edu>

Takoda <evcampoverde@ufl.edu>

Carmen Medina-Mora <mls.lab.forestpathmsu@gmail.com>

Adam GDale <agdale@ufl.edu>

Raymond Cloyd <rcloyd@ksu.edu>

Agenda for October 21 2024 at NC State University in Raleigh, NC

Confirmed in-person

Dr. Jose Shibu* new Administrator

Dr. Zee Ahmed* new member

Dr. Midhula Gireesh* new member

Dr. Gary Chastagner

Dr. Enrico Bonello

Dr. Kyle Broderick

Dr. Jill Pollok

Dr. Vera Krischik

is the chair and moderator on zoom, 651.675.7434, krisc001@umn.edu

I have a knee operation Oct 28. I have trouble walking, so I have decided not to attend in-person.

Dr. Enrico Bonello is the site host for issues, 614.395.3550, bonello.2@osu.edu

October 20, Sunday, arrive,

Marriott Aloft hotel, 2100 Hillsborough St, Raleigh, NC 27607,

919.828.9900, near NCSU North Hall

Meet in the lobby at 6pm group for group dinner, I donot know who will be there.

NCERA224 Dates:

12/21/2024: annual report due

NIMSS (see #7 here for guidance <https://www.aginnovationnc.org/multistate-handbook>)

9/15/2026: Deadline to let Chris know if you wish to renew - earlier is fine too, I can set up the blank template in NIMSS for NCERA_ temp224 any time in 2026 (renewal instructions and deadlines: <https://www.aginnovationnc.org/new-renewal-nc-project-instructions>)

10/15/2026: NCERA224 renewal proposal objectives due (soft deadline)

12/1/2026: FIRM deadline to submit renewal to NIMSS in its entirety	
October 21, Monday, NCERA 224 meeting Email all state reports in new template to Vera Krischik at krisch001@umn.edu Bring the state report and handouts (8 copies) and a travel drive with your ppt and state report	
7	Breakfast on your own; from the Aloft hotel coffee bar Coffee and light snacks at the meeting Walk to Gardner Hall, see map below
8:45	Start meeting and open zoom link Vera A Krischik is inviting you to a scheduled Zoom meeting. Topic: NCERA 224 Oct 21, 2024 NCSU Time: Oct 21, 2024 09:00 AM Eastern Time (US and Canada) Join Zoom Meeting https://umn.zoom.us/j/6969374363?omn=91318780660 Meeting ID: 696 937 4363 Passcode: zoom2023
	WARNING, NCSU is a large campus and the ENTOPP Department is spread out among several buildings. NCERA 224 meets in 2321 Gardner Hall, room code 27443, 100 Derieux Place, Raleigh, NC 27607, see the attached campus map Our host in Gardner Hall is Dr. Steve Franks, sdfrank@ncsu.edu , 919.515.8880 The Gardner Hall IT person is Brian Cody, bracody@ncsu.edu , 919.515.2307 Panera bread catering, Jeffrey, 919.783.5338 will deliver coffee and light snacks at 8:45am to room 2321 Gardner Hall. Registration fee = \$50 (\$300/6) cover costs. The ENTOPP office is in another building, but I informed the office manager of our meeting, in case someone gets lost, Liz Jerger, liz_jerger@ncsu.edu , 919.515.2730
9:15	In-person Remarks by Administrator, Dr. Dean Jose Shibu, Associate Dean for Research Director, MO Agricultural Experiment Station University Missouri, joses@missouri.edu
9:45	Zoom Remarks by USDA National Program Leader, Dr. Emmanuel Byamukama, NIFAupdate, Emmanuel.Byamukama@usda.gov
10 to 12	State Reports start, 20mins/member, potentially 4 reports
12 to 1	Lunch on your own
1:30 to 3	State Reports, 20mins/member, potentially 4reports
3	Discuss new information needed on the annual report, joint projects, update 2004 IPM manual, update websites
3	For the 2025 meeting, suggestion is to meet at the Aug 2-5, 2025 at the 2025 APS meeting in Honolulu, Hawaii; NCERA should organize a symposium; schedule a visit to the USDA research stations on resistance management
5	Adjourn

7	Meet in the lobby at 7pm group for group dinner, I donot know who will be there.
October 22 to 24, Tuesday to Thursday afternoon	
	<p>2024 Ornamental Workshop Program at https://ecoipm.org/ornamental-workshop/program/ J.C. Raulston Arboretum Raleigh, NC https://jcra.ncsu.edu/4415 Beryl Rd. Raleigh, NC 27606 Hosted by Department of Entomology and Plant Pathology North Carolina State University https://cals.ncsu.edu/entomology-and-plant-pathology/about/contact/ Register for the workshop at https://ecoipm.org/ornamental-workshop/</p>

Suggestions for NCERA 224 cooperative research or outreach program:

Currently in the Midwest we have one landscape and nursery oriented group, NCERA 224 "IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes" that is composed of mostly university extension and researchers in entomology and plant pathology. Learn more at NIMSS website <https://nimss.org/projects/18875>

Our goals are through collaboration on an educational manual, website, courses, workshops, and field days, we will increase ornamental plant IPM knowledge and adoption and pollinator protection.

In the Midwest, we need educational materials to train nursery and landscape managers in the principles of ornamental IPM that are crucial to reducing pesticide use and protecting non-target pollinators and beneficial insects. The Fish and Wildlife Service identifies pesticide use in urban areas as a key factor in the decline of Rusty-Patched Bumblebee and Monarch butterflies. Practitioners need training in bee friendly IPM and endangered species management IPM programs, as this information is on all new pesticide labels and managers do not know what they can do for endangered species and pollinator protection.

The NCERA 224 group collaborated in 2017 with the National elm trials https://en.wikipedia.org/wiki/National_Elm_Trial

At the National USDA eXtension website, we have an online course with slide shows, tests, and IPM certificate called "Managing invasive species in landscapes" <https://campus.extension.org/enrol/index.php?id=1245>

In 2024 we published the 2004 published the Midwest IPM manual <https://pesticidecert.cfans.umn.edu/ipm-midwest-landscapes-navigate-hit-back-button-do-not-hit-x-top> with specific IPM tactics and life-history information for over 160 pests, as well as pesticides and biocontrol information that needs to be updated with new invasive pests, new EPA registered insecticides compatible with biocontrol, and bee friendly IPM management. Members will rewrite the introductory chapters. We will add new invasive pest PIP (Pest information profiles).

Work for the National Nursery and Landscape Association on a needs survey that will be published in each state. From this information update the online IPM manual and the 3 online courses.

Cooperate and host an online course that is already completed at MN on IPM in Greenhouses with biocontrol agent and pollinator protection. This online course tells greenhouse and nursery growers how to grow plants without insecticides that can kill pollinators and how to use biocontrol to reduce pesticide use. Vera Krischik at MN created a “Landscape, nursery, greenhouse IPM” at <https://pesticidecert.cfans.umn.edu/classes-workshops/greenhouse-ipm-online-workshop-certification-commodity-group-educational-credit>

There is an accompanying online resource manual on Greenhouse IPM, biocontrol, and pests at <https://pesticidecert.cfans.umn.edu/greenhouse-ipm>

2024 NCERA 224 State Reports

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Minnesota

Project No. and Title:

NCERA 224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes, <https://nimss.org/projects/18875>

Year: 2024

Name: Vera Krischik

State: MN

University and complete mailing address: 1980 Folwell Ave #219, St Paul, MN 55108

Phone number: 612.625.7044

Email: krisc001@umn.edu

Period Covered: 10/01/2024 to 09/31/2025

Date of Report: Dec 2 2024

In attendance: Oct 20-21, 2024 at North Carolina State University in the Department of Plant Pathology and Entomology, chair and moderator

Suggestions for NCERA 224 cooperative research or outreach program:

1. Update online NCERA 224 online manual
2. Perform Nursery Landscape Greenhouse Industry commodity survey

3. Create Midwest website with updated IPM manual and 3 courses
4. Already completed course 1: Offer online IPM, Biocontrol, and Pollinator Conservation IPM course
5. Course 2: Offer online Landscape IPM course
6. Course 3: Offer online Pollinator Conservation course

2025 meeting location: December 8, 2025, Syngenta Vero Beach Research Center, Vero Beach, Florida

Brief summary: The proposed research and outreach program is to establish a biocontrol program to manage the invasive, exotic Japanese beetle to reduce insecticide use in bee lawns and parks.

Impacts:

Our proposed solution is to reduce economic and environmental damage caused by the exotic JB through two approaches: one short term and one long term.

For long term, we will survey Minnesota for the presence of Japanese beetles and their possible infection by a beneficial pathogen called *Ovavesicula popilliae*. This pathogen was first described in Connecticut and infects JB tubules and spreads systemically (Andreadis and Hanula 1987). Research shows the fungus kills 25 to 50 percent of JB grubs. After obtaining approval from the Minnesota Department of Agriculture and the US EPA, we propose to establish this fungus statewide using a nursey system to supply volunteers from various organizations like Master Gardeners with infected beetles as well as using JB traps, after testing confirms this as an appropriate pathogen dispersal method.

Short term management. The goal is to use EPA registered biorational insecticides until JB biocontrol by the pathogen can increase.

The *Ovavesicula* pathogen is widespread in the East Coast where JB populations are low and correlated to *Ovavesicula* numbers. The efficacy of EPA approved biorational and conventional insecticides for killing JB were researched through LC50 bioassays. Bioassays showed that the bee friendly biorational insecticides chlorantraniliprole (Acelepryn), Beauveria, and *Bacillus thuringiensis galleriae* killed JB, but also killed painted lady butterfly larva. Scott's GrubEx (chlorantraniliprole, Acelepryn) does not harm bees visiting flowers in bee lawns. Consequently, biocontrol by the *Ovavesicula* pathogen is very important as most insecticides used to manage JB kill some pollinators. Outreach included websites, 36 talks, 3 papers. Research supported 3 UMN UROP fellowships and a Post Doc that received a UAL professorship.

In addition, research showed that commercial JB traps with lures can be filled with leaves covered with cellulose and pathogen spores. The spores were found on JB adults and in the adult's gut. The adults move the pathogen spores with them to oviposition sites in the turf, increasing pathogen spread to new sites. Using JB traps offers a better way to distribute pathogen

spores.

Please list outputs and outcomes.

<https://www.nifa.usda.gov/logic-model-planning-process>

Outputs: Research investigated ways to reduce insecticide use on bee lawns to protect pollinations.

Japanese beetle (JB), is a plant pest for which the most insecticides are used in urban areas. UMN collaborated with Michigan State University on surveying and establishing a JB pathogen as a biocontrol agent to kill JB, called *Ovavesicula* (microsporidia, fungi, spread by spores).

For the qPCR research we surveyed in 2022 44 sites and in 2023 34 sites for 2 dates and collected 80,000 JB/year. JB were preserved for spore counting and for qPCR analysis to identify *Ovavesicula*. Soil health and fungal biomass parameters were correlated to JB and pathogen numbers.

We surveyed 30 consumer sites that had high scarab grub populations in their lawns from JB (in MN since 1990) or European chafer (EC, in MN since 2020). Over 96% of the grubs (n=320) found were EC that feed on lawns with dryer soils compared to JB. *Ovavesicula* is a native US pathogen first discovered in CT and kills only JB grubs and not invasive European chafer. The homeowner program, <https://ncipmhort.cfans.umn.edu/consumer-lawns-infested-grubs>, was accomplished with the help of MN Master Gardeners, by placing an article in their newsletter that led to a JB site at the UMN Extension website on our homeowners JB survey program. Over 130 homeowners registered for our online educational program that consists of a training video, educational bulletin, and pre and post surveys to determine if participants used less insecticides and had better management.

Outcomes:

Change in knowledge- The online Japanese beetle program changed use of insecticides by 90% of the 30 participants.

Change in behavior - The online Japanese beetle program changed management by 90% of the 30 participants.

Change in condition -none

Change in pesticide use. Yes, 90% participants changed use to a biorational, bee friendly insecticide timed to the correct stage of the Japanese beetle

Change in pollinator conservation. Yes, management for 90% was changed to a bee friendly insecticide.

Change in management that reduces crop loss and or economic loss. Yes, the new IPM knowledge will reduce insecticide purchasing costs, and the cost of retrofitting a new lawn from grub damage.

Publications Outreach and research:

Outreach section

The homeowner program <https://ncipmhort.cfans.umn.edu/consumer-lawns-infested-grubs>
Outreach programs were designed to educate professionals, consumers, and park visitors on ways to reduce pesticide use. Our outreach programs included a table at the Monarch Festival for 2 years, an online educational program with site visits, and an online Advisory Committee meeting for stakeholders, state agencies, Master Gardeners, Golf Courses and Nursery Industry that met 3 times. Outreach included websites, 36 talks, 3 peer-reviewed papers, 8 articles for the nursery, golf course, and Master Gardener newsletters. Research supported 3 UMN UROP fellowships and a Post Doc that received a UAlabama professorship

An online educational site on pollinator conservation and Japanese beetle management was created at <https://ncipmhort.cfans.umn.edu/ipm-case-studies/ipm-case-study-japanese-beetle>

An article was published in the MN Golf Course Superintendents magazine. JB MN Golf Corse Superintendent's Hole Notes 57(5) June 2022

A poster on the research was presented at the UMN Research Symposium on March 14 2024

Research section

3 research publications are in manuscript form.

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Washington

Project No. and Title: NCERA 224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes, <https://nimss.org/projects/18875>

Year: 2024

Name: Gary Chastagner

State: Washington

University and complete mailing address:

Washington State University
Research and Extension Center
2606 West Pioneer Ave.
Puyallup, WA 98371

Phone number: 253-445-4528 (O); 253-882-6856 (C)

Email: chastag@wsu.edu

Period Covered: 1/01/2024 to 12/31/2024

Date of Report: November 30, 2024

In attendance: In person

Impact nuggets

- WSU, in collaboration with the USFS, WSDA, and the Port of Tacoma established a first of its kind sentinel plant garden at the Port of Tacoma to monitor introduction of exotic insects and plant pathogens at this port of entry.
- WSU genotyping work of isolates of *Phytophthora ramorum* from positive streams, nursery, and landscape sites showed that detections of the pathogen in streams was the result of direct spread of the pathogen in runoff water from specific infested nurseries, and not from unknown infections in the landscape.
- WSU developed mitigation steps, particularly the use of steam treatments, have been effective in eradicating and preventing the movement of *Phytophthora ramorum* from nurseries and landscape sites into WA forests.
- WSU and USFS collaborators have identified seed sources of Pacific madrone that may be best adapted to climate change and seedlings from these seed sources are being grown for out planting in Seattle and Tacoma city parks, among other places.
- WSU's Arbutus ARME program provides education, conservation, and connection among Pacific madrone enthusiasts. It has 492 members and there were more than 250 participants in outreach events in 2023/24.
- A WSU CAHNRS news release about the effect of climate on Christmas tree root diseases generated nearly 400 separate media mentions and was among WSU's better performing news releases in the past year or so.

Selected Accomplishment Summaries:

Sentinel garden project - Washington and Ohio established a collaboration on the use of sentinel gardens to (1) detect known, and discover unknown, potential pathogenic threats to U.S. forest tree species before they reach our shores, i.e. at the source abroad (ex patria sentinel gardens); and (2) conduct effective biosurveillance on U.S. territory (in patria sentinel gardens) around ports of entry and other areas that are at high risk of transit and establishment of new, non-native pathogens. Grants from the International Programs Office of the USDA Forest Service already fund the work. The ex-patria gardens have been established for over five years now, while an in-patria sentinel garden was established at the Port of Tacoma in 2024. This collaboration will develop and apply methodologies and pipelines to sample and analyze plant material from the gardens and conduct aerobiome sampling and analysis using inexpensive spore impact traps. The project includes a strong outreach and community engagement component for the in-patria gardens. We are also working assisting a collaborator at Auburn University who is in the process of establishing an in-patria garden at the Port of Mobil in Alabama.

Phytophthora ramorum (SOD) stream - *Phytophthora ramorum*, the cause of Sudden Oak Death, has been detected in over 50 nurseries and landscape sites in Washington since the early 2000s. Millions of trees have been killed by *P. ramorum* in California and Oregon since the late 1990s and quarantines related to spread of this nationally regulated pathogen outside of infested nurseries has the potential to significant impact to nursery, Christmas tree, and timber economies in the state. Stream monitoring for early detection and tracking the spread of *P. ramorum* has

been done since 2010 by the WSU Plant Pathology Ornamental program in cooperation with state and federal regulatory agencies. Although rarely detected, the pathogen has been detected in about a dozen streams.

Phytophthora ramorum (SOD) mitigation - *Phytophthora ramorum*, a plant pathogen subject to quarantine measures and capable of causing significant environmental and economic consequences, has been identified in nurseries and landscape sites in Washington for almost 20 years. There have been several instances where this pathogen has spread via the interstate movement of infested nursery stock. The WSU Plant Pathology Ornamental program continues to work with regulatory agencies, nurseries, and landowners to eradicate the pathogen and provide education and applied research on best management practices to stop its spread. To assist WSDA/APHIS in evaluating the Critical Control Points (CCP) within nurseries and address the CCP shortfalls through Best Management Practices (BMP) recommendations, WSU continued to make on-site Critical Control Point (CCP) assessment available by advertising on the WSU SOD website, and through information provided to nurseries by WSDA nursery inspectors. Applied research is often done at *P. ramorum* positive sites during mitigation activities and has included developing steam treatment methods for eradicating *P. ramorum*, monitoring nursery runoff and streams for *P. ramorum*, understanding the movement of *P. ramorum* in soil, and the efficacy of fungicides for preventing infection by *P. ramorum* on nursery crops.

Mortality of PNW-grown Christmas trees - The PNW leads the nation in the production of Christmas trees, which are shipped throughout the nation and exported to several foreign markets. Unprecedented levels of mortality of noble and Fraser fir have occurred in Christmas tree plantations in Washington and Oregon during the past several growing seasons. In some plantations, 20,000 to 30,000 3ft-to-8ft tall trees have been killed. Initial symptoms appeared as temperatures increased during late spring, and trees continued to die throughout the summer into early fall. Ongoing survey work supported by the Real Christmas Tree Board indicates that increased mortality of trees is the result of a combination of poorly understood environmental and biotic factors.

Health of Pacific madrone - Forest owners, parks departments, and the public are concerned about the health of Pacific madrone (*Arbutus menziesii*), a broadleaf evergreen tree native to the west coast of north America. While not an economically important timber species, madrone has an important role in ecosystems and is a drought tolerant tree in urban landscapes. Under climate change conditions of increased drought, some landowners are looking to madrone as a potential replacement for Douglas-fir. The WSU Plant Pathology Ornamental program and the Green Seattle Partnership created ArbutusARME to provide education, conservation, and connection among people who are interested in preserving this tree. It holds educational events such as workshops, tree tours, webinars; maintains an email list, and provides other opportunities for community engagement. Common garden trials in OR, WA, and BC were initiated to collect data on madrone from throughout the range.

Media stories - Many stakeholders and the public are often unfamiliar with the research and extension programs that are taking place at WSU, potentially resulting in lack of awareness of the value of society-benefiting research being conducted by CAHNRS faculty, post docs, staff, and students. The WSU Puyallup PPO program is very proactive in working with CAHNRS

communication staff to develop timely news releases of interest to mass media during the past year.

Impact Statements:

Sentinel garden project - In 2024 two sentinel gardens were established, one at the Port of Tacoma and one at WSU Puyallup. The WSU Garden will be used as a training site for workshops and demonstrations. Each garden has replicated plots containing trees and shrub species that represent important timber, cultural, and landscape trees from the PNW. The gardens near the port and transfer station will be priority monitoring sites for staff and partners. Community scientists are being engaged to monitor vegetation (including mature trees) nearby and beyond priority gardens. Partnerships are being leveraged for pest ID, diagnostics, and training opportunities. For example, we are working with WSDA to identify fungal pathogens and insects from traps placed in the Port of Tacoma sentinel garden using metabarcoding. Since the WSU PREC training garden is located near the Pierce County Master Gardeners, we have discussed holding first detector trainings with them, and we will continue to hold training events at the transfer station.

Phytophthora ramorum (SOD) stream - Genotyping work on isolates of *Phytophthora ramorum* from positive streams, nursery, and landscape sites showed that detections of the pathogen in streams was the result of direct spread of the pathogen in runoff water from specific infested nurseries, and not from unknown infections in the landscape. This collaborative work with state and federal regulatory agencies has enabled these agencies to avoid imposing quarantines on the movement of forestry, nursery, horticultural crops, and municipal yard waste out of regulated areas, which would have a significant economic impact on Washington. Participation by local students, Master Gardeners, and the public in stream monitoring has raised awareness of the potential issue of regulated plant pathogens being spread via streams and facilitated sampling in a broader geographic area.

Phytophthora ramorum (SOD) mitigation - Mitigation steps, particularly the use of steam treatments, have been effective in eradicating and preventing the movement of *Phytophthora ramorum* from nurseries and landscape sites into WA forests. Additionally, monitoring positive nurseries post-treatment has allowed them to resume interstate shipping once the necessary treatments are completed. Through our SOD Education program, we provided nurseries with information such as applied research results from participating nurseries in earlier years, extension publications, updates on the WSU SOD website, and presentations at pesticide recertification classes and other trainings. We have worked with groups outside of Washington to collaborate and share information on management of *Phytophthora* and research on *P. ramorum*. This included an ongoing project with Canadian researchers on potential *P. ramorum* hybrids found in WA and BC nurseries, providing information to CDFA about BMPs recommended for WA nurseries, and discussing steaming projects with researchers in California.

Mortality of PNW-grown Christmas trees – Survey results to date indicated that *Armillaria* and *Phytophthora* root diseases are the major biotic factors contributing to the mortality of Christmas trees in the PNW. The detection of *Armillaria* root disease and large-scale mortality of Fraser fir trees at one site was unexpected because trees have been grown at this site for multiple rotations (20+ yrs) without any indication of root disease problems. It is likely the increasing frequency of

heat/drought stress in the PNW region has exacerbated *Armillaria* root disease at Christmas tree sites due to climate maladaptation of species. Climate induced seasonal changes in precipitation patterns are likely contributing to the increased occurrence of *Phytophthora* root rot in plantations. For example, western Washington and Oregon received record levels of precipitation from mid-September through November in 2021, which was followed by a protracted period of cool, wet weather during spring 2022. It is likely these increases in seasonal precipitation increased the frequency of saturated soils which are conducive to *Phytophthora* root rot development. Work is underway to determine if the increased frequency of these diseases is also associated with shifts in the species of these pathogens in Christmas tree plantations.

Health of Pacific madrone – WSU and USFS collaborative research using madrone common garden trials has provided information about seed sources of this tree species that may be best adapted to climate change and seedlings from these seed sources are being grown for out planting in Seattle and Tacoma city parks, among other places. The Arbutus ARME program provides education, conservation, and connection among Pacific madrone enthusiasts. It has 492 members and there were more than 250 participants in outreach events in 2023/24.

Impact: Media stories – WSU CAHNRS news releases resulted in regional and national interviews (Associated Press, ABC News NY, Good Morning America, NPR) and numerous TV, online, print, and radio media outlets that carried stories about WSU research on invasive pests and pathogens, and the impact of climate change and root diseases on Christmas trees. Major TV markets included New York City, Chicago, Los Angeles, San Francisco, Seattle, and Portland. Based on media engagement data for the first three weeks following the release of a December news release related to WSU’s research to identifying and managing fungal diseases impacting Christmas trees: <https://news.wsu.edu/press-release/2023/12/12/christmas-tree-scientists-work-to-identify-manage-grinchy-fungal-foes/>, this news release generated nearly 400 separate media mentions reaching a total potential audience of 636 million. Although that audience reach measures the number of times the coverage could have been seen rather than individual readers or viewers and generally is a rather large figure because many media outlets have overlapping audiences, nonetheless, David Wasson, Director of WSU News and Media Relations indicated that “this story was among WSU’s better performing news releases in the past year or so”.

Outputs:

Outputs associated with the WSU Ornamental Plant Pathology program included Workshops, Field Days, and Tours; Research and Outreach Publications; and Scientific and Outreach Oral and Poster Presentations (see below)

Outcomes:

The WSU Ornamental Plant Pathology program delivered outcomes for mitigating the abiotic and biotic stressors of cut flowers, Christmas trees, urban trees, and nursery stock through collaboration, stakeholder engagement, and applied research. Examples include:

1. Christmas tree growers remove stumps from fields prior to replanting to reduce the potential development of *Armillaria* root disease.
2. Establishment of a sentinel garden at the Port of Tacoma
3. Establishment of a sentinel garden at WSU Puyallup that is being used to train community scientists on approaches utilized to monitor for pests and diseases.

4. Sign-up sheet created for community scientists to express interest in participating in monitoring sentinel gardens on <https://treehealth.wsu.edu/sentinel-trees>
5. Community volunteers and members of the Northwest Youth Corps assisted with planting, site stewardship, and monitoring the Port of Tacoma sentinel garden during the spring, summer, and fall.
6. Preparation of a pocket field guide for community scientists to use when monitoring for pests/diseases of concern.
7. Video and news article '[Early warning system for invasive pests take root at Port of Tacoma](#)' increased awareness of the first of its kind sentinel garden at the Port of Tacoma.
8. Pest identification training increased the diagnostic skills of Washington Conservation Corps members in Tacoma, WA.
9. Steam sanitation techniques to sanitize used pots adopted by nurseries and at the Pierce County Master Gardener display garden.
10. Increase the public awareness of the benefits of WSU research via CAHNRS news releases related to Christmas trees, the sentinel garden at the Port of Tacoma, and WSU's partnership with local community colleges to enhance urban forests.

Workshops, Field Days and Tours:

1. **Chastagner, Hulbert, and Elliott.** Overview of ornamental bulb, cut flower, Christmas tree, and sentinel garden research. Legislative WSU Puyallup Legislative Staff Tour.
2. **Chastagner, Elliott, and Hulbert.** Overview of ornamental bulb, cut flower, Christmas tree, and urban forestry research. PIP525 Class Tour.
3. **Hulbert.** Preparing and Responding to Mediterranean Oak Borer in Washington State (Virtual Workshop).
4. **Hulbert.** Invasive species workshop and webinars for Tribal Audiences (Virtual Workshop).
5. **Hulbert.** Session Coordinator, Public engagement to keep urban trees and communities healthy, IUFRO 26th World Congress, Stockholm, Sweden
6. **Hulbert.** 2024 Northwest Youth Corps, Tacoma Urban Community Forestry Spring Crews.
7. **Hulbert.** 2024 Tacoma Community College, Environmental Science students, Spring
8. **Hulbert.** 2024 Port of Tacoma, Invasive Species Workshop. Tacoma, WA
9. **Hulbert.** 2024 WSU Puyallup Research and Extension Center Programming, Spring Fair, Puyallup, Washington.
10. **Hulbert.** 2024 Forest Health Watch, South Sound Sustainability Fair, Tacoma, Washington.
11. **Hulbert.** 2024 Forest Health Watch, Oregon Tree School Clackamas, Clackamas Community College, Oregon City, Oregon.
12. **Hulbert.** 2024 WSU Ravenholt Urban Forest Health Lab, WSU Small Forest Landowner's Winter School, Green River College, Auburn, Washington.

Publications Research and Outreach:

Research Journals

1. Whitney, T. D., Chastagner, G.A. 2024. Insecticide efficacy and emergence timing of the Douglas-fir twig weevil. *Journal of Economic Entomology* 117 (3): 942–950. <https://doi.org/10.1093/jee/toae048>
2. McKeever, KM, Johnson, JS, Chastagner, GA. Accepted pending revisions. Field assessment of Turkish fir (*Abies bornmuelleriana*) resistance to five root-rotting *Phytophthora* species. *Plant Disease*.
3. Andrus et al. 2024. Canary in the Forest? – Tree mortality and canopy dieback of western redcedar linked to drier and warmer summers. *Journal of Biogeography* JBI-23-0212.R1

Outreach

- Bendorf, J., B. Lindberg, B. Cregg, D. McCullough, G. Chastagner, L. Nowatzke, D. Today, and S. Parker. 2024. Climate Change Impacts on Christmas Tree Production in the Midwestern Region. Michigan State University Extension Bulletin E3489. <https://www.canr.msu.edu/resources/climate-change-impacts-on-christmas-tree-production-in-the-midwestern-region>
- Chastagner, G., and T. Whitney. 2024. Douglas-fir twig weevil management. *Christmas Tree Lookout* 57(1):10-12.
- Chastagner, G. M. Elliott, C. Landgren, and J. Kowalski. 2024. CoFirGE-2: Continuation of a national project to identify regionally adapted Trojan, Turkish and Nordmann fir to produce high quality Christmas trees. *Christmas Tree Lookout* 57(2): 30-32.
- Lindberg, B., and G. Chastagner. 2024. Managing *Phytophthora* root rot. *Great Lakes Christmas Tree Journal* 20(4): 38-42.

Abstracts

1. Chastagner, G., and H. Pappu. 2024. Integrated management of diseases of ornamental geophytes and herbaceous perennials: Botrytis and Dahlia Viruses. 14th International Symposium on Flower Bulbs and Herbaceous Perennials. Warsaw, Poland.
2. Chastagner, G. 2024. Impact of Tobacco Rattle Virus on the vase life of ‘Sarah Bernhardt’ peonies. 14th International Symposium on Flower Bulbs and Herbaceous Perennials. Warsaw, Poland.
3. Chastagner, G., M. Elliott, D. McLoughlin, J. Kowalski, and C. Landgren. 2024. Early performance of seedlings in CoFirGE2 plots in WA, OR, ID, and CA. 16th IUFRO Christmas Tree Research and Extension Conference, Kerteminde, Denmark
4. Chastagner, G., and M. Elliott. 2024. Climate-Induced Stress and Root Diseases in PNW Christmas Tree Plantations. 16th IUFRO Christmas Tree Research and Extension Conference, Kerteminde, Denmark
5. Elliott, M., Hulbert, J., Murray, T., Chastagner, G. 2024. Detecting biological invasions with sentinel plantings at ports and urban points of dispersal in Washington State. Poster presentation. 32nd USDA Interagency Research Forum on Invasive Species. Annapolis, MD Jan 9-12, 2024.
6. Hulbert, JM, M. Elliott, and G. Chastagner. 2024. Tree health and urban heat: Engaging communities to study urban forest disparities. IUFRO 26th World Congress, Stockholm, Sweden. June 23-29, 2024

7. Shamoun, S.F. and Elliott, M. 2024. *Phytophthora ramorum* Werres, de Cock & Man in't Veld; Sudden Oak Death, Sudden Larch Death, Ramorum Leaf Blight and Shoot Dieback. Biological Control Programmes in Canada, Volume 6.
8. Xu, Jing. G. Chastagner, M. J. Justesen, O. K. Hansen, U. B. Nielsen. 2024. Genetic Variation in Susceptibility to Silver Fir Woolly Adelgid in Nordmann Fir. 16th IUFRO Christmas Tree Research and Extension Conference, Kerteminde, Denmark

Scientific and Outreach Oral and Poster Presentations:

1. **Chastagner, G.** 2024. RCTB Project - Efficacy of fumigants in eradicating elongate hemlock scale on infested Christmas trees. RCTB EHS Webinar, January 30, 2024
2. **Chastagner, G.** 2024. Root Rots, Needle Casts and Christmas Trees: Diagnosis, life cycles, damage and controls. MSU Christmas Tree Winter Webinar Series, February 29, 2024
3. **Chastagner, G.**, and M. Elliott. What is Killing My Trees - Climate-Induced Stress and Root Diseases. PNWCTA Short Course, Portland, OR., Feb. 16, 2024
4. **Chastagner, G.** Overview of ongoing Christmas tree research at WSU Puyallup. WSDA CT Advisory Meeting, Olympia, WA. April 26, 2023
5. **Chastagner, G.**, and M. Elliott. Climate Related Root Rot - Distinguishing Between Phytophthora and Armillaria Root Diseases. PNWCTA Summer Meeting and Tour, June 14, 2024.
6. **Chastagner, G.**, and H. Pappu. 2024. Integrated management of diseases of ornamental geophytes and herbaceous perennials: Botrytis and Dahlia Viruses (Keynote Presentation). 14th International Symposium on Flower Bulbs and Herbaceous Perennials. Warsaw, Poland. April 17, 2024.
7. **Chastagner, G.** 2024. Impact of Tobacco Rattle Virus on the vase life of 'Sarah Bernhardt' peonies. 14th International Symposium on Flower Bulbs and Herbaceous Perennials. Warsaw, Poland. April 17, 2024.
8. **Chastagner, G.**, M. Elliott, D. McLoughlin, J. Kowalski, and C. Landgren. 2024. Early performance of seedlings in CoFirGE2 plots in WA, OR, ID, and CA. 16th IUFRO Christmas Tree Research and Extension Conference, Kerteminde, Denmark, August 12, 2024.
9. **Chastagner, G.**, and M. Elliott. 2024. Climate-Induced Stress and Root Diseases in PNW Christmas Tree Plantations. 16th IUFRO Christmas Tree Research and Extension Conference, Kerteminde, Denmark, August 14, 2024.
10. **Chastagner, G.** 2024. Summary of Christmas tree research activities at WSU Puyallup. WSDA CT Advisory Meeting, Olympia, WA. October 4, 2023.
11. **Chastagner, G.**, and M. Elliott. 2024. Climate-induced stress and root diseases in PNW Christmas tree plantations. 69th Western International Forest Disease Work Conference. Sant Fe, NM. Sept. 11, 2024
12. **Chastagner, G.**, and M. Elliott. 2024. Climate-induced stress and root diseases in PNW Christmas tree plantations. 23rd Ornamental Workshop on Insects and Diseases, Raleigh, NC. October 23, 2024
13. **Chastagner, G.** 2024. Managing Botrytis - The key to extending the storage life of peony flowers. 23rd Ornamental Workshop on Insects and Diseases, Raleigh, NC. October 23, 2024

14. **Chastagner, G.** 2024. Management of Botrytis on Ornamental Geophytes. Alaska Agriculture Conference, Fairbanks, AK. Nov. 16, 2024
15. **Chastagner, G.** 2024. Management of Botrytis on Ornamental Geophytes. Alaska Agriculture Conference, Fairbanks, AK. Nov. 16, 2024
16. **Elliott, M.,** Hulbert, J., Murray, T., Chastagner, G. 2024. Detecting biological invasions with sentinel plantings at ports and urban points of dispersal in Washington State. Poster presentation. 32nd USDA Interagency Research Forum on Invasive Species. Annapolis, MD Jan 9-12, 2024.
17. **Elliott, M.,** Chastagner G. 2024. Lateral movement of *P. ramorum* on nursery substrates and steaming updates. NORS-DUC Annual Meeting, San Rafael, CA. 3/5/2024.
1. **Elliott, M.,** Chastagner G. 2024. Steam Treatment for eradicating Phytophthora ramorum: Research at WSU. USDA_APHIS-PPQ Phytophthora ramorum Community Call. online 5/15/2024
2. **Elliott, M.,** Hulbert, J., Murray, T., Chastagner, G. 2024. Sentinel plantings in Tacoma: A tool for detecting new arrivals of invasive species. 2024 Ports of Washington webinar 4/3/2024
3. **Elliott, M.** and Hulbert, J. 2024. Invasive plant diseases and pests: Stop them before they get started. Presentation to Pierce County Master Gardeners 6/22/24
18. **Elliott, M.,** and G. Chastagner. 2024. Rice paddies and other techniques for Phytophthora root disease resistance screening. 23rd Ornamental Workshop on Insects and Diseases, Raleigh, NC. October 23, 2024
19. **Hulbert, JM.** 2024 Climate Impacts Group, Lunch and Learn, Trees and urban heat in the Northwest, University of Washington, Seattle, Washington.
20. **Hulbert, JM.** 2024 Green River College Forestry and Natural Resources Seminar, Forest Health Issues, Research and Student Opportunities in Washington.
21. **Hulbert, JM.** 2024 United States Botanical Garden (DC) Hosted Webinar, Plants and Climate Change Education (PLACCE) session, Community Science for Forest Health with Dr. Joey Hulbert and Nina Avila (Virtual Presentation).
22. **Hulbert, JM.** 2024 Washington Naturalists, Forest Health Watch - keeping trees healthy together, Washington State University (Virtual Presentation).
23. **Hulbert, JM.** 2024 Online Workshops and Webinars for Tribal Audiences, Enriching tribal management and resilience to invasive species with co-designed educational resources, (Virtual Presentation).
24. **Hulbert, JM.** 2024 Online Workshops and Webinars for Tribal Audiences, Keeping berry patches healthy- invasive species threats to Vaccinium species, (Virtual Presentation).
25. **Hulbert, JM.** 2024 Online Workshops and Webinars for Tribal Audiences, Invasive species impacts, options and resources, (Virtual Presentation).
26. **Hulbert, JM.** 2024 Oregon Tree School Clackamas, Forest Health Watch - keeping trees healthy together, Oregon City, Oregon.
27. **Hulbert, JM.** 2024 King County Rural Forest Commission Forest health issues and research in Western Washington (Virtual Presentation).
28. **Hulbert, JM.** 2024 WSU Small Forest Landowner Winter School, Western redcedar dieback: updates from WSU research Green River College, Auburn, Washington.

29. **Hulbert, JM.** 2024 USDA APHIS Emergency Preparedness Training, Enriching tribal management and resilience to invasive species with co-designed educational resources Quinault Indian Nation, Ocean Beach, Washington (Virtual Presentation).
30. **Hulbert, JM.** 2024 Northwest Natural Resources Group, Fireside Chat, Backyard citizen science opportunities in the Northwest
31. **Hulbert, JM.** 2024 Tacoma Public Schools, Climate Action Group, Trees and urban heat in Tacoma
32. **Schultz, R. J., and G. Chastagner.** 2024. Perishables-shipping, boxes, insulation, botrytis, Fed Ex, UPS, Oh MY. Alaska Agriculture Conference, Fairbanks, AK. Nov. 15, 2024
33. **Xu, Jing.** G. Chastagner, M. J. Justesen, O. K. Hansen, U. B. Nielsen. 2024. Genetic Variation in Susceptibility to Silver Fir Woolly Adelgid in Nordmann Fir. 16th IUFRO Christmas Tree Research and Extension Conference, Kerteminde, Denmark, August 12. 2024.

Newly Funded Climate Related Christmas Tree Projects.

1. **“A GIFT SEED” (Accelerated Genetic Improvement of Fir Through Sequencing, Economics, Extension and Diagnostics)** is a national \$7.4 million USDA-NIFA Specialty Crop Research Initiative program project headed up by Dr. Justin Whitehill (North Carolina State University). Collaborators on this 4-year project are located at the Connecticut Agricultural Experiment Station, Michigan State University, North Carolina State University, North Carolina Cooperative Extension, North Carolina Department of Agriculture, University of California Davis, University of Connecticut, University of Florida, Washington State University, as well as the University of British Columbia/Vancouver (Canada), and University of Copenhagen/Copenhagen (Denmark). The goals of this project are to elevate the US Christmas tree industry through development and application of molecular genotyping assays that will enable genetic analysis of Christmas trees through on-farm “Plantation-Scale Studies”. Utilizing the recently established CoFirGE-2 regional plots, trees will be evaluated for climate resilience traits, pathogen/pest resistance traits/genes, and identification of genes/traits/mechanisms involved in production of consumer preferred/deer deterring aroma compounds. Goals include the development of improved diagnostics for rapid in-field identification of disease causal agents and exploration of alternative uses for Christmas tree waste materials will increase sustainability and novel economic revenue streams for US growers. Communication of new knowledge to industry stakeholders will be carried out through the **A GIFT SEED** Extension network which is highly integrated into project goals and objectives with representatives from all Christmas tree growing regions in the US represented.
2. **Management of Climate-Induced Stress and Root Diseases in PNW Christmas Tree Plantations** is a new \$183,312 regional 3-year WSDA Specialty Crop Block Grant project. The Pacific Northwest (PNW) leads the nation in the production of Christmas trees. The sustained production of high-quality Christmas trees is threatened by the increasing frequency of climate-induced stress and root diseases. WSU, in conjunction with collaborators at Michigan State University and the US Forest Service will examine biotic and abiotic factors contributing to heat damage and increasing mortality in PNW

Christmas tree plantations. Objectives include: 1) Identify and characterize root disease pathogens at PNW Christmas tree farms; 2) Monitor changes in the levels of plant stress related to environmental factors during the growing season; 3) Determine plant drought stress levels that predispose trees to direct heat damage; the effectiveness of horticultural sprayable sunburn protectants to reduce needle temperatures; and the tolerance of Christmas tree species to drought stress.

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Ohio

NCERA 224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes, <https://nimss.org/projects/18875>

Name: Pierluigi (Enrico) Bonello

University and complete mailing address: The Ohio State University, Department of Plant Pathology, 201 Kottman Hall, 2021 Coffey Rd., Columbus, OH 43214

Phone number: 614-688-5401

Email: Bonello.2@osu.edu

Period Covered: 01/01/2024 to 12/31/2024

Date of Report: Email to krisc001@umn.edu by 10/18/2024

In attendance:

In person

Suggestions for NCERA 224 cooperative research or outreach program:

Sentinel gardens: Washington and Ohio are establishing a collaboration on the use of sentinel gardens to (1) detect known, and discover unknown, potential pathogenic threats to U.S. forest tree species before they reach our shores, i.e. at the source abroad (ex patria sentinel gardens); and (2) conduct effective biosurveillance on U.S. territory (in patria sentinel gardens) around ports of entry and other areas that are at high risk of transit and establishment of new, non-native pathogens. Grants from the International Programs Office of the USDA Forest Service already fund the work. The ex patria gardens have been established for over five years now, while the in patria component is being established at present. This collaboration will develop and apply methodologies and pipelines to sample and analyze plant material from the gardens and conduct aerobiome sampling and analysis using inexpensive spore impact traps. The project includes a strong outreach and community engagement component for the in patria gardens.

Midwest IPM Landscape and Nursery Online Training for IPM adoption and pollinator conservation: NCERA members are collaborating on an educational manual, website, courses, workshops, and field days that will increase ornamental plant IPM knowledge and adoption and pollinator protection. We will provide educational materials to train nursery and landscape managers in the principles of ornamental IPM that are crucial to reducing pesticide use and

protecting non-target pollinators and beneficial insects. At the National USDA eXtension website, we have an online course with slide shows, tests, and an IPM certificate called “Managing invasive species in landscapes”, hosted at U. Minnesota. On the website, we will also post online educational courses and links to educational courses and certificates, for example, the Online Certificate “Forest and Urban Tree Pathology and Disease Management for Practitioners and Curious People” offered at Ohio State.

Suggestion for location of 2025 meeting:

At the meeting on Oct. 21 in Raleigh, NC it was decided that the next meeting will take place on December 8-9 in Vero Beach, FL.

Brief summary:

1. Environmental risk mapping of beech leaf disease

Beech leaf disease (BLD) was first detected on American beech (*Fagus grandifolia* Ehrh.) in Ohio in 2012 and has since spread through 15 states in the northeastern U.S. and into Ontario, Canada, affecting hundreds of thousands of trees in forest, urban, suburban, and rural settings. The problem is particularly acute with small trees and saplings in the understory, many of which die within a few years of first symptom development. This has a very significant effect on the ‘recruitment’ of the next generation into the dominant forest tree layer, basically ensuring that affected forests will change significantly in the future, from habitats where beech is a major component with large, tall trees to ones where it is no longer a significant part of the ecosystem. The lack of recruitment, combined with the loss of large American beech trees, will be devastating to wildlife, as beech trees serve as important den and nest habitats, and beech nuts (mast) are a primary source of food for many woodland birds and mammals, including squirrels and bears. The current situation is such that BLD is a disease of MAJOR concern to USDA Forest Service Forest Health Protection, local and state governments, and conservation agencies and NGOs throughout the current area of incidence (Ohio to Maine) and beyond, including Europe: European beech (*F. sylvatica*) is known to be susceptible to LCM attack and BLD, based on observations in North America. LCM is now listed as a threat by the European Plant Protection Organization (https://www.eppo.int/ACTIVITIES/plant_quarantine/alert_list_nematodes/litylenchus_crenatae).

There are many reasons for this unsatisfactory situation, all related to a lack of understanding of basic BLD features that impedes the development of evidence-based, effective management. First, we do not yet know how the nematode spreads or what facilitates disease development, or whether it needs microbial associates to become pathogenic. Second, we do not know if resistant trees exist out in nature that could be identified, selected, and bred for reforestation purposes. Third, we do not have good detection tools that can be applied to biosurveillance, although recently my group demonstrated that advanced spectroscopic approaches could be developed into rapid in-field detection if resources were available for this purpose. And fourth, and related to the third, we do not yet have models to predict where the disease will go next, to better focus our detection and control efforts.

This project aims to address the fourth need by generating an accurate risk map of (BLD) across the distribution range of American beech. Access to such a map would focus survey efforts by forest managers, optimizing strategies while minimizing costs. By the end of this project, we may also be able to predict the future distribution of BLD under two moderate climate change scenarios, SSP1 and SSP2, by providing models for three 30-year periods (2010-40, 2040-70, 2070-100). (SSP stands for shared socioeconomic pathways, as defined by IPCC, the Intergovernmental Panel on Climate Change.)

2. International *ex patria* sentinel gardens project

This year, we are at the point where we can start evaluating an ongoing project, coordinated in Ohio, among Asia (China), Europe (Italy, Sweden), and the U.S. (New Hampshire, Ohio), in which we have been monitoring a number of tree species of importance to each country for the past 5 years. In particular, China monitored European and North American tree species, Europe monitored Chinese and North American tree species, and the U.S. monitored Asian and European tree species. We conducted annual surveys of all the trees and sampled them by both isolating fungi associated with foliar and stem symptoms in pure culture and by conducting foliar microbiome analyses using high throughput sequencing and advanced bioinformatics analysis.

Impacts:

1. BLD risk mapping: No estimates exist of the costs of BLD or of the efforts currently underway to conduct biosurveillance. A way of assessing the potential costs imposed by this epidemic is to consider that disappearance of just 50% of American beech trees in the future just in Ohio would result in a loss of over \$225 million in terms of environmental benefits alone [based on iTree Design (<https://design.itreetools.org/>) calculations], as Ohio has over 17 million American beech trees (personal communication from Tom Macy, Forest Health Program Administrator, Ohio Department of Natural Resources). It is clear that, although not clearly quantifiable, an enhanced ability to predict the risk of occurrence of BLD would lead to major savings in biosurveillance operations at all levels across the United States.
2. Sentinel gardens: The results of the project have been rather astounding. From culturing alone we have identified 47 novel, specific, tree species-fungus associations, several represented by what we think are new fungal species. The partial microbiome analysis we have been able to conduct so far suggests a huge diversity of asymptomatic (endophytic) fungal species, many of which represent pathogenic lifestyles. This approach is clearly a major advance in our understanding of how live plants-for-planting, i.e. ornamental plants, can harbor new threats unbeknownst even to the best port-of-entry diagnosticians, who usually focus only on symptomatic plants. Our work calls for a radical change in how we allow plant movement into the United States.

Outputs - Publications:

Outreach: None

Research:

Peer-Reviewed Journal Articles

1. **Bonello, P.** (2024). Complex forest tree diseases – diagnostics beyond Koch’s postulates. *Current Forestry Reports* – DOI: 10.1007/s40725-024-00220-w. Invited review article.
2. Munck IA, Diez-Casero JJ, Moricca S, Tanguay P, **Bonello P.** (2024) Editorial: Foliar, shoot, stem and rust diseases of trees IUFRO 2022. *Frontiers in Forests and Global Change* 7. doi:10.3389/ffgc.2024.1356533
3. Chang L, Li Y, Gao Z, **Bonello P**, Cleary M, Munck IA, Santini A, Sun H. (2024). Novel pathogen–plant host interaction: *Colletotrichum jiangxiense* and *Fraxinus americana* L. (white ash) in a sentinel garden in China. *Plants* 12: 4001 – DOI: 10.3390/plants12234001.
4. Chang L, Li Y-l, Gao Z, **Bonello P**, Cleary M, Munck IA, Santini A, Sun H. (2024). First report of *Epicoccum latusicollum* causing leaf spot disease on red maple (*Acer rubrum* L.) in China: Insights from a sentinel planting garden. *Crop Protection* 175:106439 – DOI: 10.1016/j.cropro.2023.106439.
5. Williams GM, Ginzler MD, Ma Z, Adams DC, Campbell F, Lovett GM, Pildain MB, Raffa KF, Gandhi KJK, Santini A, Sniezko RA, Wingfield MJ, **Bonello P** (2024) The Global Forest Health Crisis: A Public-Good Social Dilemma in Need of International Collective Action. *Annual Review of Phytopathology* 61 (1) – DOI:10.1146/annurev-phyto-021722-024626.

Abstracts and Proceedings (Including Posters)

1. Ghosh S, Selvi E, **Bonello P.** 2024. Environmental risk mapping of beech leaf disease in the U.S. and Europe in a changing climate. Annual Meeting of the American Phytopathological Society. Memphis, TN, July 27-30.
2. Miles A, Fearer C, Vieira P, **Bonello P.** 2024. Characterization of beech leaf disease: From molecules to Landscapes. Annual Meeting of the American Phytopathological Society. Memphis, TN, July 27-30.
3. **Bonello P.** 2024. A Possible Future? The Center for Forest Invasion Resistance (C-FIR). Annual Meeting of the American Phytopathological Society. Memphis, TN, July 27-30.
4. **Bonello P.** 2024. A Possible Future? The Center for Forest Invasion Resistance (C-FIR). 63rd annual Southern Forest Health Work Conference. Greenville, SC, July 16-18.
5. Schlößer R, Migliorini D, Pepori AL, Gianni A, Pecori F, **Bonello P**, Santini A. 2024. New fungi associated with sentinel plants from North America in Italy. 26th IUFRO World Congress, Stockholm, Sweden, June 23-29.
6. Sun H, Chang L, Cleary M, Digirolomo M, Gao Z-w, Kime CG, Li Y-l, Migliorini D, Munck IA, Santini A, Shetlar D, Sherwood P, **Bonello P.** 2024. Sentinel plantations in China – early warning for threats to economically important European and North American tree species. 26th IUFRO World Congress, Stockholm, Sweden, June 23-29.
7. Williams G, Ginzler M, Ma Z, Adams D, Campbell F, Lovett G, Pildain MB, Raffa K, Gandhi K, Santini A, Sniezko R, Wingfield M, **Bonello P.** 2024. The global forest health crisis: a public-good social dilemma in need of international collective action. 26th IUFRO World Congress, Stockholm, Sweden, June 23-29.

Outcomes:

As can be deduced from the products listed, the work conducted in Ohio is mostly fundamental research. Thus, measuring outcomes as changes in behavior, condition, or management is challenging. By the same token, Ohio has contributed to change in knowledge, as measured by the same products. In particular, by being the founder and current member of an international beech leaf disease research coordination group (which meets virtually every two months), Bonello has contributed knowledge directly to both other researchers and state cooperators.

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Colorado State University

NCERA 224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes

Colorado State Report (CSU) for 2024
Ada Szczepaniec

Department of Agricultural Biology, Colorado State University, Fort Collins, CO 80523

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01/01/2024 to 12/09/2024

Date of Report:	Sent to committee chair on December 9, 2024
Annual Meeting Dates:	10/21/2024
In attendance:	no
Suggestions for NCERA 224:	Explore collaborative efforts to coordinate planting and monitoring of trees adapted to changing climate conditions and biotic pressure common to each region.

Brief summary:

The key activities in 2024 focused on establishing and coordinating connections between CSU and local Forestry Divisions to mitigate the increasing impact of emerald ash borer on urban forests and developing means to provide research-supported recommendations for tree selection. Several training opportunities were also provided for Master Gardeners and Arboriculturist Society members from Colorado and Wyoming. Significant improvements and updates have been completed to the educational resources focused in sustainable pest management on the Colorado Center for Sustainable Pest Management website (<https://agsci.colostate.edu/agbio/ipm/tree-and-shrub-pests/>). Most of the resources were updated based on the latest primary literature on each pest, and all the resources now meet accessibility standards. A website dedicated to IPM recommendations for emerald ash borer has been created.

Impacts:

Japanese beetles, emerald ash borer, and engraver beetles remain the main threat to trees and shrubs in Colorado. Climate-related decreases in precipitation and increases in temperature are likely to add scale insects and mites to the list of key pests. The updates and expansion of online educational resources for professionals and public are going to improve our ability to respond and address increasing impacts of these pests. CSU has partnered with City of Fort Collins Forestry Division to create models and resources that support selection of urban trees suited to the predicted climate conditions and meeting diversity standards that promote sustainable urban forests. These efforts were started in 2024 and once optimized will be shared with NCERA 224 members.

Outputs and outcomes:

Presentations and training:

- **Szczepaniec, A.** Pest Management in the Intermountain West – 25 min talk “Key pests and pests management updates”. November 2024

Educational and Extension resources and activities:

- Extensive improvements to the website for the Colorado Center for Sustainable Pest Management and content within, particularly related to insect and mite pests. All content is accessible and is continually updated with new pages and peer- reviewed information. I oversaw the following improvements in 2024:
 - 16 new webpages were created and posted. All meet accessibility standards and are easily viewed on mobile devices.
- CSU interacted with CDA staff to address and mitigate the impact of new invasive pests. This included assisting with updated potential pests lists and response plans in case of detection.
- CSU also engaged with City of Fort Collins Forestry Division to address and mitigate the impact of invasive beetle (emerald ash borer) and explore climate-forward and pest resilient urban tree species.

University of Tennessee

Bill Klingeman (University of Tennessee, Plant Sciences Department) and Midhula Gireesh [guest attendee] (University of Tennessee, Entomology and Plant Pathology Department)

Our work remains focused on evaluating disease diagnostics and insect monitoring approaches for horticultural landscape and native plant pests. Ongoing efforts of research team members and collaborators span several projects including:

- Direct extraction from suspect woody plant tissues and detection of *Bretziella fagacearum* (Oak Wilt pathogen) using molecular markers (SSRs), TaqMan fluorescing probes (M. Ony’s PhD Research project), & LAMP (collaborative work with Villari Lab at UGA) for:

- Oak wilt disease (*Bretziella fagacearum*) – update: SSR primer Bf0045 optimized for use in diagnostic screening & capable of detecting at least 0.008 ng/μL (qPCR) and 0.04 ng/μL (conventional PCR with blue light excitation). Results will be presented via poster at the *Ornamental Workshop* in Raleigh.
- LAMP detection succeeded with samples collected from oak wilt infested water oak and southern red oak in neighboring Aiken, SC. LAMP can detect as low as 1.0 pg DNA in infected host tissues.
- Screening for oak wilt DNA on sap beetle insects associated with infected live and red oak group host plants in Texas has been completed (a component within M. Ony's PhD Research project); DNA was recovered principally from early April – May 2022 specimen collections from 6 of 11 (total) beetle species collected in TX, using Bf045 primer with TaqMan and fluorescing probe. Positive *B. fagacearum* DNA detections are likely to coincide with presence of viable mat production within infected trees. Most abundant sap beetle species recovered across the study were *Carpophilus mutilatus*, *Colopterus maculatus*, and *Cryptarcha concinna* (journal article *in prep.*). Results will be presented via poster at the *Ornamental Workshop* in Raleigh.
- Work with other plant pathogens & fungi of interest (update):
 - Koch's postulates of evaluation of *Botryosphaeria dothidea*, a canker-forming pathogen new to TN, has been completed on red oak, based on oozing wounds found on a Knoxville-area landscape tree specimen (plant disease report *in prep.*).
 - Several field-collected isolates of *Trichoderma* species recovered as endophytes from black walnut (*Juglans nigra*) were assayed against isolates of *Geosmithia morbida* (fungal pathogen associated with Thousand Cankers Disease of Walnut) in assays that revealed a *Trichoderma simmonsii* isolate capable of significant culture-based antagonism to *G. morbida* in presence of juglone (study published in *BioControl*). Field trials are needed to validate potential utility of this TN *Trichoderma* isolate.

Landscape and Forest Tree Pest Species Monitoring: *Chrysobothris* flatheaded borers

- (part of a larger USDA NIFA SCRI project) 4th year of morphological and molecular systematics using trapped and borrowed (museum specimens of) captured adult *Chrysobothris* beetles used for documenting relationships within the genus and between *C. femorata* species group members
 - 2024 update: PhD student A. Gonzalez is assembling Illumina (short-read) genome resources for approx. 70 of ~130 North American *Chrysobothris* species; a minion (long-read) genome is being developed using high-molecular weight DNA and RNA recovered from hand-collected male and female *C. adelpha* specimens. Mitochondrial genome resource assemblies for these *Chrysobothris* species are in progress and are expected to benefit from a more complete long-read mitochondrial genome (assembly and annotation in progress); screening for candidate endosymbiont species (primarily bacterial) have revealed intriguing early results; reporting efforts remain in progress.
 - Suspected hybridization between economically important species (e.g., morphologically indeterminate specimens of “*C. shawnee*”, “*C. rugosiceps*”, “*C. quadriimpressa*”, and “*C. viridiceps*” may inform confusion about specimen identification and further work with these unusual individuals is planned.

- Use of new Illumina-based mitochondrial genome resources have enabled identification of pear fruits being exploited as a new economically important host plant resource being used as reproductive hosts by larvae of *C. mali* = Pacific Flatheaded Borer, particularly in organic orchards in California (journal article in progress); Results will be presented via poster at the *Ornamental Workshop* in Raleigh.
- A new descriptive Extension guide for identifying *Chrysobothris femorata* species group members is in progress; Axel Gonzalez has been assembling a Z-stack image archive of high resolution, high quality, gender-based photographs of key structural characteristics used in identification to assist illustration of this effort (in collaboration with Adesso Lab [LEAD] at TN State University).
- In 2024, Midhula Gireesh (UT) and Shimat Joseph (UGA) received a Southern IPMC grant to develop a new working group to address spotted lanternfly issues in specialty crops in the Southeastern US. Spotted lanternfly was confirmed in Tennessee in September 2023. A meeting was organized at the UT central region extension office where 31 participants (in person and zoom) including researchers, extension agents, plant inspectors (TDA), entomologists, vineyard manager and industry personals. The working group members including Bill Klingeman (UT) and participants ranked extension and research priorities during the meeting. The group has a diverse representation from the southeastern US states.
- Other Relevant News: TDA Plant Pathologist & Diagnostician (Sylvia Moraes) has collaborated with Dr. Nar Ranabhat and Dr. Midhula Gireesh, both with UT Entomology and Plant Pathology Department, on a summary report of lab diagnostic detection results of plant diseases, insect pests, and other factors impacting ornamental and landscape plants and crop samples submitted between 2023 and 2024. This will be published in Jan. 2025 in trade journal quarterly magazine *TN Greentimes*. Additionally, the team worked on quarterly newsletters (spring and summer) and statewide in-service aiming educating agents in plant health diagnostics, important insect and pest updates, sample submission, etc.

Impacts:

Limited direct impacts available; outputs remain efforts *in progress* (as indicated above).

Please list outputs and outcomes.

<https://www.nifa.usda.gov/logic-model-planning-process>

Outputs: Products, services, are *in progress*. Events in 2024 included:

Outcomes: *None to report: ongoing efforts remain in progress:*

Change in knowledge - Occurs when there is a change in knowledge or the participants actually learn.

Change in behavior - Occurs when there is a change in behavior or the participants act upon what they have learned.

Change in condition -Occurs when a societal condition is improved.

Change in pesticide use.

Change in pollinator conservation.

Change in management that reduces crop loss and or economic loss.

Publications Outreach and research:

Outreach section

Ranabhat, N.B., D.F. Gomez, W.E. Klingeman, M. Ony, E. Lopez, D. Hadziabdic. 202x. Oak Wilt Disease: A guide to recognizing symptoms, diagnosing the problem and safeguarding oak trees. UT Extension Publication W XXX. 13pp.

Gireesh, M., F. Hale, B. Joshua, B. Joshua, J. Grant and C. Bilbrey. 202X. Spotted Lanternfly. UT Extension Publication W XXX.

Gireesh, M., K. Dhakal, and K.M. Adesso. 202X. Redheaded Flea beetle. UT Extension Publication W XXX.

Ranabhat, N.B., M. Gireesh, and S. Moraes. 2025. What was spied with our (*microscopic*) eye: Updates on plant health problems diagnosed during peak months of 2023 and 2024. Tennessee Greentimes 26(1): (*pp. TBD*).

Gireesh, M. 2024. The Buzz on Cicadas. Cultivate, State Botanical Garden of Tennessee Magazine.

Gireesh M., and C. Bilbrey. 2024. Spotted Lanternfly Detected in Middle Tennessee. Tennessee Greentimes 25:16-18

Ony, M.A., G. Pietsch, M.L. Sakalidis, W.E. Klingeman, M. Staton, and D. Hadziabdic. 2024. Molecular detection of oak wilt pathogen by pairing TaqMan probes with an inexpensive blue flashlight. International Oak Symposium: Science-based management for dynamic oak forests, Knoxville, TN, *October 7-10, 2024* (oral presentation to 30 participants).

Pietsch, G.M., M.A. Ony, D.F. Gomez, K. Moulton, D. Hadziabdic, E. Davis, and W. Klingeman. 2024. Putting a new spin on an old disease: Using molecular tools to identify beetles carrying spores from the oak wilt fungus in Gillespie County, Texas, USA. International Oak Symposium: Science-based management for dynamic oak forests, Knoxville, TN, *October 7-10, 2024* (oral presentation to 25 participants).

Hadziabdic, D., M.A. Ony, A.J. Onufrak, M. Sakalidis, M. Cregger, A. Taylor, M.D. Ginzl, W.E. Klingeman, and M. Staton. 2024. Dual RNAseq analyses of the oak wilt disease complex: unraveling the silent battles of oak hosts against the fungal pathogen *Bretziella fagacearum*. 26th IUFRO World Congress in Stockholm, Sweden (*27-30 June 2024*).

Research section

- Kron, C.R., A.D. Gonzalez Murillo, C.G. Gonçalves, B.G. Zoller, K. Adesso, W.E. Klingeman, and J.K. Moulton. 202x. DNA barcoding helps establish a novel host-plant interaction for *Chrysobothris mali* (Horn, 1886) (Coleoptera: Buprestidae) larvae found infesting *Pyrus communis* cv. 'Bartlett' fruit in Lake County, California orchards. *In preparation for PanPacific Entomologist*.
- Ash, L., S.L. Boggess, A.J. Onufrak, G.M. Pietsch, M.A. Ony, S.R.G. Moraes, G.M. Pietsch, W.E. Klingeman, and D. Hadziabdic. 202x. First report of *Botryosphaeria dothidea* causing cankers in Northern Red Oak (*Quercus rubra*) in Tennessee. *In preparation for Plant Disease*.
- Ony, M.A., G. Pietsch, M.L. Sakalidis, W.E. Klingeman, M. Staton, and D. Hadziabdic. 2024. Molecular detection of oak wilt pathogen by pairing TaqMan probes with an inexpensive blue flashlight. Proc. International Oak Symposium, Southern Research Station, General Technical Report SRS-279, p. 122.
- Pietsch, G.M., M.A. Ony, D.F. Gomez, K. Moulton, D. Hadziabdic, E. Davis, and W. Klingeman. 2024. Putting a new spin on an old disease: Using molecular tools to identify beetles carrying spores from the oak wilt fungus in Gillespie County, Texas, USA. Proc. International Oak Symposium, Southern Research Station, General Technical Report SRS-279, pp. 125-127.
- Onufrak, A.J., S. Khodaei, I. Perez, C. Chen, A. Finnell, S. Givens, D. Holdgridge, R. Gazis, K.D. Gwinn, W. Klingeman, and D. Hadziabdic. 2024. Potential biological control agents of *Geosmithia morbida* restrict fungal plant pathogen growth via mycoparasitism and antibiosis. BioControl, <https://doi.org/10.1007/s10526-024-10277-y>
- Pietsch, G.M., M.A. Ony, D.F. Gomez, J.K. Moulton, D. Hadziabdic, E. Davis, and W.E. Klingeman. 2024. Fungal (Place) Mats for Messy Eaters: Screening Sap Beetle Species from an Oak Wilt Epicenter in the Lone Star State to Detect Seasonal Presence of *Bretziella fagacearum* DNA. 23rd Ornamental Pest and Plant Disease Workshop, Raleigh, NC, 10/22 - 24/2024.
- Ony, M.A., G. Pietsch, M.L. Sakalidis, K. Chahal, P.P. Parra, L.A. Miles, D.F. Gomez, M.D. Ginzler, R.N. Trigiano, M. Cregger, W.E. Klingeman, M. Staton, and D. Hadziabdic. 2024. "Ender" Reveal for Dying Red Oaks: Using TaqMan Probes and an Inexpensive Blue-flashlight to Diagnose the Oak Wilt Pathogen. 23rd Ornamental Pest and Plant Disease Workshop, Raleigh, NC, 10/22 - 24/2024.
- Gonzalez Murillo, A., J. K. Moulton, K. Adesso, C. Kron, C. G. Gonçalves, B. Zoller, and W. E. Klingeman. "Peering" Adult Flatheaded Borer Genome Resources with Morphology to Diagnose a Novel Plant Niche-Larval Pest Interaction. 23rd Ornamental Pest and Plant Disease Workshop, Raleigh, NC, 10/22 - 24/2024.

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Clemson University

NCERA 224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes, <https://nimss.org/projects/18875>

Year: 2024

Name: Zee Ahmed

State: South Carolina

University and complete mailing address: 2200 Pocket Rd, Florence, SC 29506

Phone number: 352-283-0173

Email: mahmed2@clemson.edu

Period Covered: 01/01/2024 to 12/31/2024 (I joined Clemson on January 8, 2024, so my report covers the period from January 8, 2024, to December 31, 2024)

Date of Report: Email to krisc001@umn.edu by 10/18/2024

In attendance:

In person

Suggestions for NCERA 224 cooperative research or outreach program:

Suggestion for location of 2025 meeting:

A suggestion is to meet at the Aug 2-5, 2025 at the 2025 APS meeting in Honolulu, Hawaii; NCERA should organize a symposium; schedule a visit to the USDA research stations on resistance management

Brief summary:

What you did, how it helps, what was solved.

Write a paragraph separated by a space each issues

I identified significant gaps in extension efforts for five key pests affecting turf and ornamentals: *Acanthococcus lagerstroemiae* (crapemyrtle bark scale), *Lycorma delicatula* (spotted lanternfly), *Nipaecoccus viridis* (lebbeck mealybugs), *Spodoptera frugiperda* (fall armyworm), and *Thrips parvispinus* (pepper thrips).

The crapemyrtle bark scale is already established in South Carolina, and extensive research has been conducted in other states. However, its persistent issues in landscapes and nurseries, partly due to mistimed chemical applications, necessitate further extension efforts. I plan to update its Land Grant Press article, present an extension talk in November, and collaborate with researchers from Georgia and Tennessee on a Crop Protection and Pest Management grant next year.

The spotted lanternfly, recently reported in North Carolina, is expected to invade South Carolina imminently. I have joined its multistate working group, designed a field guide, and presented an extension talk in Florence, SC. Additionally, I am preparing a Southern IPM grant application with collaborators in Georgia and Tennessee, focusing on organizing more extension meetings in South Carolina, Georgia, and Tennessee.

The fall armyworm, a seasonal pest in South Carolina's turf, has been reported earlier than usual this year. I intend to write a Land Grant Press article to emphasize the importance of early detection and management for stakeholders.

Notably, I discovered pepper thrips and lebeck mealybugs for the first time in South Carolina. I developed comprehensive extension materials for these pests in Florida and plan to adapt them for South Carolina.

Scale insects, though comprising only 1% of the total insect fauna in the United States (US), account for 13% of the introduced insect fauna, inflicting billions of dollars in damage annually. Among these, mealybugs (Hemiptera: Pseudococcidae) are notably invasive and economically significant. They reproduce both sexually and asexually, leading to multiple overlapping generations. Mealybugs directly harm plants by extracting sap from the phloem, which diminishes plant vigor, induces chlorosis, and causes defoliation. Indirectly, they excrete honeydew, promoting the growth of black sooty mold that reduces the aesthetic value of plants and obstructs photosynthesis. Additionally, mealybugs serve as vectors for plant viruses and toxins. Over the past 25 years, numerous exotic mealybug species have established themselves in the Southeast US, a primary entry point to the US. Effective management and regulatory measures are essential to protect the US agricultural industry from these pests. Existing taxonomic keys for mealybug identification are limited and not comprehensive for all species in the Southeast US. I am working with collaborators to build a framework for mealybugs in the Southeast US. Accurate pest identification is crucial for effective integrated pest management (IPM); without reliable identification tools, the entire IPM strategy against mealybugs is compromised. Here is one of the studies which was completed this year.

Taxonomy, hosts, and distribution of an emerging invasive mealybug, *Phenacoccus miruku* Tanaka and Choi (Hemiptera: Coccoomorpha: Pseudococcidae), in Florida
 An invasive mealybug (Hemiptera: Coccoomorpha: Pseudococcidae) was first detected and identified in Florida in 2019 as *Phenacoccus sisymbriifolium* Granara de Willink. This species was originally described from Uruguay in 2007 on *Solanum sisymbriifolium* Lam. (Solanaceae), and the Florida specimens largely matched this description. However, new morphological and molecular evidence supports that this species is *Phenacoccus miruku* Tanaka & Choi, recently described from Japan in 2022. *Phenacoccus miruku* is presumed to be of Neotropical or Nearctic origin and is invasive in Japan. This mealybug species has the potential to spread from Florida to the rest of the US, especially to states in the Southeast. We discussed the issues surrounding the taxonomic identities of *Phenacoccus* species found in the Southeast US and provided diagnoses for each. An available list of host plants, a current distribution map, notes on ecological associates, images of live specimens in the field, and a key to the species of *Phenacoccus* are also provided. Since its detection, this mealybug has been widely found throughout 20 Florida counties with a continuously expanding host list. It is currently most common on roadside weeds

such as *Bidens alba* (L.) DC. and *Ambrosia artemisiifolia* L. (Asteraceae), but it has recently been identified on cultivated crops such as tomato (*Solanum lycopersicum* L.), eggplant (*Solanum melongena* L.), naranjilla (*Solanum quitoense* Lam.), peppers (*Capsicum* L.) (Solanaceae), and sweet potato (*Ipomoea batatas* L.) (Convolvulaceae). This paper provides information on this emerging mealybug pest, offers resources for its identification, and facilitates detection and management in the US.

One of my objectives is to investigate the genetic makeup and endosymbionts that contribute to the invasion success of invasive species and explore the potential for manipulating these factors to manage invasive species. I aim to advance this objective through sustained collaboration with distinguished colleagues and by pursuing future funding opportunities. This objective is divided into two sections: the genetic composition of invasive species and their endosymbionts. My research capabilities in this domain are relatively unique both in the US and globally. Recently, I concluded three seminal studies under this objective in collaboration with researchers from China, South Africa, and the US.

A. Invasive Species Endosymbionts

Evolutionary history of *Wolbachia wsp* gene in host *Bemisia tabaci* cryptic species complex
Wolbachia is one of the most common endosymbionts infecting arthropods and is found in several of species belonging to the *Bemisia tabaci* cryptic species complex. The most abundantly expressed protein of *Wolbachia* in arthropods is *Wolbachia* surface protein (*wsp*). There is an extensive *wsp* sequence dataset available from across the cryptic species complex. We analyzed our *wsp* gene sequences along with all possible available dataset of *wsp* from *Bemisia* cryptic species in order to study the evolution history this gene. After accounting for possible recombination in the *wsp* gene, we identified 30 genotypes, 22 of which belonged to the genetic identity *wBt1* that was predominant and occurred in members of the *B. tabaci* complex found in Asia, Africa, Australia, and Europe. We found evidence of identical *wsp* genotypes between indigenous *B. tabaci* and members of the complex that have recently invaded Asia. Since the invader and indigenous individuals are unable to copulate, we assumed that some non-sexual means of transmission, such as natural enemies, especially parasitoids, may have played a role in this inter-species horizontal transmission of *Wolbachia*. Our results further suggest parasitoids among natural enemies used for biological control could have unintended negative consequences.

B. Invasive Species Genetic Makeup

Geographical distribution and genetic analysis reveal recent global invasion of whitefly, *Bemisia tabaci*, primarily associated with only three haplotypes

The whitefly, *Bemisia tabaci* is a cryptic species complex in which one member, Middle East-Asia Minor 1 (MEAM1) has invaded globally. After invading large countries like Australia, China, and the USA, MEAM1 spread rapidly across each country. In contrast, our analysis of MEAM1 in India showed a very different pattern. Despite the detection of MEAM1 being contemporaneous with invasions in Australia, USA, and China, MEAM1 has not spread widely and instead remains restricted to the southern regions. An assessment of Indian MEAM1 genetic diversity showed a level of diversity equivalent to that found in its presumed home range and significantly higher than that expected across the invaded range. The high level of diversity and restricted distribution raises the prospect that its home range extends into India. Similarly, while

the levels of diversity in Australia and the USA conformed to what was expected of the invaded range, China did not. It suggests that China may also be part of its home range. We also observed that diversity across the invaded range was primarily accounted for by a single haplotype, Hap1, which accounted for 79.8% of all records. It was only the invasion of Hap1 that enabled outbreaks to occur, as well as MEAM1's discovery.

Global invasion of *Thrips parvispinus* (Karny) (Thysanoptera: Thripidae) across three continents associated with its one haplotype

Thrips parvispinus (Karny) is an exotic pest that has invaded many regions around the world in the last three decades. It was first detected in Florida in 2020 on ornamental plants (*Hoya* and *Anthurium*) in greenhouses and subsequently on ornamental plants in residential landscapes (*Gardenia*) in 2021. However, its first report on open vegetable field crops (*Capsicum*) in Florida was in 2022. We conducted field surveys and genetic analysis to answer three questions: 1) Is the population of *T. parvispinus* that invaded Florida the same as the one that has spread globally in the last few decades? 2) Is the host expansion to *Capsicum* in Florida a new population or the extension of the existing population reported on ornamental plants? 3) What are the native and invaded distribution ranges of *T. parvispinus*? We analyzed the genetic variation in the mitochondrial gene cytochrome oxidase I (COI) to address these questions. The global genetic diversity analysis of *T. parvispinus* revealed 18 haplotypes (populations) worldwide based on available data, but only one population (Hap1) invaded three continents: Africa, Europe, and North America. Based on available data, the highest haplotype diversity was observed in India, suggesting India may be part of the presumed native range (South and Southeast Asian countries) of *T. parvispinus*. Our survey of retail plant stores across ten Florida counties indicated that plant trade is the source of *T. parvispinus* in open vegetable field crops and ornamental landscape plants. The outcome of this study will assist with regulatory and management decisions of *T. parvispinus* in Florida and elsewhere.

Impacts:

All research and outreach programs were concerned with using IPM principles to reduce pesticide use, better time pesticide use, use cultural management, better identify pests, and protect pollinators and improve worker safety.

Please list outputs and outcomes.

<https://www.nifa.usda.gov/logic-model-planning-process>

Outputs: Products, services and events that are intended to lead to the program's outcomes.

Outcomes: Planned results or changes for individuals, groups, communities, organizations or systems. Types of outcomes include:

Change in knowledge - Occurs when there is a change in knowledge or the participants actually learn.

Change in behavior - Occurs when there is a change in behavior or the participants act upon what they have learned.

Change in condition -Occurs when a societal condition is improved.

Change in pesticide use.

Change in pollinator conservation.

Change in management that reduces crop loss and or economic loss.

Publications Outreach and research:

Outreach section

Ahmed MZ, 2024. Spotted Lanternfly Field Guide. <https://zeeahmed.weebly.com/publications-extensions.html>

Research section

Ahmed MZ, Roberts JW, Soto-Adames FN, McKenzie CL, and LS Osborne. 2024. Global invasion of *Thrips parvispinus* (Karny) (Thysanoptera: Thripidae) across three continents associated with its one population. *Journal of Applied Entomology* <https://doi.org/10.1111/jen.13376>

Powell E, Deeter LA, Moore MR, Ahmed MZ, and DR Miller. 2024. Taxonomy, hosts, and distribution of an emerging invasive mealybug, *Phenacoccus miruku* Tanaka and Choi (Hemiptera: Coccothraupidae: Pseudococcidae), in Florida. *Florida Entomologist* 0024.

Peng J, Xiao-Lu, L, Xiao-Tong R, Jindal V, Mohindru B, Banta G, Gupta VK, Kumar V, Qing-Jun W, McKenzie CL, Osborne LS, Ahmed MZ, Bao-Li Q 2024. Geographical distribution and genetic analysis reveal recent global invasion of whitefly, *Bemisia tabaci*, primarily associated with only three haplotypes. *Bulletin of Entomological Research* (accepted)

Ahmed MZ. 2024. Global invasion of *Thrips parvispinus* across three continents associated with a single population. The 23rd Ornamental Workshop on Insects and Diseases, Raleigh, North Carolina, October 22–24.

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University of Florida

New format for annual state report

The chair will complete all state reports into a final report, send it out for review, and post it in NIMMS by Dec 1 2024. Answer all questions below. DO NOT use bullets or outlines. Write cohesive paragraphs. Email by Oct 18 2024 to chair Vera Krischik, UMN, krisc001@umn.edu

Project No. and Title:

NCERA 224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes, <https://nimss.org/projects/18875>

Year: 2024

Name: Shimat V Joseph

State: GA

University and complete mailing address: 1109 Experiment Street, Griffin, GA 30223

Phone number: 770 228 7312

Email: svjoseph@uga.edu

Period Covered: 01/01/2024 to 12/31/2024

Date of Report: Email to krisc001@umn.edu by 10/18/2024

In attendance: Did not attend

In person or by zoom

Suggestions for NCERA 224 cooperative research or outreach program:

Suggestion for location of 2025 meeting:

A suggestion is to meet at the Aug 2-5, 2025 at the 2025 APS meeting in Honolulu, Hawaii; NCERA should organize a symposium; schedule a visit to the USDA research stations on resistance management

Brief summary:

What you did, how it helps, what was solved.

Write a paragraph separated by a space each issues

Impacts:

All research and outreach programs were concerned with using IPM principles to reduce pesticide use, better time pesticide use, use cultural management, better identify pests, and protect pollinators and improve worker safety.

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Change in pesticide use.

Change in pollinator conservation.

Change in management that reduces crop loss and or economic loss.

Publications Outreach and research:

Outreach section

Research section