United States Department of Agriculture

Progress Report

Title:	**Ecology and Integrated Management of Ambrosia Beetles in Eastern US Orchard and Ornamental Tree Crops**

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Recipient Organization

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Departments

{NO DATA ENTERED}
Entomology
Entomology & Plant Pathology
Agricultural and Applied Economics

Non-Technical Summary

Exotic ambrosia beetles established in the U.S. are emerging as highly destructive pests in apple and pecan orchards and continue to be damaging insects of trees in ornamental nurseries. Infestations are a major source of revenue losses in these three commodity groups. Substantial losses have been reported throughout the eastern U.S. Ambrosia beetles are consistently ranked among the most concerning insect pests of horticultural tree crops in the eastern U.S. Rapid branch dieback and tree death on alarming scales are commonly observed following infestations due to their wood-boring behavior and association with symbiotic and secondary microorganisms. A multi-disciplinary team has been assembled to conduct field and laboratory research to maximize tree health and reduce tree vulnerability, optimize monitoring tactics, identify chemical and biological alternatives to broad-spectrum insecticides, determine the economic impacts of ambrosia beetles, and transfer new knowledge via outreach and extension to end-users. The expected accomplishments of this research include: (1) improving the understanding of stakeholders across the three commodity groups about ambrosia beetle monitoring and management; (2) implementing pest management tactics for ambrosia beetles beyond solely relying on preventive applications of broad-spectrum insecticides; (3) establishing and disseminating knowledge about the economic impact and cost:benefit ratio of managing ambrosia beetles; and (4) determining effective outreach avenues and expanding IPM tactics to reduce the risk of ambrosia beetle attacks.

The collaborative nature of this project will facilitate cooperation among researchers, extension, and stakeholders resulting in productive outcomes to solving an emerging agricultural issue. Economic benefits will be realized by decreasing the negative economic impacts of ambrosia beetle through prevention of tree loss, increasing marketability of nursery trees, sustained orchard production, reduced management inputs by growers, and improved profitability. Social benefits from this project include improved knowledge and research-driven decision making for growers in their respective production systems. Furthermore, reducing applications of broad-spectrum insecticides, particularly during spring months, will reduce impacts on pollinating

insects and end-users and enhance environmental stewardship within communities. Addressing these pest management issues can help enhance grower and farmworker health and quality of life by reducing exposures to harmful chemicals.

Accomplishments

Major goals of the project

Exotic ambrosia beetles established in the U.S. are emerging as highly destructive pests in apple and pecan orchards and continue to be damaging insects of trees in ornamental nurseries. Ambrosia beetle nfestations are a major source of revenue losses in these three commodity groups (i.e., apples, pecans, ornamentals). Infestations result in perforated stems, oozing sap, bark staining, branch dieback, and rapid tree death. Ambrosia beetles can render trees unmarketable, decrease integrity of surviving trees, and make trees vulnerable to infection. This project will address the needs of stakeholders in the Eastern U.S., but will have applications to stakeholders across the U.S. where ambrosia beetles and horticultural tree crops overlap. Stakeholder needs were identified through the Ambrosia Beetle Working Group supported by the Southern IPM Center using a comprehensive stakeholder survey and in-person and virtual meetings attended by researchers, extension specialists, agents, and growers affiliated with eastern and southeastern US states. The goal of the proposed research and outreach activities align with the priorities of stakeholders to develop sustainable management practices for ambrosia beetles that maximize tree health and reduce tree vulnerability, optimize monitoring tactics, and identify chemical and biological alternatives to broad-spectrum insecticides. A systems approach will be used to achieve our overall goal of developing sustainable ambrosia beetle management strategies in our three commodity groups by integrating expertise on plant physiology, horticultural science, chemical ecology, plant pathology, insect-microbe interactions, engineering, applied insect ecology, biocontrol, economics, and social science.

A multi-disciplinary team of experts has been assembled to address the following objectives:

Objective 1) Predict the risk of infestations in orchard and nursery crop systems through improved understanding of ambrosia beetle biology and ecology. The following sub-objectives will be addressed: 1a) Characterize abiotic stressors that induce ethanol production and ambrosia beetle attacks, 1b) Characterize biotic plant stress-related factors that influence ambrosia beetle attacks, 1c) Assess the pathogenicity and virulence of auxiliary and symbiotic fungi associated with ambrosia beetles to elucidate the basis for branch die-back and tree death, and 1d) Determine ambrosia beetle dispersal and attack patterns within agro-ecosystems and relate to landscape level factors.

Objective 2) Develop novel tools to enhance the accuracy and precision of ambrosia beetle infestation and monitoring tactics. The following sub-objectives will be addressed: 2a) Evaluate trapping tactics and lure release rates for species-specific monitoring of ambrosia beetles and correlating trap captures with attacks, and 2b) Develop and compare existing and portable technologies to monitor tree ethanol production in orchard and nursery crop systems.

Objective 3) Implement comprehensive management strategies. The following sub-objectives will be addressed: 3a) Compare new and current insecticidal active ingredients at different timings and frequencies to reduce ambrosia beetle attacks, 3b) Test and integrate repellents and attractants into a push-pull strategy, 3c) Evaluate plant defense elicitors for promoting tree health and inhibiting ambrosia beetle attacks and/or colonization, and 3d) Assess antagonistic fungi and entomopathogenic nematodes against ambrosia beetles and their symbiotic fungi.

Objective 4) Determine the economics of ambrosia beetle damage and control interventions on orchard and ornamental tree crop stakeholders. The following sub-objectives will be addressed: 4a) Quantify the commodity-specific economic impact of ambrosia beetles, 4b) Determine the risk adjusted cost-benefit framework and feasibility of alternative management tactics for ambrosia beetles, and 4c) Identify social barriers for technology adoption and facilitators to enhance grower acceptance of improved strategies.

Objective 5) Transfer research-based information to stakeholders. The following sub-objectives will be addressed: 5a) Developing a publicly accessible centralized website and project specific social media, 5b) Promote existing land grant Extension programs, 5c) Evaluating stakeholder reaction and utilization to Extension efforts, and 5d) Coordinate with other Regional IPM Centers to increase promotion of project outputs and calls for participation.

What was accomplished under these goals?

Objective 1) Predict the risk of infestations in orchard and nursery crop systems through improved understanding of ambrosia beetle biology and ecology.

- Co-PIs at TSU conducted experiments to compare the impact of flooding and drought on tree attractiveness to ambrosia

beetles. The influence of Phytophthora cinnamomi infection on tree suitability to ambrosia beetles was also examined. The presence of stress-induced ethanol within stems was also quantified. Data are being processed.

- Co-PIs at NCSU inoculated apple trees with fireblight to determine the impact of infection of tree attractiveness to ambrosia beetles and ethanol production. Data are being processed.
- Co-PIs at Cornell Univ. isolated cultures of fire blight for inoculating trees in field experiments in 2023.
- Co-PIs at NCSU, PSU, USDA-ARS (OH, NY) collected ambrosia beetles in traps and/or dissected from ethanol-soaked stem sections (i.e., bolts) to culture auxiliary and symbiotic fungi associated with the beetles. Extraction of DNA is being conducted to confirm identifications.
- Co-PIs at VT characterized an ambrosia beetle infestation in a commercial nursery to improve our understanding of their host selection. A commercial block with ornamental trees was selected and the number of ambrosia beetle attacks were counted along with tree characteristics. Data are being processed.

Objective 2) Develop novel tools to enhance the accuracy and precision of ambrosia beetle infestation and monitoring tactics.

- Co-PIs at Clemson Univ., NCSU, PSU, TSU, UGA, USDA-ARS (OH, NY), and VT evaluated trapping tactics to improve the monitoring of ambrosia beetle. Researchers evaluated high vs. low ethanol release lures, and ethanol-baited traps vs. ethanol-infused bolts. The high release ethanol lures generally performed better than the low release lures and the ethanol-infused bolts.
- Co-PIs at TSU tested wooden dowels infused with ethanol to monitor ambrosia beetle tunneling. Data are being processed but a type/species of wood was preferred by beetles.
- Co-PIs at Cornell tested five different traps for ambrosia beetles and a clear sticky trap consistently captured the highest number of beetles.
- Co-PIs at UGA, USDA-ARS (GA, OH), and VT deployed expansive grids of traps within cooperating commercial nurseries and orchards to characterize dispersal patterns of ambrosia beetles in relation to landscape factors and tree crops. Data are being processed.
- Co-PIs at UGA, TSU, and USDA-ARS (OH) conducted experiments to evaluate portable devices for detecting the emission of ethanol from stressed trees. Co-PI at UGA developed a 3-D printed sensor mounting device for housing a commercially available sensor. The sensor mounting device was tested and the basic design was moderately successful. Co-PIs at TSU tested a commercially available ethanol detector and alcohol enzyme strips for detecting ethanol. The ethanol detector performed well but the enzyme strips were less reliable. Researchers with the USDA-ARS tested a handheld air sampling device for detecting the emission of ethanol from flood-stressed trees. Ethanol was detected at 5 and 8 days after initiating flooding, but the technique is not sensitive enough to detect ethanol before ambrosia beetles begin infesting the trees.

Objective 3) Implement comprehensive management strategies:

- Co-PIs at Clemson, NCUSU, UGA, USDA-ARS (GA), and VT evaluated several insecticides against ambrosia beetles. Among all products tested, only bifenthrin and permethrin achieved a significant reduction of attacks. Other formulations were ineffective or partially effective.
- Co-PIs at the USDA-ARS (OH) and the UGA evaluated verbenone, methyl salicylate, and a proprietary formulation for interrupting the attraction of ambrosia beetles to ethanol. Verbenone and the proprietary formulation almost completely interrupted the attraction of beetles to ethanol. Methyl salicylate alone provided a slight reduction in trap captures, but verbenone + methyl salicylate was not more effective than verbenone alone. A complementary study determined that an ethanol release rate of 1 g/d was optimal for attracting ambrosia beetles. These results will be used to improve the repellent and attractant tactics for ambrosia beetles when tested as part of a push-pull strategy in FY23.
- Co-PIs at TSU tested four putative repellent products. The proprietary product resulted in a near complete shutdown of beetle attraction to ethanol-baited traps. The proprietary formulation was slightly less effective when traps became more attractive due to increased ethanol release rate.
- Co-PIs at TSU tested a plant defense elicitor (acibenzolar-S-methyl; ASM) against ambrosia beetle tunneling. Tunneling was significantly reduced in trees treated with ASM (drench or foliar) compared to the control. Drench application gave superior control of ambrosia beetle over foliar application. Only the plant tissues collected from the flooded plants produced ethanol.
- To test antagonistic fungi, a co-PI with UF established a collection of ambrosia fungi and potential antagonistic fungal strains. Selected strains will be tested in bioassays and for their ability to be incorporated into living trees to disrupt establishment of the ambrosia beetle fungal symbiont. The in vitro protocol to test the antagonistic effect of Trichoderma other strains against the ambrosia beetle fungal symbionts.

• Co-PIs at USDA-ARS (GA) assessed the effectiveness of different strains of commercially available entomopathogenic (insect-killing) nematodes on the granulate ambrosia beetle (Xylosandrus crassiusculus) and black stem borer (Xylosandrus germanus). This involved learning how to create a diet for rearing ambrosia beetles in the lab to produce colonies for experiments. Four commercial strains of nematodes were tested. Differences in efficacy were detected among the strains, and all of the strains produced higher mortality than the control group.

Objective 4) Determine the economics of ambrosia beetle damage and control interventions on orchard and ornamental tree crop stakeholders.

• Agricultural economists with the UGA, Auburn Univ., and University of Tennessee have begun developing the producer and consumer surveys and they will be launched during Spring 2023 to assess economic impact associated with ambrosia beetles infesting ornamental and orchard tree crops.

Objective 5) Transfer research-based information to stakeholders.

• An information brochure and newsletter article were prepared and distributed by Clemson University.
• A total of 32 presentations were given to stakeholders representing growers, producers, and the scientific community.
• The website https://stopab.org/ was established to provide the first level of outreach efforts. A content manager was hired to gather information from the different objective leaders, get feedback on website design, and collect news and products from the existing land-grant Extension programs. The site targets academics working with ambrosia beetles, growers working in pecan, nursery, or tree fruit, and individuals wanting to know more about the project activities and impacts.
• AB monitoring and management tactics have been established in all three cropping systems. Ambrosia beetle flight seasonal activity is available in near real time through the website to provide growers and extension agents with activity.
• Survey questions regarding importance of different types of content and communication methods with the different audiences have been developed and will be distributed to stakeholders with the survey sent in objective 4.

What opportunities for training and professional development has the project provided?

• Co-PIs at TSU are training a master's degree student in entomology. A master's degree student, doctoral student, and a postdoctoral researcher are also being training in plant pathology. All four positions are addressing research outlined in the SCRI proposal involving field and lab research for ambrosia beetles.
• Co-PIs at UGA have hired one master's degree student training in entomology, one postdoctoral researcher, one doctoral student training in engineering, and one doctoral student training in agricultural economics to address research outlined in the SCRI grant.
• Co-PIs at Clemson hired a technician and have provided training on field collection and ambrosia beetle identification.
• Summer interns from Hobart and William Smith Colleges and Saint John Fisher University participated in a two day informal workshop on establishing a potted planting of apple trees as part research activities at Cornell University. Students worked one on one with PIs to learn about the horticultural practices of establishing an orchard to be used in scientific field experiments. Training was provided on experimental design and practice data analyses. A PhD student at Cornell training in entomology and funded by the SCRI grant visited a PD lab with the USDA-ARS in Wooster, OH to receive training in ambrosia beetle rearing.
• A co-PI at the UF and an intern participated of the Bark Beetle Academy, October 19-23, 2022: Gainesville, FL, USA. Intern Carlos Sendoya received training in processing ambrosia beetle for fungi. A UF intern and postdoc participated of the International Technical Course Laurel Wilt of Avocado.
• Laboratory technicians and summer employees at PSU received training and became familiar with the project activities and gained necessary experience to obtain project objectives in the coming years.
• Co-PIs with the USDA-ARS in Wooster, OH hired and have started training two postdoctoral researchers in entomology. One of the postdocs is characterizing the dispersal patterns of ambrosia beetles into cropping systems. The other postdoc is optimizing repellent and attractant tactics for use in a 'push-pull' strategy against ambrosia beetles. Three undergraduate student interns were hired and received training in experimental design and ambrosia beetle identification during the spring and summer of 2022.
• A post-doc with the USDA-ARS in Byron, GA learned how to rear both ambrosia beetles and nematodes in a laboratory setting. Ambrosia beetle training involved visiting the USDA-ARS in Wooster, OH lab for a week to learn and develop rearing techniques. In addition, the postdoc has also gained experience in culture, bioassay techniques, and application of EPNs.
• Co-PIs at NCSU hired and began training a postdoctoral researcher in entomology to support SCRI research objectives. NCSU researchers also transferred knowledge by participating in the International Tree Fruit Association Conference in Hershey PA. A student at Texas A & M (Kelman Scholars Internship Program) hosted at NCSU conducted research on the

effect of ambrosia beetles and opportunistic fungi on young apple trees. Growers, Extension agents, crop consultants, and agrichemical industry representatives attended "Apple Field Day" at the NCSU Mountain Horticultural Crops Research and Extension Center to learn about the impact of ambrosia beetles in apple trees and the initiative that are being undertaken with the SCRI project.

How have the results been disseminated to communities of interest?

- The www.stopAB.org was launched in FY22. It includes a database of ambrosia beetle flight activity in participating regions of the U.S.
- The stakeholder advisory panel was formed. A virtual presentation was held on January 27, 2022 to update the SAP on administrative and research activities. PDs and co-PIs gave 15 minute presentations followed by questions and feedback from the SAP. A Box folder was created that stores documents, presentations, photos, etc. supporting the USDA-NIFA-SCRI project. The folder includes presentations of monthly meetings (Nov. 2021 - present) organized and led by PD Ranger.

Presentations

Addesso, K. M. 2022. Pests in the landscape - preparing for spring. Middle Tennessee Nursery Association Horticultural Expo. McMinnville, TN.

Addesso, K. and J. Oliver. 2021. Pest management in landscape trees. Extension Service Fall Lawn and Landscape Training. Rutherford Co.

Addesso, K. and J. Oliver. 2022. Middle Tenn. State Univ. Nursery Production Class tour of TSU Nursery Research Center and entomology / chemical ecology laboratories. McMinnville, TN.

Addesso, K. and J. Oliver. 2022. Warren County TN Third Grader Agricultural Day Display and Education Event.

Addesso, K. and J. Oliver. 2022. Cumberland County Extension Youth Outreach.

Addesso, K. and J. Oliver. Tenn. Tech Univ. Nursery Plant Class tour of TSU Nursery Research Center.

Addesso, K. and J. Oliver. 2022. Southern Division of American Phytopathological Society field and nursery tour at the TSU Nursery Research Center.

Addesso, K. and J. Oliver. Media Publicity: Phone interview with Tash Lemley (Multimedia Producer for "This is Nashville WPLN - Nashville Public Radio) to discuss invasive species issues.

Blaauw, B. 2022. Apple insect pest management update. North Georgia Apple Production Meeting. Ellijay, GA.

Cottrell, T. 2022. Managing insect pests across the season. Annual Meeting of the Southeast Pecan Growers Association.

Cox, K. and Rivera, M. 2022. Lake Ontario Fruit Program - Cornell University: Announcement of USDA-NIFA-SCRI ambrosia beetle research efforts.

Del-Pozo, A., D. Calpo and P. Schultz. 2021. Documenting the changes in species composition through time of ambrosia beetles in Virginia. ESA annual meeting.

Del-Pozo, A. 2022. Managing ornamental pests. Virginia Cooperative Extension. Pesticide Recertification Meeting. Winchester, VA.

Del-Pozo, A. 2022. Managing ornamental pests. Virginia Turf Council. Pesticide Recertification Meeting. Virginia Beach, VA.

Del-Pozo, A. 2022. Managing ornamental pests. Virginia Cooperative Extension. Pesticide Recertification Meeting. Painter, VA.

Del-Pozo, A., E. Hopkins, D. Calpo, J. Brindley and P. Schultz. 2022. Improving monitoring efforts for ambrosia beetles in Virginia. ESA Eastern Branch. Philadelphia, PA.

Del-Pozo, A. 2022. A research update on relevant pests for Virginia nurseries. ESA Eastern Branch. Philadelphia, PA.

Del-Pozo, A., E. Hopkins, D. Calpo, J. Brindley and P. Schultz. Improving monitoring efforts for ambrosia beetles in Virginia. 22nd Ornamental Workshop. Raleigh, NC.

Del-Pozo, A. 2022. Expanding the toolbox: applied research for improving IPM in specialty crops. Iowa State University. Entomology Department.

Gresham, S., Villani, S.M., and Walgenbach J. 2022. Pathogenicity of fungi associated with ambrosia beetles attacking apple trees. 2022 American Phytopathological Society. Pittsburgh, PA.

Gresham, S.D. 2022. Unraveling the relationship between ambrosia beetles and rapid apple decline. 2022 Apple Field Day. Mills River, NC.

Neupane, K., Ojha, V., Oliver, J., Addesso, K., Baysal-Gurel, F. 2022. Comparative efficacy of integrated fungicide, insecticide and blocking agent to manage Phytophthora root rot and Ambrosia beetles in flood stressed flowering dogwoods. 3rd Association of Nepalese Agricultural Professionals of Americas (NAPA) Biennial International Scientific Conference. Atlanta, GA.

Neupane, K., V. Ojha, J.B. Oliver, K.M. Addesso, and F. Baysal-Gurel. 2022. Efficacy of fungicides, insecticides and crop protectants to manage Phytophthora root rot and ambrosia beetles in a simulated flooding condition. Southern Division American Phytopathological Society 99th Annual Meeting. Chattanooga, TN.

Neupane, K., Ojha, V., Oliver, J., Addesso, K., Baysal-Gurel, F. 2022. Integrated management of ambrosia beetles and

Phytophthora root rot of flowering dogwoods in a simulated flooding condition. 2022 joint Southeastern branch & APS-CD Meeting. San Juan, Puerto Rico.
Neupane, K. 2022. Three minute thesis. MANRRS National Competition. Masters Division 1st Place.
Oliver, J., K Addesso, A. Witcher, N. Youssef, P. O'Neal, A. Morrison, S. King, D. Oi, R. Weeks, and L. Alexander. 2022. Fire ant update and other important woody ornamental insect updates. Tennessee Green Industry Field Day. Hosted by Tenn. State Univ. and Tenn. Nursery & Landscape Assoc. 25 Aug. 2022. McMinnville, TN.
Oliver, J., K. Addesso, C. Ranger, M. Reding, F. Baysal-Gurel, N. Youssef, P. O'Neal, M. Brown, V. Ojha, K. Neupane, C. Werle, A. Bray, J. Saroli, P. Schultz, and B. Sampson. 2022. Managing insect pests of nursery and landscape: ambrosia Beetle. Gulf States Horticultural Expo.
Parajuli, M. 2022. Plant defense elicitor reduces ambrosia beetle attacks in flowering dogwoods exposed to simulated flood stress condition. 3rd Association of Nepalese Agricultural Professionals of Americas (NAPA) Biennial International Scientific Conference.
Parajuli, M., Oksel, C., Neupane, K., Ranger, C.M., Oliver, J.B., Addesso, K.M., Baysal-Gurel, F. 2022. Plant defense elicitor reduces ambrosia beetle attacks in flowering dogwoods exposed to simulated flood stress condition. 2022 Tennessee Academy of Science Meeting. Nashville, TN.
Peter, K. 2022. Overview of rapid/sudden apple decline (RAD/SAD) in Pennsylvania (and elsewhere in the U.S.). Fundazione Edmund Mach, San Michele d'Aldige, Trento, Italy. Special seminar via Zoom.
Poudel, A., Oliver, J. B., Perkovich, C., O' Neal, P. A., Mafra-Neto, A., Saroli, J., Addesso, K.M. Assessment of ambrosia beetle attack using repellents in ethanol infused bolts to facilitate its effective management. Tennessee Entomological Society. Knoxville, TN.
Ranger, C.M. 2022. Exotic ambrosia beetles as wood-boring insect pests in nurseries and orchards. AmericanHort Cultivate '22. Columbus, OH.
Ranger, C.M. 2022. Biology and management of wood-boring ambrosia beetles. 2022 Green Industry Field Day, University of Tennessee.
Ranger, C.M., Villani, S., Joseph, S., Chong, J., Campbell, B., and J. LaForest. 2022. Ecology and integrated management of ambrosia beetles in Eastern US orchard and ornamental tree crops. 1st Annual Meeting with the USDA-NIFA-SCRI Stakeholder Advisory Panel.
Ranger, C.M. Monitoring and reporting in near real-time the flight activity of ambrosia beetles in tree orchards and nurseries. Annual meeting of the ESA.
Reding, M. and Ranger, C. 2021. Seasonal vulnerability of trees to colonization by ambrosia beetles. Annual meeting of the Entomological Society of America.
Villani, S.M. 2022. Ambrosia beetles, borers, and interactions with RAD/SAD incidence. 2022 International Tree Fruit Association Meeting in Hershey, PA.
Walgenbach, J. 2022. Research update. Blue Ridge Apple Growers Winter Conference. Flat Rock, NC.
Weber, A. and Gresham, S. 2022. Unraveling the relationship between ambrosia beetles and trunk disease in apple. Presented at the 2022 Apple Field Day in Mills River, NC.

What do you plan to do during the next reporting period to accomplish the goals?

{Nothing to report}

Participants

Actual FTE's for this Reporting Period

Role	Non-Students or faculty	Students with Staffing Roles			Computed Total by Role
		Undergraduate	Graduate	Post-Doctorate	
Scientist	0.4	0.3	1.9	2.4	5
Professional	0	0	0	0	0
Technical	3.1	0	0	0	3.1
Administrative	0	0	0	0	0
Other	0	0	0	0	0

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Computed Total	3.5	0.3	1.9	2.4	8.1

Student Count by Classification of Instructional Programs (CIP) Code

Undergraduate	Graduate	Post-Doctorate	CIP Code
1			26.07 Zoology/Animal Biology.
1			26.03 Botany/Plant Biology.
	2		26.07 Zoology/Animal Biology.
	2		01.01 Agricultural Business and Management.
	1		14.03 Agricultural Engineering.
		5	26.07 Zoology/Animal Biology.

Target Audience

The primary audience for this research is any grower who works with an agricultural commodity (e.g., nut trees, fruit trees, ornamentals) that are used as hosts for ambrosia beetle. Currently, insecticides are the primary method of ambrosia beetle management. The primary methods for sharing this research will be done through extension and outreach including grower meetings and publications that target these audiences (e.g., The Pecan Grower magazine). Target audiences reached by our efforts to improve the management of exotic ambrosia beetles include commercial and homeowner growers/producers of apple, peach and pecan crops in the Eastern, mid-Atlantic, and Southeastern U.S.; ornamental tree and shrub producers in the Eastern, mid-Atlantic, and Southeastern U.S.; retail nurseries and garden centers; arborists, ground managers, and landscape care professionals; county and regional extension agents; pest management specialists; master gardeners; agrichemical industry representatives; and the scientific community, including entomologists, plant pathologists, biologists, economists, engineers, undergraduate students, graduate students, and postdoctoral researchers. Specifically, the apple grower stakeholders of NY collectively represent more than 600 farm business and 50,000 acres of commercial apples in six growing regions.

Products

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2022	YES

Citation

Chong, J. 2022. How to prevent attacks of ornamental trees and shrubs by ambrosia beetles. Clemson University Cooperative Extension. (A trifold brochure for growers and retail nurseries.)

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2022	YES

Citation

Chong, J. H. 2022. New management strategies to be developed for ambrosia beetles. Newsletter of the SC Green Industry Association. February 2022.

Other Products

Product Type

Databases

Description

The www.stopAB.org was launched in FY22 and is active. It includes a database of amborisa beetle flight activity in participating regions of the U.S.

Ambrosia Beetle Activity Monitoring Network. (2022). Trap Catch Data. [Site based trap catch data]. Accessed on 8/31/2022 from www.eddmaps.org (281 records on 9 species from 11 reporters in 6 states.)

Product Type

Physical Collections

Description

Researchers with the University of Florida assembled an ambrosia fungi collection (~100 strains, several genera), from locally collected beetles associated to tropical fruit trees and landscape ornamentals (palms/woody ornamentals in the landscape). They also assembled a Trichoderma strain collection (25 strains from different sources). These strains have been barcoded (ITS/LSU marker). These, together with the ones that will be isolated from commercially available formulations, will be used in the in vitro pathogenicity assays. Selected strains, based on their antagonistic performance, will be used in the in-planta assays. We will screen these strains under the framework “no fungi, no beetles” since the objective is to prevent the growth of the nutritional symbiont so the beetle is unable to survive.

Product Type

Instruments or Equipment

Description

A prototype volatile sampling chamber was 3-D printed by engineers at the University of Georgia. The chamber will be used to detect the emission of stress-induced volatiles (i.e., ethanol) released by trees that attract ambrosia beetles.

Product Type

Databases

Description

A Box folder was created that stores documents, presentations, photos, etc. supporting the USDA-NIFA-SCRI project. All program staff have access to the folder and sub-folders. The folder includes presentations of monthly meetings (Nov. 2021 – present) organized and led by PD Ranger with all levels of program staff to discuss administrative topics pertaining to the SCRI ambrosia beetle grant. The folder also includes a virtual presentation organized and held on January 27, 2022 to update the Stakeholder Advisory Panel on administrative and research activities. PD Ranger and Objective Leaders (Villani, Joseph, Chong, Campbell, and LaForest) gave 15 minute presentations.

Changes/Problems

{Nothing to report}