Research Highlights from the Ambrosia Beetle Working Group

Background

Ambrosia beetles (Coleoptera: Curculionidae, Scolytinae) are increasingly being recognized as key pests of field-grown ornamentals. *Xylosandrus germanus* (Fig. 1A) and *Xylosandrus crassiusculus (*Fig. 1B*)* are two of the most important exotic ambrosia beetles infesting US nurseries. Ambrosia beetles are wood-boring pests that create galleries inside trees (Fig. 1C-D), where the adults and larvae consume symbiotic fungi introduced into the host. Due to their wood-boring behavior, detecting infestations can be difficult (Fig. 1E-G). Ethanol-baited bottle traps are used to monitor flight activity for timing insecticide applications (Fig. 1H). FNRI-funded ambrosia beetle research is focused on improving our understanding of the biology, behavior, and control of *X. germanus* and *X. crassiusculus.* Research highlights from three projects are featured on this poster.

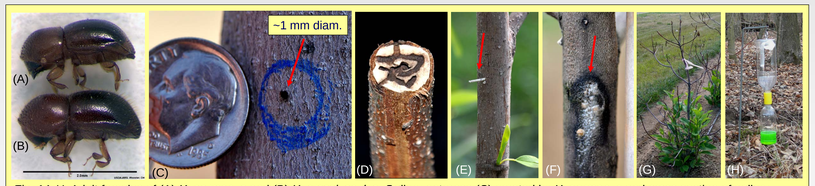

Fig. 1A-H. Adult females of (A) *X. germanus* and (B) *X. crassiusculus*. Gallery entrance (C) created by *X. germanus* and cross section of gallery chambers (D) where adults and larvae feed on symbiotic fungi. Symptoms of infestation include frass toothpick (E) during gallery creation, sap production (F) at site of colonization, and terminal dieback (G). Ethanol-baited bottle trap (H) used for monitoring ambrosia beetles.

Project I

Improving the Monitoring, Trapping, and Management Tactics of Ambrosia Beetles in the Nursery Agroecosystem

Team Members

Christopher M. Ranger[1], Michael E. Reding[1], Jason B. Oliver[2], Peter B. Schultz[3], and Charles Krause[1]

[1]Application Technology Research Unit, USDA-ARS, Wooster, OH; [2]Otis L. Floyd Nursery Research Center, Tennessee State Univ., McMinnville, TN; [3]Hampton Roads Agricultural Research and Extension Center, Department of Entomology, Virginia Tech, Virginia Beach, VA

Selected Research Highlights

• Ethanol is currently the most attractive lure, but attraction to *X. germanus* improves using a combination of ethanol and alpha-pinene. Additional blends of volatiles are being tested for synergistic activity with ethanol to improve lure attractiveness.

• Trapping efficiency improves with increasing ethanol release rate and traps low to the ground (≤1.7m) (Fig. 2).

• Initial spring flight of *X. germanus* and *X. crassiusculus* begins around 100 degree days. Peak flight activity typically occurs in late spring followed by a smaller peak in mid-summer, but varies between years (Fig. 3).

• Trunk injections of ethanol into individual trees rapidly induces attacks by *X. germanus* and *X. crassiusculus*, which aids in monitoring flight activity. Inducing attacks also allows for efficacy trials to be conducted with conventional and botanical insecticides (Figs. 4-6).

• Trunk applications of permethrin outperformed other products during insecticide efficacy trials. Systemics were ineffective (Fig. 6).

• Botanically-based repellents have also shown promise in efficacy trials as alternatives to conventional insecticides.

• *X. germanus* is more attracted to flood-stressed trees than unstressed trees (Fig. 7). *X. crassiusculus* is also attracted to stressed trees, but appears more willing to attack unstressed trees than *X. germanus* (Fig. 7).

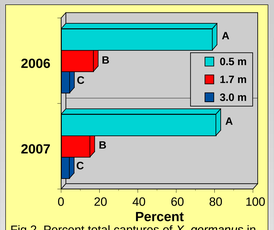

Fig.2. Percent total captures of *X. germanus* in Ohio using ethanol-baited traps positioned at different heights above the ground. Traps are most effective when positioned low to the ground.

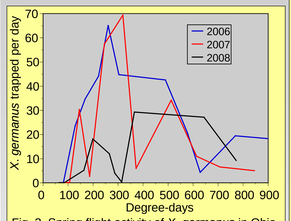

Fig. 3. Spring flight activity of *X. germanus* in Ohio documenting initial activity beginning around 100 degree days.

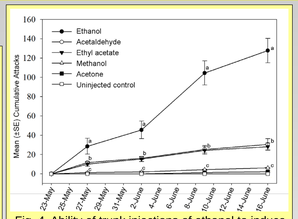

Fig. 4. Ability of trunk injections of ethanol to induce significantly more attacks by ambrosia beetles on *Magnolia virginia* compared to other stress-related volatiles. Reliably inducing attacks will improve monitoring and allow for efficacy trials to be conducted with conventional and biopesticides.

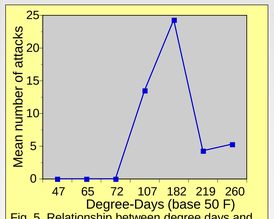

Fig. 5. Relationship between degree days and initial attacks by ambrosia beetles on *Magnolia virginiana trees* injected with ethanol and placed at a cooperating nursery.

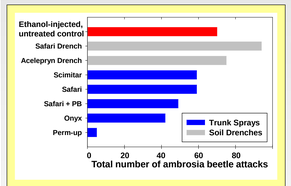

Fig. 6. Efficacy of conventional insecticides for preventing attacks by ambrosia beetles on Magnolia Tennessee. Trees were injected with ethanol prior to insecticide application to increase host attractiveness to ambrosia beetles.

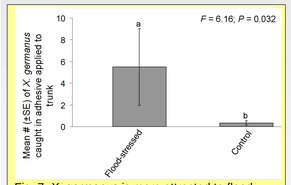

Fig. 7. *X. germanus* is more attracted to flood-stressed dogwoods compared to unstressed trees.

Project II

Microbial Control of Ambrosia Beetles *Xylosandrus crassiusculus* and *X. germanus* and their Symbiotic Fungi *Ambrosiella* spp.

Team Members

John D. Vandenberg[1], Louela A. Castrillo[1], Christopher M. Ranger[2], Michael E. Reding[2], Peter B. Schultz[3], and Jason B. Oliver[4]

[1]Bio-IPM Research Unit, USDA-ARS, Ithaca, NY; [2]Application Technology Research Unit, USDA-ARS, Wooster, OH; [3]Hampton Roads Agricultural Research and Extension Center, Department of Entomology, Virginia Tech, Virginia Beach, VA; [4]Otis L. Floyd Nursery Research Center, Tennessee State Univ., McMinnville, TN

Selected Research Highlights

• 77 isolates of symbiotic fungi have been isolated from *X. germanus* (Fig. 8A).

• DNA extracted from each isolate is being sequenced to compare geographic variability.

• A rearing protocol has been established for *X. germanus.*

• Commercially-available biocontrol fungi (*Beauveria bassiana* and *Metarhizium anispoliae*) limit growth of ambrosia fungi (Fig. 8B).

• Biocontrol fungi also cause mortality of *X. germanus* (Fig. 8C).

Fig. 8A-C. (A) Fungal symbionts (*Ambrosiella* species) isolated from *X. germanus* collected in NY (top row), OH (mid row), and VA (bottom row). (B) Biocontrol agent *Beauveria bassiana* placed in center of petri dish attacking an ambrosia beetle fungal symbiont as it spreads outwardly. (C) *X. germanus* adult fatally infected with the biocontrol agent *Metarhizium anisopliae* strain F52.

Project III

Biological, Microclimate, and Transport Processing Affecting Pest Control Application Technology

Team Members

Heping Zhu[1], Christopher M. Ranger[1], and Michael E. Reding[1]

[1]Application Technology Research Unit, USDA-ARS, Wooster, OH

Selected Research Highlights

• A sensor-based spray system has been designed that uses intelligent technologies to match crop structure with insecticide delivery (Fig. 9). Thorough coverage of trunks is important for ambrosia beetle management.

Fig. 9. SMART sprayer that uses laser sensors to adjust spray output based on the size, shape, and density of target.

Significance

✓ Optimizing trap design and lure blends will improve our ability to detect and monitor ambrosia beetles, thereby leading to more effective timing of insecticide applications.

✓ Rapidly inducing ambrosia beetle attacks by injecting solutions of ethanol into select trees represents a novel trap tree strategy that assists with detecting and monitoring, and potentially diverting beetles away from vulnerable nursery stock.

✓ Efficacy studies involving the ethanol-injection technique are providing growers with accurate information on insecticide and biopesticide efficacy.

✓ Understanding the importance of stress factors on nursery stock attractiveness to ambrosia beetles will aid in preventing, predicting, and detecting infestations.

✓ Isolating ambrosia beetle fungal symbionts will aid in comparing their genetic variability and pathogenicity to nursery stock.

✓ Determining the efficacy of biocontrol fungi for controlling ambrosia beetles and their symbiotic fungi will assist in developing sustainable management practices.

✓ A laser-based spray system will ensure adequate trunk coverage and minimize non-target excess.

Acknowledgments

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