Monitoring, Repellent Trials, and the Relationship of Tree Stress to Attack by Ambrosia Beetles in NY Apple Orchards

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• Trapping Trials to Determine Occurrence and Timing of *Xylosandrus germanus* (Black Stem Borer, BSB) Ambrosia Beetles in NY Orchards, 2018

[collaborators: Mike Basedow and Dan Donahue and Sarah Elone (ENY CHP); Tess Grasswitz and Elizabeth Tee (LOFP); Kenneth Lamm and Adam Nardone (Entomology)]

Methods

In 2018, traps were placed at a total of 24 orchards around the state (Wayne Co., 8 sites; Orleans Co., 5 sites; Geneva, 1 site; Champlain Valley/Capital District, 8 sites; Hudson Valley, 2 sites) to determine the occurrence and timing of BSB. Traps consisted of inverted 1.75-L plastic juice bottles, which had 6 x 10-cm rectangles cut out of each of the sides and were baited in the upper portion of the traps with pouch-style dispensers loaded with 10 ml of 95% ethanol; water with a small amount of dish detergent was placed in the cap was used as a capture medium. The traps were suspended from 1.2-m tall metal garden hangers at a 1-m height; at each site, traps were placed on an edge of the planting adjacent to a hedgerow, and, in all but the Hudson Valley locations, two additional traps were located in the orchard interiors, ~20–30 m from the orchard edge and in proximity to previously attacked trees, to verify their attractiveness. Traps were checked weekly starting in early May, before maximum temperatures of 20°C began to occur, and through the summer. Beetles trapped were collected, sorted and identified.

Results

Beetle activity began in most locations on 3-8 May in WNY and during the week of 14 May in ENY (corresponding to 63–87 and 91–157 $DD_{10°C}$ among trap sites in the Lake Ontario and ENY regions, respectively). The first peak flight was 24 May in Orleans Co. (200 beetles avg per edge trap, Fig. 1) and 29 May in Wayne Co. (over 120 beetles avg per edge trap, Fig. 3), and 23–28 May in the ENY locations, which had significantly lower trap numbers. An uncharacteristically similar size second flight was seen in both Orleans (19 Jul) and Wayne (2 Aug) counties this year, with peak numbers higher than those of the first flight in both locations (428 and 128 avg per trap, respectively). All the eastern NY sites recorded relatively low captures throughout the season (Figs. 5–7), with peak numbers of only 31 per trap in the Champlain (Fig. 5) and 4 per trap in the Hudson Valley (Fig. 7). The first adult flight ended on 13–14 Jun statewide. The second summer flight proceeded through August, as has been observed previously, with very few beetles captured after 1 Sep. Higher numbers of beetles were routinely captured at the orchard edges than in the interiors, although appreciable numbers were taken inside the blocks at some of the most heavily populated sites.

• Long-Lasting Insecticide Netting as a Preventive Against Ambrosia Beetle Attacks

[collaborators: Kenneth Lamm and Adam Nardone (Entomology)]

Recent efforts to prevent *X. germanus* attacks on trees have included proposals to wrap the trunks with a polyethylene long-lasting insecticide netting (LLIN) impregnated with an insecticide (deltamethrin) commonly used as an insect deterrent for livestock and human

habitations (D-Terrence, Vestergaard, Lausanne, Switzerland). We conducted a trial to evaluate this tactic using bolts of apple wood soaked in ethanol and placed in wooded sites.

Methods

Bolts (approx. 30 cm x 3 cm) of apple branches were soaked in 95% ethanol for 2–3 weeks, and were deployed starting 25 May in mixed hardwood forests at two sites (Arnot Forest, Van Etten, NY; and Mt. Pleasant, Freeville, NY) with known *X. germanus* populations, to attract the adults and assess their ability to attack and bore into the wood when bolts were wrapped with insecticide-impregnated netting and secured using cable ties. The bolts were hung at a 1-m height from a garden-type shepherd's hook hanger; each netting-wrapped bolt was paired with an unwrapped bolt, placed approximately 1 m away, as a comparison. Treatment pairs were replicated 5 times at each site, separated by approximately 20 m, and were retrieved and replaced on a weekly basis for 7 weeks. Bolts retrieved from the field were returned to the lab and inspected for the presence of attack sites (holes).

Results

Bolts wrapped with deltamethrin netting uniformly had significantly fewer BSB infestations than did the plain bolts (Figs. 8–9). Population pressure was higher at the Arnot Forest site than at Mt. Pleasant, and peak numbers were seen during the first week (ending 1 Jun) at both sites. Virtually no beetles were active during the second week because of a cold snap. Bolts wrapped with LLIN sustained only 0.3–14.3% of the attacks of the unwrapped bolts at Arnot Forest, and 0.0–17.3% at Mt. Pleasant; nearly all of the holes found in the wrapped bolts were at the cut ends of the bolts, which were not protected by the netting. Because of the impracticality of wrapping individual tree trunks with netting (up to the 2-m height at which infestations can often be found), this study should be regarded primarily as a test of the principle of using a physical-chemical barrier as opposed to an argument proposing it as an industry practice, until such time as some more pragmatic way is identified to incorporate this as a management tactic.

• Preventive Trials for Control of Ambrosia Beetles in NY Apple Orchards

[collaborators: David Combs, Kenneth Lamm, and Adam Nardone (Entomology)]

The ambrosia beetle *Xylosandrus germanus* has been documented to cause tree death and decline in dozens of NY apple orchards since 2013, mostly in young dwarf apple plantings. Preventive trunk sprays using chlorpyrifos or pyrethroids have not provided acceptable levels of control, nor have topical applications of the repellent verbenone, a component of anti-aggregation pheromone produced by various species of bark beetles that has been found to repel this and related species of scolytines from traps and attractive host trees.

Methods

In 2018, we tested trunk applications of different repellents for *X. germanus* control in potted apple trees (2-yr old 'HH1503' on G.935 rootstock), waterlogged to stress them to produce ethanol, and placed inside wooded areas directly adjacent to orchard sites. Additionally, individual ethanol lures were attached to each tree to increase their attractiveness to the beetles. The preventive treatments included different topical formulations and rates of methyl salicylate (a host defense and signalling compound), alone and combined with verbenone; additional treatments were the Systemic Acquired Resistance (SAR) activator Actigard (acibenzolar-S-methyl) and the grower standard insecticide Lorsban (chlorpyrifos). Each treatment was

replicated on 6 trees, which were arranged in 6-tree groupings at each of the sites, with groups of trees separated by a distance of 10 m (one group per treatment per site). Trunk and tree damage was assessed among the different treatments on 10 Jul, after the end of the first adult flight, and on 23 August, as the second flight was subsiding, to determine what effect these treatments had in preventing attacks by this beetle. On each date, half the trees in each treatment group were uprooted and brought to the lab, where they were dissected to count and characterize the infestation levels.

Results

- Infestation holes: On the 23 Aug evaluation date, all the repellent treatments had fewer infestation sites (holes) than the Untreated (flooded) checks. There was a similar trend on the earlier evaluation date, but not at statistically significant levels. On 10 Jul, Actigard had fewer holes than the Lorsban treatment. The untreated drought-stressed check had the lowest incidence, likely due to insufficient attractiveness of these trees to the beetles.

- Gallery contents, adults: The fewest number of galleries containing adults was seen in the Actigard and all repellent treatments, especially on the 23 Aug evaluation date.

- Gallery contents, brood: No brood was present in galleries on 10 Jul. On 23 Aug, lower numbers were seen in all treatments than in the Check except Lorsban, with zero in all treatments containing methyl salicylate.

- Empty or aborted galleries: The fewest numbers were found in the combination verbenone + methyl salicylate treatments, particularly at the higher rates.

In general, all the repellent treatments had fewer infestation sites (holes) than the Untreated Checks. The combined verbenone+methyl salicylate treatments had the lowest incidences of galleries containing adults or brood; effects were more pronounced according to rate. The combination formulation was more effective than either verbenone or methyl salicylate alone. SAR inducers like Actigard prime the host for stress events by inducing the expression of host defense genes; in apples, these have been used primarily for fire blight control. Only a single application of Actigard was used in these trials, but some trends were still apparent, which suggests the possibility of increased efficacy with multiple applications. We were apparently not able to generate enough stress to attract beetles in simulating drought stress in the trees by sealing off the root zone to exclude all external moisture (Table 1).

Acknowledgements

We wish to thank the following growers for allowing us to conduct these trials on their farms: T. Furber; J. D. Fowler; J. Teeple; W. Hermenet; Scott Palmer; K. Simpelaar; T. C. Chao; R. Lamont; C. Pettit; C. Plummer; M. Zingler; M. Forrence; S. Forrence; G. Bowman; D. Wilson; B. Sullivan; W. Gunnison; J. Toohill; B. Fix; D. Minard, R. Minard. We wish to thank Wafler Nursery for providing the trees and facilities for potting them; Michael Griggs, USDA-Ithaca, for providing technical supplies and support for conducting the research.

This work was supported by the donation of products for testing from ISCA Technologies (Jesse Saroli, Agenor Mafra-Neto), Dow AgroSciences (Alejandro Calixto), Chris Werle (USDA-Poplarville, MS), and funds from the USDA Hatch Program and the NY Apple Research & Development Program.

Table 1. Ambrosia beetle infestations in two-year old potted flooded apple trees treated with a single preventive trunk application of different repellents, Wayne Co. 2018

		Mean # Infestation Sites		Mean # galleries with Empty Galleries		Adults		Brood
Treatment[a]	**Rate**	**10 Jul**	**23 Aug**	**10 Jul**	**23 Aug**	**10 Jul**	**23 Aug**	**23 Aug**
Lorsban	1.5 qt/100 gal	6.3 a	9.2 a	2.8 a	4.0 a	3.6 a	4.1 ab	2.0 ab
Verbenone	10 g/tree	3.7 ab	2.9 b	2.8 a	1.0 bcd	0.9 b	1.6 bc	0.3 bc
MeSa	10 g/tree	2.0 bc	2.7 b	1.2 ab	2.1 abcd	0.8 b	0.8 c	0.0 c
Actigard	0.7 oz/100 gal	1.6 bc	4.7 ab	1.0 ab	3.1 ab	0.6 b	1.2 bc	0.3 bc
Verb+MeSa	1 g/tree	0.8 bc	1.9 b	0.2 b	1.6 bcd	0.6 b	0.3 c	0.0 c
Verb+MeSa	10 g/tree	1.6 bc	1.0 b	1.1 ab	0.9 bcd	0.4 b	0.1 c	0.0 c
Verb+MeSa	35 g/tree	0.0 c	1.3 b	0.0 b	0.7 cd	0.0 b	0.7 c	0.0 c
Control (flooded)	—	3.1 abc	9.8 a	2.6 a	2.8 abc	0.6 b	5.4 a	3.4 a
Control (drought)	—	0.4 bc	0.3 b	0.0 b	0.1 d	0.4 b	0.1 c	0.0 c

Values in a column followed by the same letter not significantly different ($P < 0.05$, Student's t-test.) Data pooled across three replicated orchard sites.

[a] Lorsban, chlorpyrifos; MeSa, methyl salicylate; Verb, verbenone; Actigard, acibenzolar-S-methyl

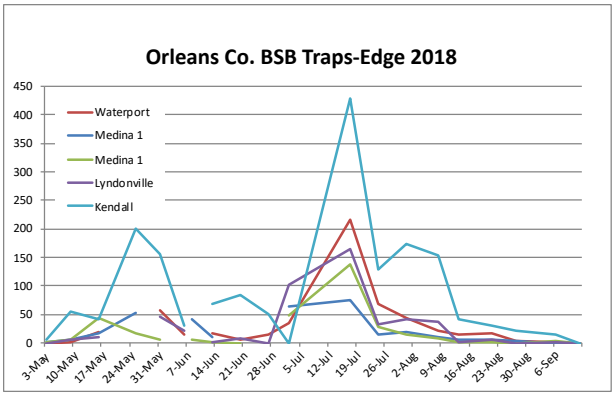

Fig. 1. Orleans Co. trap numbers, edge

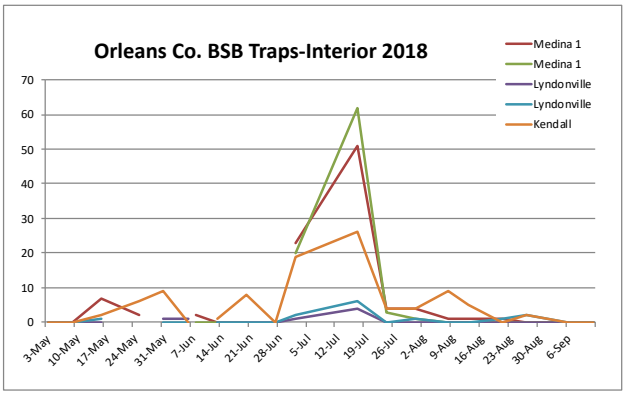

Fig. 2. Orleans Co. trap numbers, interior

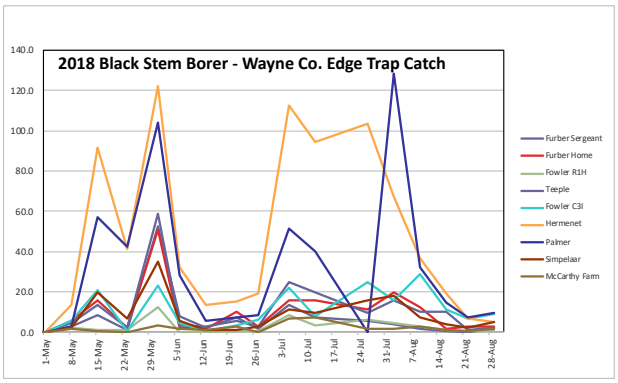

Fig. 3. Wayne Co. trap numbers, edge

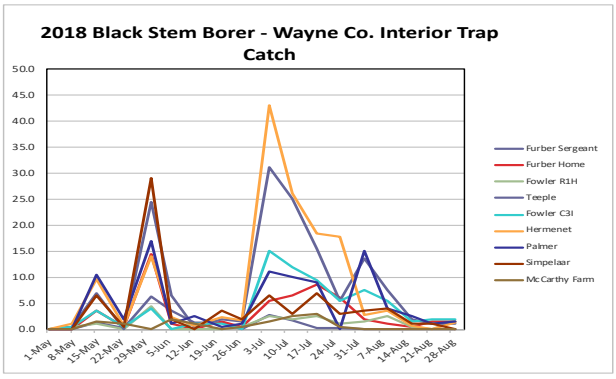

Fig. 4. Wayne Co. trap numbers, interior

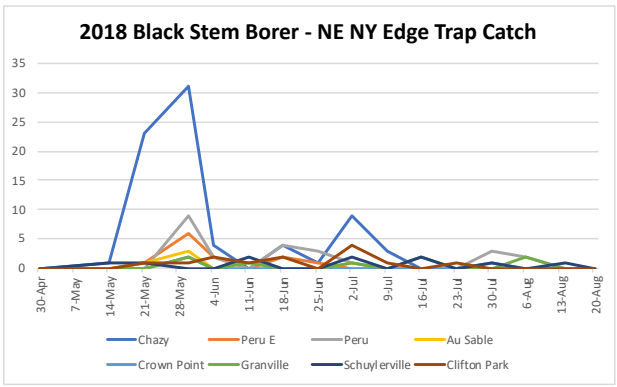

Fig. 5. NE-NY trap numbers, edge

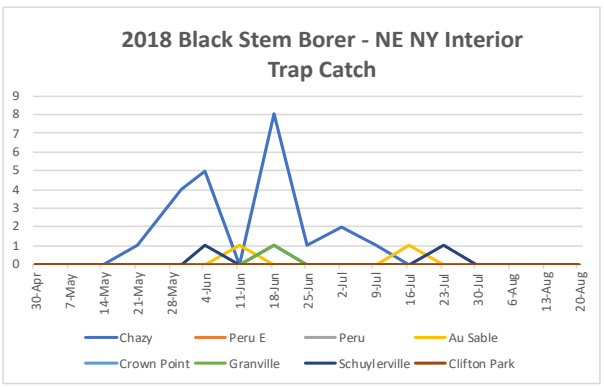

Fig. 6. NE-NY trap numbers, interior

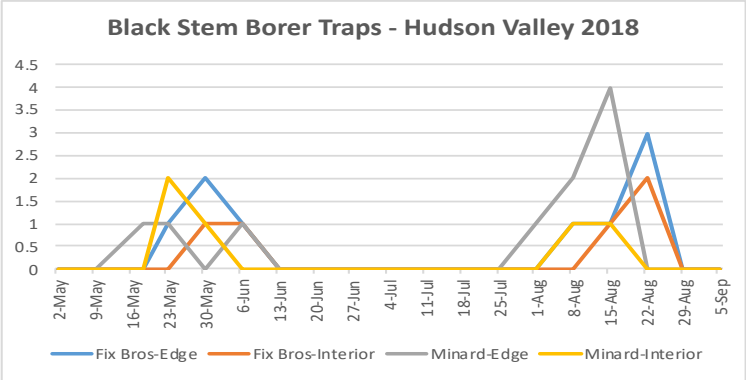

Fig. 7. Hudson Valley trap numbers

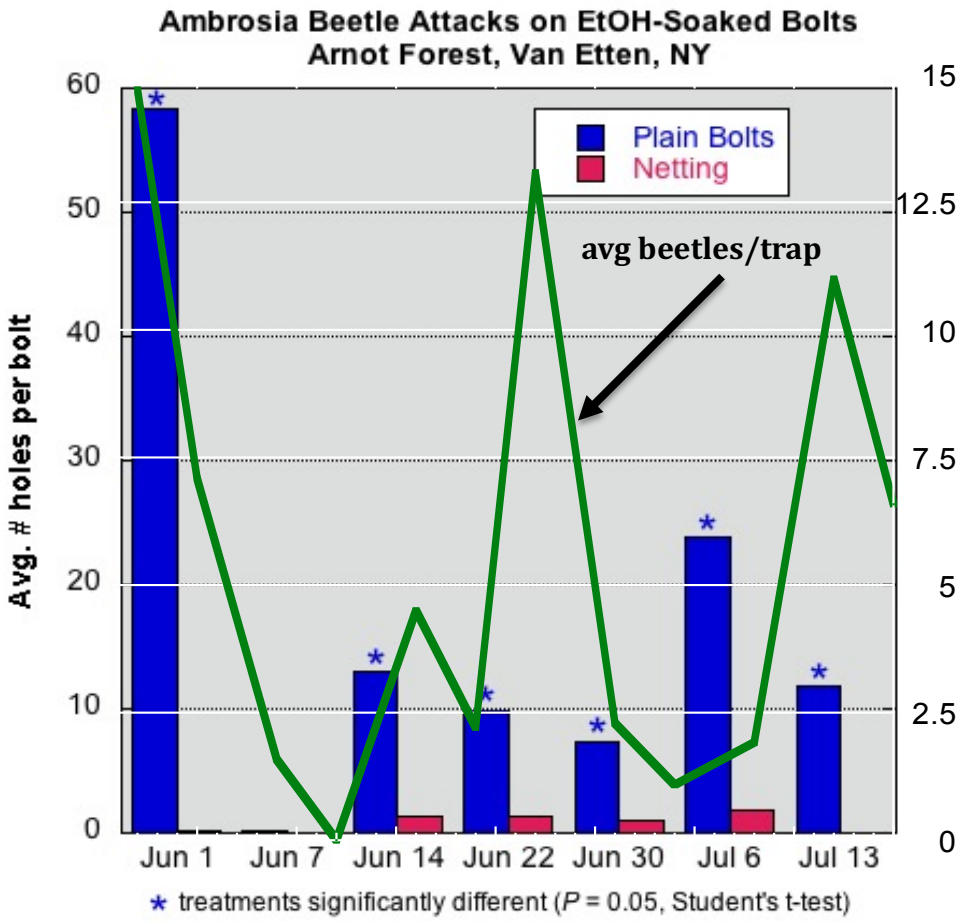

Fig. 8. BSB attacks on bolts wrapped with insecticide-impregnated netting, Arnot Forest.

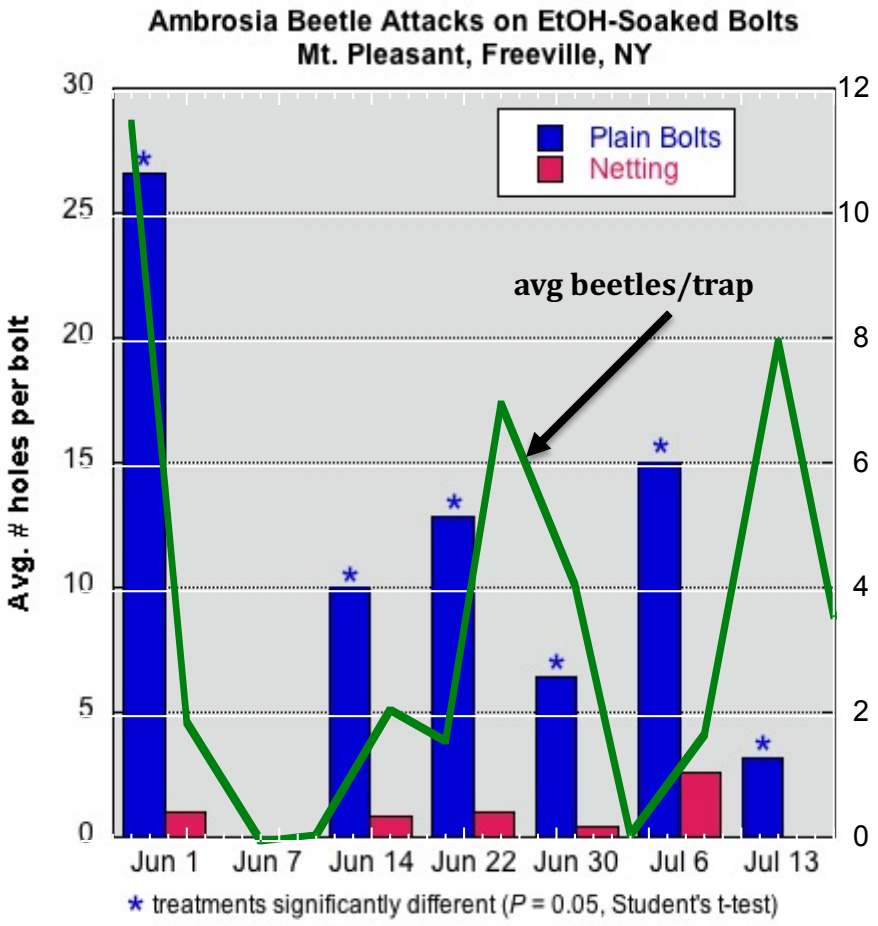

Fig. 9. BSB attacks on bolts wrapped with insecticide-impregnated netting, Mt. Pleasant.