Ambrosia beetle (*Xylosandrus germanus*) infestations and management trials in high-density apple orchards

Arthur Agnello, Deborah Breth, Abagail Davis and Elizabeth Tee
Dept. of Entomology, Cornell University

Background

The ambrosia beetle *Xylosandrus germanus* (Blandford) (Coleoptera: Curculionidae: Scolytinae), also known as the black stem borer, is a serious pest in ornamental tree nurseries and landscapes in North America. A native of Asia (mainly Japan, Korea, Vietnam, China, and Taiwan), it now occurs in central Europe and the US, first documented here in New York, in greenhouse-grown grape stems. Since then, it has become established in much of the United States. It has previously been noted as a pest in ornamental nurseries, with a wide host range including oak, elm, red maple, beech, and other hardwood species. It attacks and bores galleries into the wood of trunks or limbs of apparently healthy plants and those that are stressed, dying or recently dead. Galleries are excavated by the females, and comprise entrance tunnels, brood chambers containing eggs, and branch tunnels where young develop. The species is bivoltine and overwinters as adults, primarily females, in galleries of its host plants.

The term "ambrosia beetle" refers to species that derive nourishment during the larval and adult stages from a mutualistic "ambrosia" fungus carried by the adult female in mycangia (internal pouches) and introduced into host plants during gallery excavation. The ambrosia fungus associated with *X. germanus* is *Ambrosiella hartigii* Batra, visible in the galleries as an abundant grayish-white mycelium growth. It is this fungal growth that the insects feed on, and not the host plant tissue. However, its presence signals the tree that it is under attack, and as the tree walls off its vascular system, symptoms develop including wilting, dieback, tree decline and death.

In 2013, infestations of *X. germanus* were seen for the first time in commercial apple trees, in multiple western NY sites; some affected trees additionally exhibited fire blight symptoms. Indeed, one of the few instances of streptomycin-resistant fire blight in 2013 was obtained from an *X. germanus infestation.* In addition to fire blight, mycelium of *Fusarium* was observed in some heavily infested samples in 2013, and *Nectria haematococca* (*Fusarium solani*) was recovered from several beetles in 2014. By the end of 2013, hundreds of trees were removed in high density apple plantings during the middle of the growing season. In 2014, trapping and inspection efforts were initiated in the general apple-growing region along Lake Ontario. To date, at least 30 additional infestation sites have been documented, extending as far as to Long Island, and it appears that these ambrosia beetles may have been present in the area for some years before first detected, as they are now being found in nearly every orchard showing these tree decline symptoms; several hundred trees have already been destroyed.

Current studies suggest that this species invades from nearby wooded areas, but there is relatively little research on movement of ambrosia beetles from wooded areas into nurseries or orchards. The insects attack stressed (including some apparently healthy) trees, boring into the trunk or limbs to create galleries where young develop. A variety of stressors, including flooding, drought, and freezing exposure have been identified as potential causes of physiological stress that preferentially attract ambrosia beetles. Trees under this type of stress produce several types of volatiles, among them ethanol, which has been documented to be a strong attractant to the beetles. In commercial ornamental tree nurseries, growers routinely rely on insecticide trunk sprays to prevent new infestation and colonization of trees by ambrosia beetles. For effective protection against these insects, pesticide applications must be closely timed with insect attack, applied repeatedly, and/or have long residual activity. A reliable monitoring system would give growers the ability to coordinate any needed control treatments with beetle activity. Ethanol-baited traps have been demonstrated to be useful for monitoring the flight activity of ambrosia beetles in ornamental nurseries.

Methods

In 2015, we assessed black stem borer (BSB) adult occurrence and distribution in several New York apple growing regions, using ethanol-baited bottle traps hung on metal garden hangers at a 1-m height, placed along the edges of orchards bordered by hedgerows and woods likely to be a source of immigrating beetles. Additional traps were located (in the western NY orchards) adjacent to previously attacked trees, to verify their attractiveness. Traps were checked weekly starting at the end of April, before maximum temperatures of 20°C began to occur, and continuing until the first week of September. Traps were placed on 14 farms in Wayne Co., 19 farms in Orleans and Niagara Counties, 11 farms in the Hudson Valley, and 9 farms in the Champlain Valley. BSB adults were captured at nearly all of the sites, and were most numerous in the western NY locations. First activity was noted in WNY on May 5, and there were higher counts along the orchard edges than in the interiors. June 2 was the peak of beetle emergence from the overwintering sites, and 1st generation adults emerged from July 6-27. On August 5, the 2nd generation adults emerged, with catch continuing into September.

The efficacy and practicality of trunk sprays using chlorpyrifos and two pyrethroid products (lambda-cyhalothrin and gamma-cyhalothrin) was evaluated against infestations of ambrosia beetles on two commercial farms having documented infestations (Sodus, NY and Medina, NY). All treatments were replicated in randomized complete plots at each of the individual test sites. Potted 2-yr old Mutsu trees from the nursery were placed in turn into larger pots, which were then flooded to induce stress and promote ethanol production. These potted trees were placed in the rows between the orchard trees, with 5 pots per replicate, and 4 replicates per treatment at each site. The trunks of the potted trees plus the orchard trees were sprayed using a handgun sprayer (Rears Nifty Pul-Tank) on May 7 and 8, before the start of major BSB flight. The treatments were:

- chlorpyrifos (Lorsban Advanced); 1.5 qt/100 gal
- lambda-cyhalothrin (Warrior II); 2.56 fl oz/100 gal
- gamma-cyhalothrin (Declare); 2.05 fl oz/100 gal
- Untreated Check (potted trees only; orchard trees in Check plots sprayed with chlorpyrifos)
- Grower Standard (Lorsban 1.5 qt/100 gal applied by grower using airblast sprayer)

Treatment efficacy was assessed for evidence of new infestations by preliminary inspection of treated and untreated trees on July 9, after termination of the first flight. A final evaluation of the potted trees was conducted on August 19; these were destructively sampled to document all occurrences of holes, galleries, adults, and brood in the treated trees.

Results

In the Preliminary Evaluations, efficacy of the handgun treatments in the potted trees was not consistent between the two sites, with the Lorsban plots tending to have lower levels of infested trees than the Warrior plots at the Sodus site, but the opposite trend occurring at the Medina site (Table 1). Damage in the Lorsban airblast (Grower Standard) treatment was low at both sites; however, because these plots were situated in a different part of each orchard (to prevent the airblast application from interfering with the handgun treatments), there was almost certainly a site variability factor introduced in regard to BSB population pressure, so it is difficult to make any reliable inference about comparative treatment efficacy as a result. There were no significant treatment differences in percent infested trees in the established orchard trees.

Results of the Final Evaluations varied somewhat between sites (Table 1). At Sodus, there was a slight trend toward lower infestations (infestation holes, presence of galleries, gallery contents) in the sprayed vs. Check treatments; however, there was no real separation among the handgun treatments. The Grower Standard was lower in all categories. At the Medina site, the Lorsban handgun treatment generally had the lowest infestations, with the pyrethroid products not performing as well. The Grower Standard was again lower in all categories.

Table 1. Ambrosia beetle insecticide control trials, 2015

	Preliminary Evals - July 9		Final Evaluations - Aug. 19				
	% infested trees		Avg # holes/	Avg. # infestation sites with presence of			
Treatment	Potted	Orchard	tree	gallery	live adults	brood	dead adults
Sodus							
Check	35.0 a	-	2.25 a	1.30 a	0.45 a	0.25 a	0.05 a
Warrior	40.0 a	95.0 a	1.00 ab	0.80 ab	0.05 bc	0.05 a	0.10 a
Declare	30.0 a	75.0 a	0.95 ab	0.85 ab	0.40 ab	0.30 a	0.05 a
Lorsban	15.0 a	77.5 a	1.30 ab	0.85 ab	0.25 abc	0.20 a	0.05 a
Grower Std	20.0 a	25.0 b	0.25 b	0.20 b	0.0 c	0.05 a	0.0 a
Medina							
Check	45.0 a	-	1.65 ab	1.00 ab	0.10 a	0.25 a	0.0 a
Warrior	5.0 b	25.0 a	2.25 a	1.45 a	0.10 a	0.25 a	0.15 b
Declare	20.0 ab	45.0 a	1.00 bc	0.45 bc	0.0 a	0.05 ab	0.0 a
Lorsban	35.0 a	40.0 a	0.35 c	0.15 c	0.0 a	0.05 ab	0.0 a
Grower Std	5.0 b	20.0 a	0.15 c	0.10 c	0.0 a	0.0 b	0.0 a

For each site, values in the same column followed by the same letter are not significantly different ($P < 0.05$, Student's t-test).

These trials will likely need to be repeated for a clearer indication of the most effective measures to take, but although recommendations for controlling this pest are still being formulated, it appears that tree health – avoiding stress to the trees – will be an important factor in BSB management. Current recommendations are for growers to remove and destroy any infested trees detected in a planting, to prevent new infestations in surrounding trees. Trapping and monitoring adults using ethanol lures is a useful and informative tactic, but the fact remains that ambrosia beetles are difficult to control with insecticides. Sprays must be closely timed with beetle attacks, and multiple applications may be necessary. Using a material with long residual activity is a plus, and the best timing is likely against emerging overwintered brood, according to the literature. Because these insects do not feed on the tree tissue, systemic insecticides are not effective. In addition, current regulatory actions suggest that the loss of Lorsban as an option is imminent, which will add to the challenge of finding a suitable control method for this insect.

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