EMERALD ASH BORER TRAP TREES: EVALUATION OF STRESS AGENTS AND TRAP HEIGHT

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ABSTRACT

Emerald ash borer (*Agrilus planipennis* Fairmaire), an Asian buprestid discovered in June 2002, has killed an estimated 15 million ash trees (*Fraxinus* sp.) in southeast Michigan. Larvae feed in serpentine galleries in the phloem, disrupting translocation of water and nutrients. At least 16 *Fraxinus* species in North America are threatened by this exotic pest. Operational programs to contain emerald ash borer (EAB) populations are under way in Michigan, Ohio and Indiana. Quarantine regulations and public awareness campaigns have been implemented to prevent transport of infested ash firewood, trees, or logs.

Effective methods to (A) detect newly established and low-density EAB populations; (B) survey and delimit the extent of infestations; and (C) monitor eradication sites are critical components of the EAB operational programs. Researchers have not yet developed effective lures for adult beetles, which appear to rely on ash volatiles rather than pheromones to locate hosts. Visual surveys for EAB detection that rely on external symptoms such as D-shaped exit holes left by emerging adults are problematic. In recently established or low-density populations, many larvae require 2 years for development and even when exit holes are present, they are likely to be high in the canopy on most trees. Climbing trees or destructive sampling to look for larval galleries is difficult and expensive, especially on a large scale. Because native *Agrilus* sp. Beetles, including bronze birch borer (*A. anxius*) and two-lined chestnut borer (*A. bilineatus*), are attracted to stressed or declining host trees, we hypothesized that EAB may demonstrate similar preferences.

Our primary objective was to determine whether stressed ash trees are more attractive to EAB than relatively healthy ash trees. In 2003, 2004, and 2005, we compared the number of adult beetles captured on sticky traps and the density of larvae on healthy, stressed and wounded ash. In 2005, we also evaluated effects of tree exposure/shading and trap height on EAB adult capture rates.

Cut logs and stressed trees—2003 study

In May 2003, we selected 18 similarly-sized ash trees at each of four sites in southeast Michigan (72 trees total). In addition, freshly cut white ash (F. americana), black ash (*F. nigra*) and green ash (*F. pennsylvanica*) logs (2 m long x 15 cm diam) from uninfested areas were transported to each site. We established six blocks at each site; each block included a healthy ash, a girdled tree and a tree frilled every 3-6 cm with a hypo-hatchet and Pathfinder herbicide. Three trap logs, one of each species, were placed within the blocks (total of 18 trap logs per site; 72 trap logs total). Trap logs were set vertically and supported by a t-post. A 20-cm-wide band of plastic shrink wrap was wrapped around the trunk of all trap trees and logs, then covered with Tanglefoot. Bands were checked weekly and EAB adults were removed and recorded. Trees were felled in the winter and sections of the trunk and large limbs were debarked to quantify larval density.

In 2003, we found that significantly more EAB adults were captured on girdled trees at all three sites than were captured on the untreated control trees or any of the trap logs. On average across all sites, roughly five times as many beetles were captured on the girdled trees as on the control trees. Trees treated with the hypo-hatchet and herbicide remained generally healthy throughout the summer. They consistently captured more adults than healthy trees or logs but differences between herbicide and control trees were not significant at any site. We found that girdled trees functioned as a sink for EAB oviposition at two sites where EAB densities were low or moderate in 2005. At these sites, larval density differed significantly among treatments and was at least four to five times higher on girdled trees where than on control trees. At two sites where EAB densities were high, nearly all phloem was consumed & larval density did not differ among treatments. Few eggs were laid on cut logs; larval density averaged < 3 larvae per m^2 regardless of site or log species.

Wounds versus stress—2004 study

In 2004, we determined whether EAB adults were attracted to volatiles emitted from the open wounds associated with girdled ash trees or to volatiles associated with stressed ash trees. We compared adult EAB capture on banded white ash trees in three closed-canopy forests in Washtenaw County. In May 2004, we established six blocks at each site, each consisting of four similarly-sized white ash. Trees within blocks were randomly assigned to one of four treatments: (A) standard horizontal girdling (stress + wound); (B) Garlon 4 herbicide (stress, no wound); (C) vertical wounding (wound, but little stress); or (D) healthy (no stress or wound) (72 trees total). On the wounded trees, we removed an area of bark equal in size to the area removed on the girdled trees. Because most of the phloem remained intact, however, physiological stress was minimal. Adult EAB were collected weekly from sticky bands on the trunk of each tree as before. Trees were felled and sections of the trunk and branches were again debarked in winter to quantify larval density.

In 2004, trees treated with the Garlon 4 herbicide obviously began to decline in June and were dead by mid to late July. Significantly more adult beetles were trapped on the highly stressed Garlon trees than on control trees, but differences in adult capture rates among treatments were not substantial. In late fall when we felled and debarked trees, we found a girdled tree (horizontal girdle) had significantly more EAB larvae than control, wounded or herbicide trees. On average, roughly twice as many larvae were present on the girdled trees as on the control or Garlon trees. Garlon trees, which declined and died by late July, were probably unsuitable hosts by the time most adult beetles were ovipositing. Overall, results indicated that EAB adults were more attracted to volatiles emitted by stressed trees than to volatile compounds associated with wounding.

Comparison of stress agents—2005 study

In 2005, we again compared adult EAB attraction to healthy ash trees and trees treated by either girdling (a physical stress), Garlon 4 herbicide (a chemical stress) or methyl jasmonate (a plant stress-eliciting hormone). Using a completely randomized block design, we established 18 blocks at three sites (total of 72 trees). Trees in nine of the 18 blocks were in open areas; the trees in the other nine blocks were in forested sites. Amount of shading experienced by each tree was qualitatively ranked as 1 (open-grown), 2 (super-dominant extending above the canopy), 3 (shading on one aspect), 4 (edge tree) and 5 (mostly shaded). Sticky bands were placed at 1.5 m on all trees. We placed a second sticky band 3-5 m high and suspended two purple sticky panels (20 x 30 cm in size) in the canopy of half of the trees at each site. Sampling to quantify larval density is in progress.

Overall in 2005, five times more adult EAB were captured on girdled trees than on control trees. Trees treated with Garlon herbicide or exposed to methyl jasmonate captured an intermediate number of beetles and were significantly more attractive to beetles than control trees. Open-grown and super-dominant trees with exposed canopies tended to capture more beetles than trees growing in shaded conditions. Low sticky bands (1.5 m), which are simple to apply and check, captured as many or more EAB as high sticky bands and purple panels throughout the flight season.

Summary and Conclusions

Girdled trees were consistently more attractive to EAB adults than untreated, relatively healthy control trees or cut logs in all 3 years. Until effective lures and traps are developed for EAB, girdled trees remain the most effective means to locate low-density EAB infestations. Results also show that adult EAB respond to volatiles produced by stressed trees, rather than volatiles associated with wounds. Ongoing laboratory studies have similarly shown that the suite of volatiles emitted by stressed ash seedlings differs from the volatiles emitted by healthy seedlings and that EAB adult females are attracted to volatiles from stressed seedlings (see Poland et al., this volume). These results, along with our field studies, indicate that stress-related volatiles should remain the primary focus for lure development. In addition, increased understanding of EAB behavior can likely improve effectiveness of trap trees and eventually EAB lures. For example, sticky bands on open-grown trees or dominant trees were more likely to capture adult EAB than bands on shaded trees in closed-canopy settings. Results from these and related studies indicate that debarking trees to find larval galleries is especially important for EAB detection in low density populations and closed-canopy forests, where fewer adult EAB were likely to be intercepted by sticky bands on tree trunks.