EFFECTS OF HOST STRESS ON EMERALD ASH BORER DEVELOPMENT: WHAT MAKE A GOOD HOME?

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ABSTRACT

Background. Since 2003, we have documented a two-year larval development of emerald ash borer (EAB), *Agrilus planipennis* Fairmaire, at a number of newly infested outlier sites. For example, we debarked over 100 ash trees in February 2004 at an outlier site that was infested when nursery trees were planted in 2003. We found a total of 22 larvae in eight relatively healthy trees growing within 800 m of the origin of the infestation; of those 22 larvae, at least 75% were first, second, or third instars and would likely have required an additional summer of feeding to complete development (a 2-year life cycle). A ninth tree, which was highly stressed, contained a total of 36 larvae; all of the larvae on this tree were prepupae or fourth instars and would likely have emerged as adults the following summer (a 1-year life cycle). If the prolonged development of EAB larvae documented at this site is typical, it would strongly influence EAB spread, population dynamics, and survey activities of program managers.

Methods. In 2006, we began to examine the role of tree stress on the development, mortality and within-tree distribution of EAB larvae. Our study involved a randomized block design with 90 healthy green ash trees (average DBH of 12.3 ± 0.3 cm) in a 15-year-old, well-stocked ash plantation. There were 30 trees receiving one of three treatments: 1) girdling, 2) exposure to methyl jasmonate (MeJa), a stress-elicitor, or 3) untreated controls. This site had a very low, nearly undetectable population of EAB. An average of 0.9 ± 1.8 adult beetles per tree were trapped on sticky bands during the summer; nearly all of the 81 beetles were trapped on girdled trees. All 90 trees were felled between January and March 2007 and bucked into 1 m sections to height of 7 m. Each section was debarked and larvae identified to instar. Fourth instars and prepupae were recorded as one-year larvae, while first, second, or third instars were classified as 2-year larvae because they would likely have fed for an additional year to complete development. When dead larvae were encountered, they were assigned to one of three categories: predation by woodpeckers, cannibalism, or death from unknown causes (most likely a pathogen or desiccation).

Larval density and within-tree distribution. Larval density varied greatly among treatments. Girdled trees had an average of 57.62 ± 13.13 larvae per m^2, while control and MeJa trees had an average of 3.92 ± 1.60 larvae per m^2 and 5.76 ± 5.06 larvae per m^2, respectively. Larval density was consistently highest at 3 to 4 m aboveground regardless of treatment. Woodpecker predation was the most common cause of death, causing 61% of all larval mortality. We also found that 70% of woodpecker attacks occurred at least 4 m aboveground.

Tree Stress and Larval Development. A significantly greater proportion of larvae on girdled trees were 1-year larvae (57.3%) compared to larvae on control trees (18.9%) and MeJa-treated trees (11.9%). When calculated by height and treatment, about 90% of larvae below the girdle (0 – 1 m) were 1-year larvae, while about 50% of larvae above the girdle (1 – 7 m) were 1-year larvae. The pattern of larval feeding was also different below the girdle than above the girdle. The horizontal distance that a larva traveled (the furthest horizontal distance that the gallery extended) averaged 10 cm below the girdle compared with 3 cm above the girdle. The average horizontal distance traveled for larva on control and MeJa-treated trees was also 3 cm at all heights. Only galleries made by larvae that had reached the prepupal stage were measured.

We repeated the study in 2007 with 90 new trees and applied the same three treatments. The number of adult EAB captured on sticky bands during the summer increased by a factor of ten over the 2006 results. We expect to see a similar increase in larval density: debarking of these study trees is in progress.