EMERALD ASH BORER MICROBIAL CONTROL WITH THE ENTOMOPATHOGEN BEAUVERIA BASSIANA GHA FORMULATED AS BOTANIGARD®

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ABSTRACT

The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), a sporadic wood-boring pest native to northeastern Asia, was found attacking ash trees (*Fraxinus* spp.) in southeastern Michigan in 2002. Despite regulatory efforts to quarantine and eradicate EAB, this invasive beetle has continued to spread throughout Michigan, Ohio, Indiana, and Ontario, Canada, and caused the death of millions of ash trees. Infestations have also been found in Illinois, Maryland, Pennsylvania, and West Virginia. EAB adversely impacts our forest biodiversity, ash resources, and urban areas as ash species are widely distributed in forested ecosystems and planted as shade trees and ornamentals. While eradication may be a viable option for small, outlier infestations, effective and environmentally sound management measures are clearly needed for containment and suppression of dense EAB populations over large areas to help protect our ash resources in other areas in North America.

Entomopathogenic fungi were determined to be the major mortality factor of EAB in Michigan field populations during a survey of EAB natural enemies in 2002. We found localized fungal epizootics and isolated more than 100 strains from five fungal species. Fungal infections were most prevalent among mature larvae or prepupae, which are found near the bark surface during winter. From 2003-2005, we evaluated insect-pathogenic fungi for management of EAB by 1) screening potential fungal isolates for virulence using laboratory bioassays, 2) evaluating the most virulent strain for efficacy against EAB using different treatments in greenhouse and caged-field trials, and 3) expanding efficacy studies using fungal applications on infested ash trees in the field. The results of these studies are summarized below.

Laboratory bioassays showed adult EAB were susceptible to *Beauveria bassiana* and *Metarhizium anisopliae*. Significant time-mortality response was found for each isolate tested. Isolate *B. bassiana* GHA killed EAB adults at a faster rate when compared to other isolates tested, with the lowest average time-to-death values. Significant concentration-mortality responses were also observed for two registered *B. bassiana* GHA bioinsecticide formulations, BotaniGard® ES and Mycotrol® O, which were applied as foliar sprays using a spray tower. The LC_{50} values ranged from 114.5 to 309.6 conidia/cm^2 and 18.4 to 797.3 conidia/cm^2 for BotaniGard® and Mycotrol®, respectively (Liu and Bauer 2006).

Subsequent greenhouse and field trials with formulated *B. bassiana* GHA demonstrated its lethal and sublethal effects on emerging EAB adults as well as active larvae. Adult infection rates ranged from 27.7 to 37.7% for the application rate of 25-75 × 10^{13} conidia/ha under greenhouse conditions and 58.5 to 83% for the application rate of 10 and 100 × 10^{13} conidia/ha in the field. The sublethal effects of *B. bassiana* GHA was observed on adult longevity, female fecundity, and larval development. The longevity of adult EAB surviving the fungus was reduced from approximately 22 days to 13 days in females and from approximately 28 days to 14 days in males. In addition, fewer eggs were produced by *B. bassiana* GHA-treated adults, and surviving EAB larvae took longer to develop than controls. We also evaluated the efficacy of *B. bassiana* GHA impregnated fungal bands, which were wrapped around the trunks of infested trees during the period of peak EAB emergence. Adult mortality was 31.6% from fungal infection on treated trees compared to 1.1% on control trees. During the fall, *B. bassiana* GHA was also found effective against EAB larvae overwintering under the bark when applied through trunk application. A total of 7.9% of the larvae were infected in the treated trunk sections compared with 1.6% in the controls. Larval infection rate was positively correlated with larval density in the field.

Finally, the effects of *B. bassiana* GHA on newly colonized and well-established EAB populations were evaluated in the field using foliar and trunk sprays. We found *B. bassiana* GHA applications on leaves and trunk reduced EAB colonization on relatively healthy green ash trees. Results from our trials carried out at one site showed a 40.7% reduction in new EAB colonization in fungal treated trees compared with that of untreated controls. *B. bassiana* GHA was also responsible for reducing the larval population from the previous year by 19.6%. For the well-established EAB population at the other site, larval density was reduced by 46.7% for trees treated with *B. bassiana* GHA compared to the controls, in which 20.9% hatched larvae of the current generation died of fungal infection. Fungal-treated ash trees also produced fewer adults the following year, with a 63.3% reduction in adult density observed from treated trees compared to the controls. As a result, fungal-treated trees sustained 41.5% less crown defoliation than the controls. *Beauveria bassiana* GHA conidia persisted well under field conditions, with EAB adult mortality of 100, 96, 88, and 78% observed on leaves collected at 0, 4, 7, and 11 days after the treatment, respectively.

Our results demonstrated that BotaniGard® was capable of reducing EAB populations and slowing ash decline in the field through trunk and foliar applications. Thus, this bioinsecticide may be useful for treatment of heavily infested ash trees in the core zones, slowing the spread of EAB. BotaniGard® may also be useful for the treatment of healthy trees surrounding outlier infestations to facilitate containment and possibly eradication. The ultimate role of this fungal pathogen in the overall EAB management in North America, however, will depend on further research on optimizing application methods, rates, frequency, environmental and nontarget effects, as well as management decisions made by program managers in the field.

REFERENCE

Liu, H-P. and L.S. Bauer. 2006. Susceptibility of *Agrilus planipennis* (Coleoptera: Buprestidae) to *Beauveria bassiana* and *Metarhizium anisopliae*. *Journal of Economic Entomology* 99:1096-1103.