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2024 Updates on Box Tree Moth

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Introduction

Box tree moth (BTM), *Cydalima perspectalis*, was first found in the United States in Niagara County, NY in 2021. BTM is an invasive moth (order: Lepidoptera, family: Crambidae) that, with heavy infestation, can completely defoliate evergreen boxwood plants (*Buxus* spp.) in a matter of days. At the time of this writing (February 2025), BTM has been observed in Michigan, Ohio, Massachusetts, Delaware, and Pennsylvania.

Once BTM is confirmed in an area, a quarantine is set in place to regulate the sale and shipment of boxwood outside of the contained area. To assist growers in their continued commercialization of boxwood outside of the quarantine, the National Plant Board (NPB) and the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ) created a compliance agreement outline. Each state must propose and enforce their own compliance agreement based upon this template. Since 2022, Virginia Polytechnic Institute and State University (Virginia Tech) has been working alongside a USDA-APHIS-PPQ team led by Gregory Simmons and Ignacio Baez to both understand the ecology of and suppress the spread of BTM in Western NY. The spread of BTM threatens the commercial viability of boxwood, one of the United States' most economically important landscape plants, as well as the native *Buxus* spp. in both Puerto Rico and St. Croix in the U.S. Virgin Islands.

For more information on BTM identification and biology, visit the Virginia Cooperative Extension's 2021 publication on box tree moth.

Phenology

Virginia Tech tracked the phenology (peaks of activity throughout the year) of BTM at residential sites around Niagara County, NY in 2022, 2023, and 2024. Weather data loggers collecting air temperature were placed throughout Niagara County to calculate the accumulation of growing degree days (GDD) for BTM (Table 1).

Table 1. Chart showing the Growing Degree Days in base 10.1°C for the first appearance, 1st peak, and 2nd peak for early (1st-3rd) instar larvae and adult BTM, calculated from 2023 weather data.

Event	Adults	Early instar larvae
First appearance	518 GDD	568 GDD
1st peak	616-776 GDD	613-953 GDD
2nd peak	1,374-1,523 GDD	1,323-1,455 GDD

This GDD model uses information from Maruyama and Shinkaji (1987) that places the lower temperature threshold for BTM development at 10.1°C. Above 10.1°C, BTM acquire the necessary heat units for development, and the accumulation of these heat units are described numerically as GDD. In the wintertime, without adequate heat units, the development of early instar larvae is halted during a process called diapause. As temperatures rise, and enough heat is acquired to continue development, diapause is terminated and larvae become active again. BTM spend the majority of GDDs as larvae because larval development requires greater heat input than pupal development. During the relatively short pupation, these overwintered larvae metamorphosize into the first adult generation of the season. In 2023, these adult BTMs appeared 50 days prior to the appearance of the first generation of early instar larvae. Each peak of adult moths is

followed closely by a peak of early instar larvae, and the two peaks in Table 1 are indicative of the two generations per year observed in Niagara County. There were approximately 1,000 GDDs in base 10.1°C between the first appearance of adults and the end of the second adult peak. Table 1 represents the growing season in GDD for BTM in Niagara County, NY during 2023.

Biological Controls

Yellow sticky cards (YSC) and green bucket traps with sex-pheromone lures were employed to monitor insects in the quarantine area (Figure 1).

Figure 1. Adult bucket trap next to yellow sticky card and weather data logger. Photo by Alejandro Del-Pozo, Virginia Tech.

Analysis of YSCs from 2022 and 2023 showed no relationship between the presence of insect predators (including lacewings, ichneumonids, ladybugs, and spiders) and BTM larvae, which indicates that these biological control agents may not yet be fully utilizing BTM as prey.

Earwigs (order: Dermaptera) were observed living in infested boxwoods and repurposing BTM webbing structures (Figure 3).

Figure 2. Earwig shown inside structure made by BTM from boxwood leaves and silk. Photo by Lelia Milner, Virginia Tech.

In 2023, researchers at Virginia Tech collected and reared two BTM pupae from Niagara County, NY that were parasitized by the wasp *Pimpla disparis* (Hymenoptera: Ichneumonidae) (Figure 2). After 28 and 29 days, respectively, adult *Pimpla disparis* wasps emerged. In 2024, 62 BTM pupae from the same area were collected and monitored for the presence of parasitoid wasps, though none of these wasps were found. Other observed evidence of predation on BTM during 2024 included partially eaten pupae and wounded le (Figure 3).

Figure 3. *Pimpla disparis* wasp on a BTM infested boxwood plant. Photo by Britaney Hight, Virginia Tech.

Figure 4. BTM pupa (left) and larva (right) with evidence of predation. Photos by David Rivera, Virginia Tech (left), and Lelia Milner, Virginia Tech (Right).

Mating Disruption

In 2023 and 2024, Virginia Tech worked alongside USDA-APHIS-PPQ and the Niagara County community on an area-wide BTM mating disruption (MD) effort in Western NY. Within 3 residential areas in the north, center, and southern part of western Niagara County, researchers set up untreated control sites and treated experimental sites. The treatment sites received a combination of solid meso-emitter sex pheromone-impregnated dispensers hung regularly at each site (Figure 5), and foliar applications on boxwood plants of the biorational insecticide *Bacillus thuringiensis* subspecies *kurstaki* (Btk), which selectively targets insects in the order Lepidoptera (Figure 6).

Figure 5. Mating Disruption pheromone dispenser. Photo by Gregory Simmons, USDA.

Figure 6. BTM larva one week after ingesting Btk insecticide. Photo by Lelia Milner, Virginia Tech.

All boxwoods within the experimental plots were visually scouted monthly. Sex-pheromone baited delta traps were used as a proxy to measure the ability of males to follow these chemical cues. Data collected from weekly trap checks show that traps within untreated control sites had higher densities of BTM adults than the treatment sites in both 2023 and 2024. Similarly, higher BTM larva densities and damage rates on boxwood plants were recorded from untreated control plots.

Insecticide Efficacy Trials

In 2024, Virginia Tech entomologists, with assistance from USDA-APHIS-PPQ, conducted two in-field experiments to test the efficacy of several insecticides on BTM larvae under field conditions. The tested products were Acelepryn (chlorantraniliprole, foliar and drench), Hachi-Hachi (tolfenpyrad, foliar), Mainspring (cyantraniliprole, foliar and drench), Pradia (cyclaniliprole + flonicamid, foliar), Safari (dinotefuran, foliar and drench), and XXpire (Spinetoram + Sulfoxaflor, foliar). Up to 20 larvae were manually infested onto boxwood plants within each treatment. At 7, 21, 35, and 49 days after treatment (DAT), larvae from each plant were re-collected and classified as dead, sick, or alive. Results show that plants treated with diamides (Acelpryn, Mainspring, and Pradia), as either foliar sprays or drenches, resulted in the highest mortality rates for BTM larvae at 7 DAT

(Figure 7), and across the duration of these trials (data not shown).

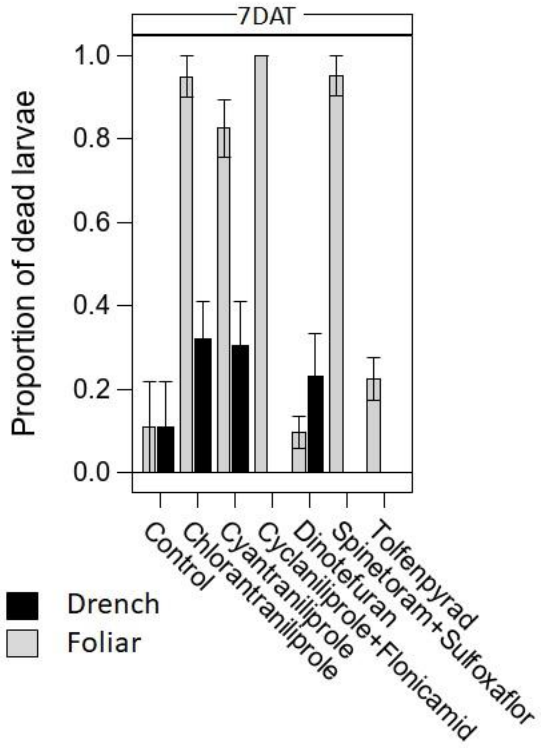

Figure 7. Graph showing proportion of dead BTM larvae ± SEM at 7 DAT for each insecticide treatment. Black and gray bars show drench and foliar treatments, respectively.

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Reference for calculating growing degree days: Maruyama, T. and N. Shinkaji. 1987. Studies on the life cycle of the box-tree pyralid, Glyphodes perspectalis (Walker) (Lepidoptera: Pyralidae). I. Seasonal adult emergence and developmental velocity. Japanese J. Appl. Entomol. Zool. 31: 226-232.

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