New model predicts spotted lanternfly egg hatching

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Spotted lanternfly hatchlings emerge from egg cells on an Ailanthus altissima tree. New hatchlings are initially white in color before their exoskeletons harden and turn black in color. Credit: Erica Smyers

Research conducted by scientists in Penn State's College of Agricultural Sciences has led to the creation of an online tool that can help predict seasonal egg hatch for spotted lanternflies.

The spotted lanternfly, an invasive insect from Asia, was discovered in North America in Berks County in 2014. The pest since has spread to at least 34 Pennsylvania counties. It also has become established in New Jersey, New York, Connecticut, Delaware, Maryland, Ohio, Virginia and West Virginia.

PestWatch uses weather records available for specific dates and durations to provide an estimate of first instar emergence based on current temperature conditions, noted lead researcher Erica Smyers, a doctoral candidate in entomology.

The tool allows users to zero in on a geographic region to view the probability of egg hatch for that location based on the weather conditions experienced there to the present date. The hatch percentage is displayed using color gradients ranging from light yellow representing zero hatches to dark burgundy for 100% hatch.

As of June 30, this map shows primarily burgundy throughout the country, meaning that in any area where lanternfly might be present, sufficient heat has accumulated for the eggs to have hatched.

"The spotted lanternfly poses a significant threat to Pennsylvania agriculture, landscapes and natural ecosystems—including the grape, hardwood and nursery industries—as well as to outdoor recreation, backyard enjoyment and biodiversity," Smyers said. "Having a better idea of when eggs will hatch can help with control tactics to reduce the number of first-instar nymphs."

Citizens and the agricultural industry can use this tool, which is located at stopSLF.org under "resources," to make decisions about timing and management strategies, she pointed out. Government agencies, university researchers and extension professionals also should find it helpful in their monitoring and surveillance efforts.

Smyers explained that there are maximum and minimum temperatures that govern insect growth. These thresholds differ between species and even can vary within a species when a population adapts to a specific geographic location to survive in its environmental conditions. The insects must accumulate a certain amount of heat from their environment before transitioning to their next life stage.

An insect's temperature thresholds can be determined through controlled-temperature laboratory experiments. Scientists can use these thresholds to estimate the amount of heat units—called growing degree days—that an insect needs to transition to the next phase of life, noted Smyers, who worked under the guidance of Julie Urban, associate research professor of entomology, and Dennis Calvin, an entomologist who also is a former associate dean and director of special programs in the college.

A tray of spotted lanternfly egg masses during the constant temperature study. Sets of 30 egg masses were placed inside temperature-controlled environmental chambers to study the effects of constant temperature on egg developmental rate. Credit: Erica Smyers

Similar growing degree day models are used by growers to predict the timing of the development of their crops.

"We wanted to see how the minimum, or base temperature, for spotted lanternfly egg development in Pennsylvania populations compared with those in South Korea, where the insect also is an invasive," she said. "We then could use this information, along with observed hatch data from field sites at different geographic locations, to create a model for predicting hatch over time and space."

The experiments, the findings of which were published in Environmental Entomology, took place from 2016 through 2019 in a quarantine research lab at Penn State's University Park campus and at a residential property in Oley, Pennsylvania.

The homeowners, Tracy and Chris Kolb, had been dealing with spotted lanternflies on their property for some time. Not only did they agree to allow Smyers to conduct her research in their backyard, but they also invited her to stay at their home while conducting her studies.

"My stay with the Kolbs was one of the most memorable experiences of my student career," Smyers said. "I would wake up every morning and spend the day in the woods behind their home, counting newly hatched nymphs on egg masses. For an entomologist, it could not be better."

During these field studies, which spanned three months in the spring of 2017, Smyers observed 112 marked egg masses every one to two days throughout May and every three to six days in June for the emergence of first-instar nymphs. She recorded the number of new hatchlings on an egg mass and open egg cells for each sampling interval. Temperature loggers took readings every hour.

In the controlled lab studies, Smyers evaluated sets of 30 individual egg masses at five constant temperatures of 67, 76, 77, 80 and 86 degrees Fahrenheit. After placing the egg masses in incubation chambers, the entomologists monitored the temperature and humidity conditions. The researchers inspected the chambers regularly for newly emerged first-instar nymphs to determine the days to hatch for the entire population.

Smyers found that the egg developmental rate increased as the constant temperature increased in the laboratory experiments. When compared to similar experiments performed by researchers in South Korea, the individual studies resulted in different minimum temperatures; however, the egg developmental rates were not statistically different.

"That meant we were able to combine the data from the different studies to determine an average model and minimum temperature value to describe the relationship between temperature and the rate of egg development," said Smyers.

By combining results from the lab experiments with her field experiment, Smyers constructed a model for predicting percentage of hatch. A research group from Virginia Tech verified the use of the model through hatch observations in Winchester, Virginia, in 2019.

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