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Western Michigan University

Black Soldier Fly Larvae Composting
Phase II: Breeding

Introduction:

Black Solider Fly Larvae (BSFL) demonstrated in phase I experiments their capacity to reduce solid waste at 20:1 ratios; displaying strong potential for large-scale solid waste reduction at commercial entities and businesses. To have an efficient system, with continual cycles of waste reduction year-round, the larvae must be self-renewing. This encompasses creating and maintaining environmental conditions in which adult black soldier flies can breed and oviposit. That said, adult fly conditions are primarily ambient, whereas the conditions for optimal larvae waste consumption relied on internal compost conditions. Phase II comprises of monitoring ambient and internal temperature, relative humidity (RH), and light to determine optimal conditions for breeding, oviposition, and egg eclosion.

Method:

All research took place in a 12' X 24' south-facing climate-controlled research room at WMU's Finch Greenhouse (FGH) inside a 16'X 6' X 7' screened breeding structure. Within the breeding structure stood a Protapod™, DIY bin, two leachate collection buckets, two pupae collection buckets, two house plants and seven burlap sacks. Food for the BSFL was sourced through WMU's Bistro3 cafeteria's pulper. Two 10-gal buckets were filled and collected three times a week to feed the larvae. This amount of waste was much larger than the actual amount needed to feed the larvae. However, since this was the first time collecting food waste from Bistro3 cafeteria, we created a safety food stock for the BSFL to avoid any interruption in the feeding cycle. All excess food waste was dumped at the Gibbs House Permaculture Research and Demonstration Site's static compost pile.

Two HOBO® Data Loggers and human observations were used to collect data. Each HOBO® Data Logger recorded every five minutes. Device readouts were conducted every two weeks starting February 29, 2016 and ending May 13, 2016. The external logger collected maximum, minimum, and average data on temperature, relative humidity, and light intensity inside the breeding structure. The internal logger collected maximum, minimum, and average data on temperature and light intensity within the DIY compost pile. Water-proof housing allowed for placement inside compost pile, however did not allow for data collection on relative humidity.

Results:

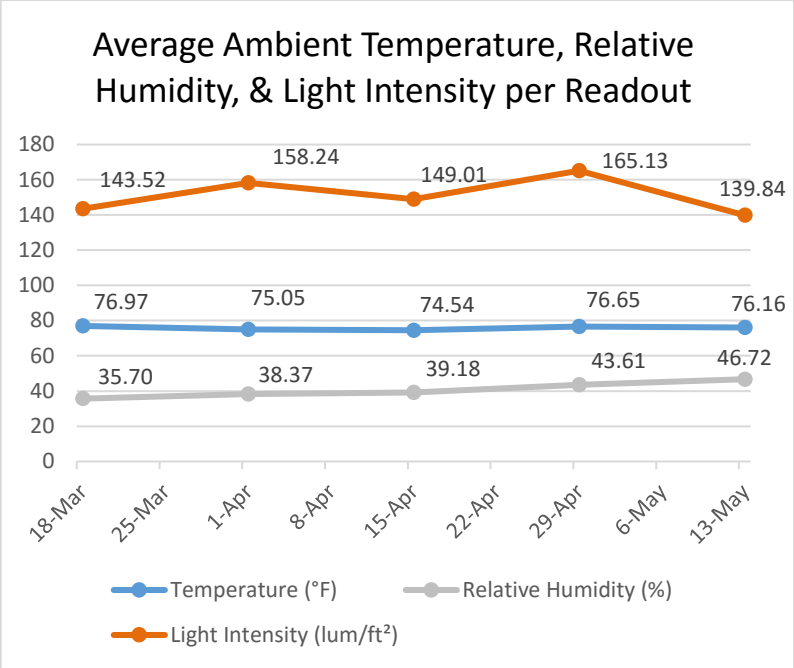

Figure 1

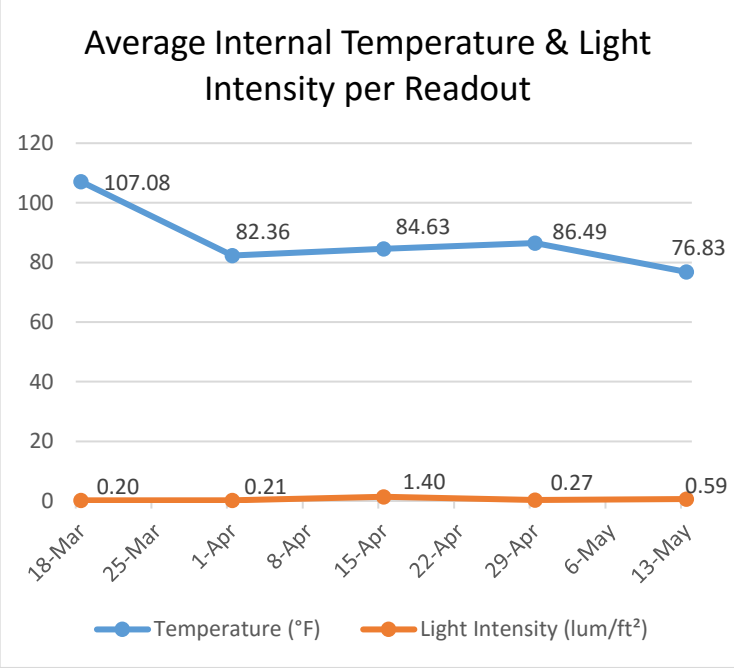

Figure 2

BSF mating and oviposition (laying of eggs) were observed within a small range of conditions that were likely influenced by both temperature, relative humidity, and ambient light intensity. Through February 29, 2016 and May 13, 2016 the average ambient temperature inside the breeding structure was 75.87° F; ambient relative humidity: 40.72%; and an ambient light intensity: 151.15 lum/ft2. The average internal temperature inside the DIY compost pile was 87.48° F; average internal light intensity was 0.53 lum/ft2. Mating and oviposition was observed during the peak of the day (10:00-14:00) at ambient temperature ranges between 87.1° F and 70.63° F and at an ambient relative humidity between 60.4% and 33.2%. Egg eclosion, or the emergence of an adult insect from its pupal casing, was not physically observed; however, was likely successful at all temperatures due to the increased adult population inside the screened structure.

Based on the above results, a temperature range between 87.1° F and 70.63° F with a relative humidity range between 60.4% and 33.2% and direct sunlight is recommended for a BSF breeding structure.

Limitations of analysis and proposed future work:

Though the controlled climate in WMU's FGH was a benefit, it also had its drawbacks. Each time air vents opened (to maintain room temperature), the relative humidity would drop approximately 15%. To increase relative humidity within the structure, seven water-soaked burlap sacks were introduced. The burlap sacks were regularly soaked three times a week. In addition, the ambient temperatures required to breed adult BSFs negatively impacted the internal compost pile temperature.

Moving forward, we recommend utilizing fog nozzles to maintain relative humidity rather than regularly soaking burlap sacks. We also recommend utilizing a camera, or some type of device to monitor and observe fly behavior. We do not recommend using pulped food waste due to its thick, wet consistency. In the beginning pulped waste seemingly aided in the processing by BSFL. We now believe that the think

consistency of the organic waste contributed to anaerobic conditions and house fly populations. This is because of the increased moisture levels per volume of food waste.

The first focus for the future is to refine our existing practices and understanding of variables influencing the BSF life cycle and composting effectiveness.

Our goal is to move forward with the questions:

- What are the core questions that will lead us to a point where we can give WMU a thorough recommendation?
- How do we integrate this with other projects at the Office for Sustainability?

In addition, the team will continue to reach out to other institutions such as University of Massachusetts-Amherst in effort to collaborate knowledge. Long-term, we would like to integrate the BSFL Composting system with other projects at WMU's Office for Sustainability, such as Aquaponics.

For more information, please see the full report at:
http://wmich.edu/sustainability/reports-publications/green-jobs-student-reports