Examining the efficacy of pesticide use in the laboratory to treat *Tillandsia utriculata* against the exotic invasive arthropod species *Metamasius callizona*

Katie Schulman, Dr. John Herman, Dr. Teresa Cooper

Figure 1. Tillandsia utriculata [Photograph]. Retreived from http://www.bandabou.info/Bromeliaceae.htm

ABSTRACT

Florida is home to the giant airplant, *Tillandsia utriculata*, an essential resource to multiple South Florida ecosystems because it acts as a habitat for many vertebrate and invertebrate organisms. Recently, *T. utriculata* has become endangered because of the exotic invasive arthropod species *Metamasius callizona*, the Mexican weevil. Once an adult weevil lays its eggs on the plant and the eggs hatch, the larvae mine the surrounding leaf area and meristem, the place at which new growth takes place in plants, which ultimately kills the air plant. In an attempt to protect the species, specimens have been collected with permits from the field, (Fakahatchee Strand Preserve and Okaloacoochee Slough State Forest), by local botanical gardens, Naples Botanical Garden and Marie Selby Botanical Gardens, to be quarantined. To rid the quarantined *Tillandsia*s of the weevil, the use of a pesticide is the desired course of action because of the quickness and effectiveness. Currently, no research has tested the efficacy of pesticide control on *M. callizona* within a laboratory setting. This study tested the efficacy of four chemically different systemic insecticides, (imidacloprid, dinotefuran, azadirachtin, and Isoclast™ Active), by analyzing weevil larva mortality over time.

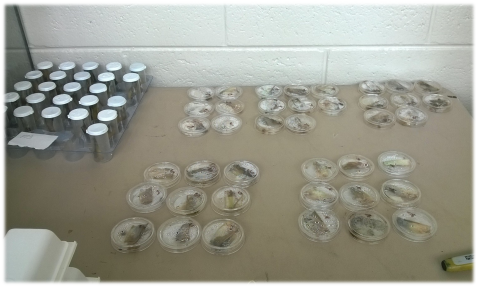


Figure 6. Petri dishes separated by pesticide group before experiment one

INTRODUCTION

•Host-plant species, which not only provide food to herbivores, can provide an assortment of other resources for various organisms. Florida is home to the giant air plant *Tillandsia utriculata*, a vital resource that acts as a steady and reliable wet ecosystem for many amphibians, insects, and microorganisms year-round (Cooper, 2008); some species that have coevolved with the giant air plant are so specialized that they are only found living in the tanks of the giant air plant (Frank and Fish, 2008; Frank et al. 2004).

•The introduced species *Metamasius callizona*, is quickly destroying *T. utriculata.* The larvae eat and destroy the meristem, the place at which new growth takes place in a plant. (Salas and Frank, 2001). Once the meristem is destroyed, the plant dies, along with the organisms that depend on the air plant (Cooper et al., 2014).

•Data collected from five natural areas, with weevil-infested bromeliad populations, from June 2001 to June 2005 resulted in percentage deaths caused by the weevil ranging from 71-82 percent (Cooper, 2006). Ninety-seven percent of a weevil-infested *T. utriculata* population in the Enchanted Forest Sanctuary was destroyed by the weevil in 27 months (March 2007 to June 2009; Cooper 2014).

•A method used to save the giant air plant from Mexican weevil attacks involves growing the plant in protected laboratory growrooms or greenhouses until the reproductive phase. The air plants are then introduced back to the locations they were found right before they begin to disperse seeds. To rid the protected laboratory set of *Tillandsia*s of the weevil, the use of systemic pesticides is the desired course of action because of their quickness, effectiveness, and ability to remain in plant tissue for extended periods of time.

METHODS

Experiment One:

Five groups of eight or nine 20mm filter paper were treated with Merit®, Safari®, AzaSol™, and Xxpire WG™ systemic pesticide. Another group of filter paper was left untreated as the control.

Weevil larvae were separated into five groups of eight or nine and were assigned a pesticide or as the control.

Larvae were exposed to their assigned pesticide and individually placed inside 20 mm × 60 mm Petri dishes with an untreated feeding leaf.

Mortality was recorded over 48 hours in intervals of 24 hours

Experiment Two:

Five groups of eight weevil-free *Tillandsia utriculata* were treated with Merit®, Safari®, AzaSol™, and Xxpire WG™ systemic pesticide. An additional group of eight was left untreated as the control.

Weevil larvae were separated into five groups of fifteen or sixteen and were assigned a pesticide or as the control.

One month after treatment, the leaves at the base of the plants were cut 4 – 4.5 cm in length. The weevil larvae groups were fed the assigned pesticide every two days

Mortality was recorded over 96 hours in intervals of 24 hours

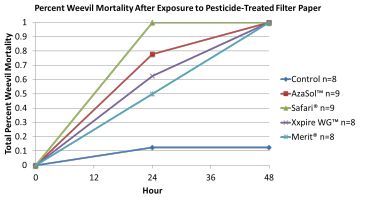
RESULTS

Experiment One:

- Weevils exposed to:
  - Merit®: 50% mortality at 24 hours; 100% mortality at 48 hours
  - Safari®: 100% mortality at 24 hours
  - AzaSol™: 78% mortality at 24 hours; 100% mortality at 48 hours
  - Xxpire WG™: 63% mortality at 24 hours; 100% mortality at 48 hours
  - Control: 13% mortality at 48 hours

Experiment Two:

- Weevils which fed on leaves exposed to:
  - Merit®: 13% mortality at 24 hours; 69% mortality at 48 hours; 88% mortality at 72 hours; 100% mortality at 96 hours
  - Safari®: 6% mortality at 24 hours; 31% mortality at 48 hours; 38% mortality at 72 hours; 56% mortality at 96 hours
  - AzaSol™: 0% mortality at 24 hours; 7% mortality at 96 hours
  - Xxpire WG™: 20% mortality at 24 hours; 53% mortality at 48 hours; 87% mortality at 72 hours; 93% mortality at 96 hours
  - Control: No mortality after 96 hours



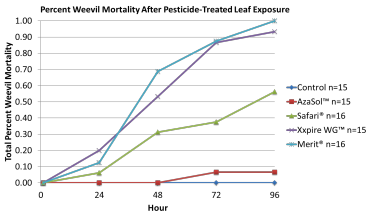


Figure 2 (top); *Figure 3* (bottom). n-starting sample size

Figure 5 (top). Mexican weevil larva. Figure 6 (bottom): Giant air plants being treated with Xxpire WG™.

Discussion

While Safari® and AzaSol™ caused a higher percentage of mortalities during experiment one than Merit®, Xxpire WG™ and the control within the first 24 hours of direct contact with the weevil larvae, Safari® and AzaSol™ caused the least amount of total mortalities during experiment two out of all the groups that fed on leaves that were treated with pesticide. For experiment two, Merit® and Xxpire WG™ caused a higher percentage of mortalities than Safari®, AzaSol™, and the control when the pesticide was delivered through the leaf and fed to the weevils.

It was found in experiment one that after 24 hours, Safari® had the highest rate of mortality at 100% of the sample group, AzaSol™ at 78%, Xxpire WG™ at 63%, and Merit® had the least amount of mortality at 50% of the sample group. The results are interesting because both Safari® and Merit®, while although chemically different, use the same Insecticide Mode of Action and are both in class 4A (Fishel, 2005), produced results on the opposite sides of the spectrum. Safari® and Merit® are nicotinic acetylcholine receptor agonists, which causes paralysis, and upon inspection after 24 hours the larvae were extremely sluggish at responding when prodded, with only their mandibles moving. Both Xxpire WG™ AzaSol™'s labels claim the pesticide starts working minutes after it is applied by halting the insect's feeding (Dow, 2014) (Arborjet, 2014), which may have caused the weevils to starve to death within 48 hours. After 48 hours, all four pesticides caused 100 percent mortality when weevil larvae were exposed to the pesticide-treated filter paper, which indicates that the pesticides used were able to kill the desired target insect.

It was found in experiment two, after 96 hours Merit® and Xxpire WG™ caused 100% and 93% mortality, respectively, which may indicate stronger systemic properties, than AzaSol™ and Safari®, which only caused 56% and 7% mortality, respectively. AzaSol™ is an insecticide, which interferes with the metabolism of ecdysone, a molting hormone, and the label claims to be an anti-feedant therefore it was surprising to find the weevils still highly active and feeding even after 96 hours. The label indicates that AzaSol™ may need three to four applications 10 days apart after the first application to be effective (Arborjet, 2014), which could have been the reason it was a weak systemic after a month of being in the plant. Safari® may have lost efficacy due to chemical degradation over time.

ACKNOWLEDGMENTS

I would like to thank Dr. John Herman from Florida Gulf Coast University for being a supportive and optimistic mentor. I would like to thank Dorothy M. Rygh for the fellowship funding to enable a research project at Naples Botanical Garden. I would like to give a huge 'thank you' to Dr. Teresa Cooper from the University of Florida for providing me with so much guidance and information to get my study started. I thank you Dr. Cooper for all of the weevil larvae deliveries and time you have dedicated to help! I would also like thank Emily Wilson, Marc Gingras, and Chad Washburn from Naples Botanical Garden, who all played major roles in this project. And a special 'thank you' to Emily Wilson who was an amazingly supportive friend, who helped me in so many ways throughout the project from plant-collecting to weevil-feeding to advice-giving.

LITERATURE CITED

•Arborjet. (2014). AzaSol: Water Soluble Bio Insecticide from Neem. Technical Bulletin. Arborjet Incorporated: Woburn, MA.
•Cooper, T. M. (2006). *Ecological and Demographic Trends and Patterns of Metamasius callizona (Chevrolat), an Invasive Bromeliad-eating Weevil, and Florida's Native Bromeliads.* Master's Thesis. University of Florida.
•Cooper, T. M. (2008). Seasonality and abundance of Metamasius callizona (Coleoptera: Dryophthoridae), an invasive insect herbivore, on two species of Tillandsia (Bromeliaceae) in Florida. *Journal of Natural History.* 42(43-44): 2721-2734.
•Cooper, T. M., Frank, J. H., & Cave, R. D. (2014). Loss of phytotelmata due to an invasive bromeliad-eating weevil and its potential effects on faunal diversity and biogeochemical cycles. *Acta Oecologica.* 54: 51-56.
•Dow. (2014). Xxpire WG Insecticide with Isoclast Active. Technical Bulletin. Dow AgroSciences: Indianapolis, In.
•Frank, J. H., & Fish, D. (2008). Potential biodiversity loss in Florida bromeliad phytotelmata due to Metamasius callizona (Coleoptera: Dryophthoridae), an invasive species. *Florida Entomologist.* 91(1): 1-8.
•Frank, J. H., Sreenivasan, S., Benshoff, P. J., Deyrup, M. A., Edwards, G. B., Halbert, S. E., & Welbourn, W. C. (2004). Invertebrate animals extracted from native Tillandsia (Bromeliales: Bromeliaceae) in Sarasota county, Florida. *Florida Entomologist*, 87(2), 176-185.
•Fishel, F. M. (2005). Pesticide toxicity profile: neonicotinoid pesticides.*University of Florida, IFAS.*
•Salas, J., & Frank, J. H. (2001). Development of Metamasius callizona (Coleoptera: Curculionidae) on pineapple stems. *Florida Entomologist*, 123-126.