2023-2024 Florida Coordinating Council on Mosquito Control

FDACS Grant Research Abstracts

- Below are the final report abstracts from the researchers for the 2023 -2024 fiscal year. If you are interested in reading the complete report, please contact Caitlin Gill: Caitlin.Gill@fdacs.gov
- If you have specific questions regarding the research, please reach out to the researcher directly.

"Evaluation of a nanoparticle encapsulated permethrin formulation against three species of adult mosquitoes: *Aedes aegypti, Culex quinquefasciatus* and *Anopheles quadrimaculatus*." FDACS Contract # 29386

Principle Investigator: Dr. Rebecca Baldwin bladwinr@ufl.edu

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Abstract:

Insecticides remain an integral component of mosquito control operations but sustained use of a limited number of active ingredients (AI) has led to widespread development of resistance. Development of new AIs and insecticide formulations will be necessary in maintaining control efficacy. Towards this, toxicity screening of metal nanoparticles were conducted via topical applications to assess their viability as potential adulticides. Nanoparticles were synthesized from silver nitrate (AgNO3) using essential oils from different plants. Essential oils contain bioactive compounds and metabolites that can act as both a reducing and capping agent to stabilize the AgNP molecule. The resultant AgNP were characterized by UV-Vis spectrophotometer analysis, transmission electron microscope and Zetasizer NSP.

"Evaluating the impact of the In2Care® Mosquito Trap at low densities in the context of integrated mosquito management in a local community of North Central Florida" FDACS Contract #29402

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Co-Principle Investigator: Dr. Eva Buckner eva.buckner@ufl.edu

Abstract:

In the last two decades, there has been an increase in the geographic range and frequency of vector-borne diseases. Management of mosquito populations has become challenging due to increasing rates of resistance to existing insecticidal products and formulations. Several alternative tools have emerged to suppress or replace mosquito populations. One of these tools is the In2Care Mosquito Station (In2Care station). This dual- action station contains the insect growth regulator pyriproxyfen which disrupts the development of immatures and the entomopathogenic fungus *Beauveria bassiana* (*B. bassiana*) strain GHA which kills exposed adult mosquitoes. The In2Care stations have previously been shown to effectively control *Aedes aegypti* in field settings at a density of 6 stations/acre rather than the label-recommended 10 stations/acre. To further test the efficacy of low station density deployment, we deployed In2Care stations in the Pleasant Street Historic District of Gainesville, Florida, at a density of 3 stations/acre over a period of 2 years in the presence or absence of ground larvicidal applications. The deployment of stations resulted in no measurable impact on *Aedes aegypti* and *Culex quinquefasciatus* adult or immature abundance suggesting that the low-density deployment of In2Care stations is insufficient to reduce mosquito abundance within treatment areas.

"Non-target effects of novel attractive toxic sugar baits for control of insecticide resistant mosquitos in Florida"

FDACS Contract # 30273

Principal Investigator: Dr. Barry W. Alto bwalto@ufl.edu

Co-Principle Investigators: Dr. Eric Caragata e.caragata@ufl.edu and Dr. Eva Buckner eva.buckner@ufl.edu

Abstract:

Domestic mosquitoes in Florida are pestiferous and major vectors of arboviruses affecting human health. The historic reliance on chemical insecticides as part of integrated mosquito management practices has contributed to the development of insecticide resistance among populations of mosquitoes. To address this challenge, we developed and assessed novel attractive toxic sugar baits (ATSBs) to provide cost- effective and sustainable control. The project focused on characterization of novel ATSBs to induce feeding and acute mortality among insecticide resistant and susceptible mosquitoes of *Aedes aegypti* and *Culex quinquefasciatus*. Mosquitoes were exposed to different ATSB configurations comprised of a feeding stimulant (sugar or sugar substitute erythritol solutions), a toxin (boric acid, neonicotinoid dinotefuran) and fungal synergist (Metarhizium robertsii). Lab experiments were performed with ATSBs, alone and in combination with toxins, using a concentration gradient of toxins to determine toxicity to mosquitoes (lethal concentrations, LC). An optimized ATSB based on initial studies was further assessed using semi-field trials outdoors to assess contact and feeding rates of mosquitoes and select insect pollinators (honeybees *Apis mellifera*; painted lady butterflies, *Vanessa cardui*) on novel ATSBs using choice and no choice experiments compared to sucrose (control) baits. Lastly, field trials were used with an optimized ATSB station (modified to maximize mosquito mortality and limit non-target effects) to assess the attraction of mosquitoes and other insects in nature to gauge efficacy and estimate non-target effects.

"Non-target impacts of mosquito larvicides and adulticides to Florida honey bees (*Apis mellifera*)"

FDACS Contract #30275

Principal Investigator: Dr. Cameron Jack cjack@ufl.edu

Co -Principal Investigator: Dr. James Ellis jdellis@ufl.edu

Abstract:

Effective mosquito control is essential to Florida residents, as the state's environment and climate are ideally suited for mosquitos, though it is possible that some mosquito adulticides and larvicides administered by operators could have non-target impacts, including on honey bees. Currently, not much is known about how simultaneous exposure to these chemicals in realistic field scenarios will impact overall honey bee colony strength. Moreover, the toxicity and impact of these products on bees in the laboratory is not well understood. The overall goals of this study are to assess the impacts of mosquito control adulticide and larvicide application practices on honey bee health in both field and laboratory settings, as well as determine the amount of these products residues that contaminate honey bee colonies matrices. First, by placing 15 colonies in areas that are treated with truck-based application of ULV mosquito adulticides and water-administered larvicides, we did not find significant differences in colony mortality or health strength parameters between colonies located in treated and control sites, as well as no direct impact of a spray event was observed in adult bee mortality. By sampling nectar, pollen, wax and honey bee larvae and subjecting the samples to residue analyses, we found some mosquito control products residues in hive matrices but at a low concentration (from 0.03 to 70.99 ng/g). Secondly, we determined the acute and chronic toxicity of mosquito control treatments (active ingredients and formulations products) on honey bee larvae reared in vitro and caged adult bees in laboratory assays. Toxicity endpoints were determined to estimate a risk using the U.S. EPA's Bee-REX tool. Finally, all our results were shared to beekeepers both locally and nationally through research conferences and beekeeper association. Our results provide immediate feedback to both mosquito control programs and beekeepers on how to work together to improve outcomes for all.

"Nontarget effects of naled, permethrin, and malathion adulticide applications on predatory arthropods"

FDACS Contract #30296

Principal Investigator: Dr. Lawrence Reeves lereeves@ufl.edu

Co-Principle Investigator: Dr. Nathan Burkett-Cadena nburkettcadena@ufl.edu

Abstract:

Predatory arthropods are ecologically important as regulators of herbivore, pest, and other insect populations within ecosystems, and, in this role, they are widely perceived as beneficial to humans. Pollinators, especially honeybees and butterflies, have dominated the conversation and research focus on the nontarget impacts of applications of mosquito adulticides. Little is known about how arthropod predators are or are not impacted by mosquito adulticides. Inferred from research that has investigated the response of arthropod communities to adulticides, larger-bodied predators (e.g., dragonflies, damselflies, orb-weaver spiders) appear to be resilient to such treatments while smaller-bodied species (e.g., predatory flies) may be susceptible. This project addresses this topic specifically, examining the acute and chronic impacts of mosquito adulticide applications on predatory arthropods. We further take into account the microhabitats in which these predators occur during hours of the day (dusk/night) when adulticide are likely to be applied and how these might mitigate their susceptibility in a field-realistic setting. The broad goal of the proposed research is to enhance our understanding of how predatory arthropods are impacted by several regularly used mosquito adulticides in Florida. Through a series of semi-field experiments performed with support from the Lee County Mosquito Control District, we investigated the acute susceptibility of multiple predatory arthropod taxa (*Hogna* wolf spiders, *Rabidosa* wolf spiders, Hentz's striped scorpions, tiger beetles, lacewings, and ladybird beetles) by exposing them to naled, permethrin, and malathion. Because such direct exposure tests can only establish the susceptibility of these species to adulticides (which may not reflect field realistic impacts), groups of the same species will be exposed in cages that simulate the taxon's microhabitats. To investigate the chronic effects of adulticides on predators, captive *Hogna* wolf spiders and Hentz's striped scorpions were fed crickets exposed to adulticides. Our results highlight that different nontarget taxa respond differently to exposure to mosquito adulticides. We found that both *Hogna* and *Rabidosa* wolf spiders and scorpions were resilient to exposure to all three adulticides with minimal mortality detected. Tiger beetles, lacewings, and ladybird beetles were susceptible, to varying extents, to all adulticides, but mortality rates for these taxa were generally lower than those of the mosquitoes exposed to the same treatments.

"Nontarget effects of naled, permethrin, and malathion adulticide applications on fireflies"

FDACS Contract #30336

Principal Investigator: Dr. Lawrence Reeves lereeves@ufl.edu

Co-Principle Investigators: Dr. Marc Branham marcbran@ufl.edu and Dr. Nathan Burkett-Cadena nburkettcadena@ufl.edu

Fireflies (*Coleoptera: Lampyridae*) are among Florida's most charismatic insect groups and are perceived to be declining in the state though long-term data establishing this trend are not available for most species. Anecdotal reports and expert opinions suggest that Florida and other regions have experienced declines in firefly populations. In part because the bioluminescent courtship displays of some firefly species correspond temporally with the dusk/night applications of adulticides, there are concerns, especially among the public, that mosquito control actions could be a contributing factor. Florida's mosquito control districts implement an integrated mosquito management approach to mitigating the public health and human comfort impacts of mosquitoes in the state. A key tenet in such an approach to mosquito control is the judicious use of pesticides. Mosquito adulticides are an essential and effective tool that can have immediate effects on mosquito abundances or can interrupt transmission of an arbovirus. However, the nontarget effects of adulticides on native insect communities remain poorly understood, particularly beyond pollinating insects (e.g., honeybees and butterflies). Fireflies are a neglected group of nontarget organisms that may be impacted by adulticide applications. The only research to date on this topic found that the firefly *Photuris congener* is resilient to

truck-based malathion ULV spray. The overall goal of this project is to elaborate on the potential direct and indirect effects of several regularly used mosquito adulticides on fireflies. We investigated the acute susceptibility of fireflies to three regularly used adulticides (naled, permethrin, malathion), assessing both direct exposure and exposure taking into account the habitats and circadian activity of fireflies. We also examined potential indirect effects of adulticides on fireflies by quantifying the susceptibility of earthworms and snails, the prey of larval fireflies. Our results confirmed those of previous studies that found fireflies to be resilient to malathion. However, fireflies were susceptible to permethrin and naled. Snails and earthworms, larval food sources for some firefly species, were largely resilient to exposure to malathion, permethrin, and naled, with the notable exception of permethrin susceptibility in earthworms.

"Synergistic effects of exposure to thyme oil and its major component, thymol, enhance sensitivity to permethrin in resistant *Aedes aegypti* mosquitoes of Florida."

FDACS Contract # 30352

Principal Investigator: Dr. Eric P. Caragata e.caragata@ufl.edu

Abstract:

The increasing detection of permethrin insecticide resistance in Florida mosquitoes has hampered efforts to control populations of nuisance biting and disease vectors around the state and increased the risk of outbreaks of arboviral disease. Accordingly, there is a clear need to improve the efficacy of current control strategies and to support those strategies by developing novel tools and programs to control mosquitoes, particularly those that are already demonstrating resistance. Increased usage of repellents for spatial or personal purposes, and the identification of novel repellents are two such strategies which could help to overcome resistance. In this project, we have investigated the synergistic effects of thyme essential oil and its major component, thymol, on susceptibility to permethrin in two populations of *Aedes aegypti* mosquitoes from Key West and Vero Beach Florida. These essential oils have both repellent and mosquitocidal activity. Via CDC bottle bioassay, we determined that the Vero Beach population was less susceptible to permethrin. Through a series of experiments, we developed and then optimized protocols for delivering thyme oil or thymol to mosquitoes either prior to permethrin exposure or simultaneously via incorporation into a standard bottle bioassay, modulating the delivery environment, delivery medium, and dosage of either essential oil. We determined that even low doses were sufficient to cause rapid mortality in our mosquito populations. After sequential exposure of essential oils and permethrin, we observed that thyme oil appeared to have an antagonistic interaction with permethrin, however thymol has a synergistic effect. Interestingly, similar effects were not observed during co-exposure experiments, suggesting that the timing and methodology of delivering thyme-derived compounds can modulate interactions with permethrin.