Aspects of Spotted-wing Drosophila Biological Control Efforts in Georgia

[1]Subin B Neupane and [1]Ashfaq A Sial

[1]Department of Entomology, University of Georgia, Athens, 30602, Georgia

Introduction:

Drosophila suzukii (Matsumura) (Diptera: Drosophilidae) commonly known as Spotted-wing Drosophila (SWD) is an invasive insect pest threatening many small fruit industries in the Americas and Europe for more than a decade. While many control approaches are being utilized in the invaded regions to manage this pest, biological control using parasitoids is one of the promising strategies for the sustainable management of SWD. We conducted two seasons-long field explorations for native parasitoids of SWD during 2021 and 2022 around major blueberry-producing locations in Georgia. Among the parasitoids that were collected, *Leptopilina boulardi* (Hymenoptera: Figitidae) and *Pachycrepoideus vindemmiae* (Hymenoptera: Pteromalidae) were the most abundant species in the collection. We also conducted a laboratory study to assess the lethal effect of nine commonly used insecticides on the blueberry growing system tested at field rates on the two most promising parasitoids of SWD. Individuals of the exotic larval parasitoids *Ganaspis brasiliensis* (Ihering) (Figitidae) were more susceptible to this insecticide exposure and they died earlier compared to the individuals of resident pupal parasitoid *Pachycrepoideus vindemiae* (Rondani) (Pteromalidae). This indicates that considerations must be made in the selection and spray to ensure minimal damage to these natural enemies.

Pest identification:
Male: a distinct dark spot in the wing margin
Females: long, sharp, serrated ovipositor

Pest status:
They have a high reproductive capacity, are capable of rapid development, and are resilient to many chemicals as most time during the lifecycle is spent inside the fruit.

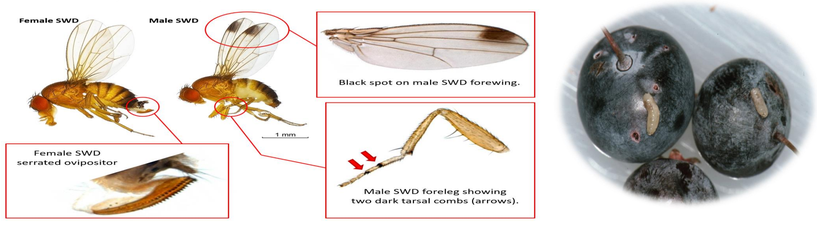


Fig 1: SWD identification (a) and SWD-infested blueberry (b)

Damage potential:
Western USA $500 million (Goodhue et al. 2011)
Eastern U.S.A. $207 million (Wiman et al. 2016)
Insecticide application is the most popular solution
Insecticides limitations:

- Pre-harvest intervals restrictions
- Increased management costs
- Kills useful natural enemies

Biological control: Using parasitoids as a complementary method

Objective 1: Exploration and study of the native parasitoids for biological control of invasive Spotted-wing Drosophila in Georgia

Why focus on biocontrol using parasitoids?
Parasitoids can reach and kill the SWD where/when chemical use becomes a limited option.

Why explore parasitoids in Georgia?
Southeast Georgia is a growing blueberry hub with multiple reports of past SWD infestation. We wanted to obtain baseline information regarding the abundance distribution, and ecology of suitable habitats for parasitoids from these regions so that we can release an imported and SWD-specific parasitoid in the future.

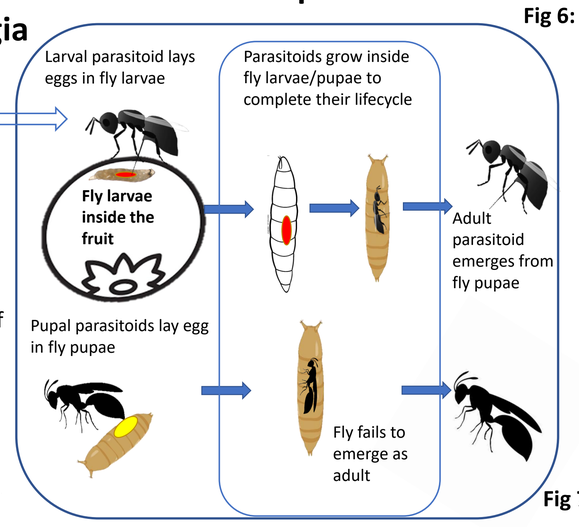


Fig2: Parasitoid lifecycle

Methods:

Parasitoids of SWD were field surveyed in 10 blueberry growing sites located in Bacon Co., Pierce Co., and Appling Co. of southeastern Georgia during 2021-22 (fig 3). Among the selected locations, seven sites were conventionally managed farms, and three others were organically managed farms. The traps were placed about 1-2 m above ground in the host plant using a metal wire attached to the trap. The SWD-infested fruit-baited traps were retained in each location for nearly two weeks to allow parasitism in the larvae and pupae in SWD-infested fruit baits. All the samples collected from the field were kept under observation for six weeks for any adult flies and parasitoids to emerge.

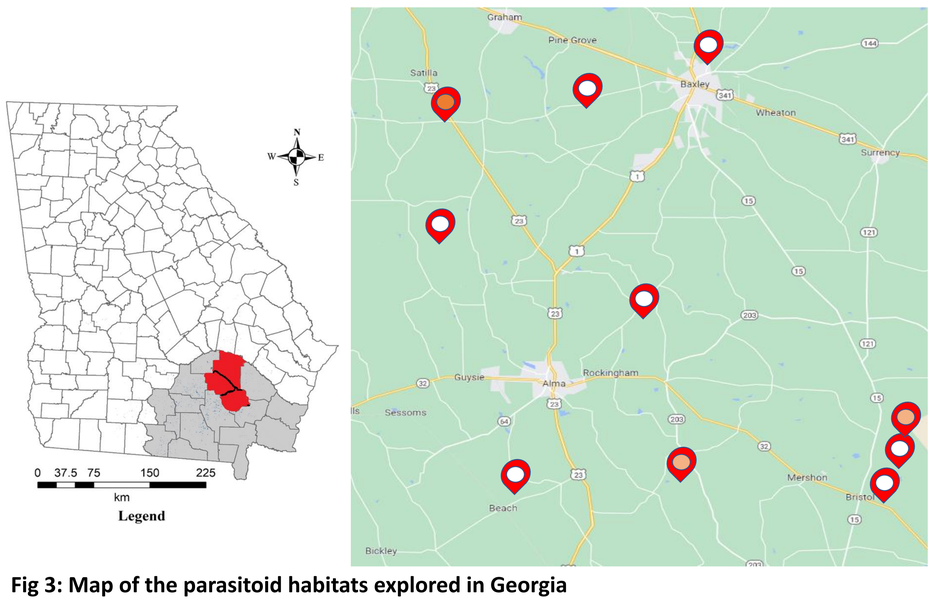


Fig 3: Map of the parasitoid habitats explored in Georgia

Results:

A total of 371 Drosophila-related parasitoids were collected and classified into three families (fig 3): Figitidae, Pteromalidae, and Diapriidae. Most of these parasitoids were collected during or immediately after the blueberry harvest in Georgia (fig 4). Among the collected species, *L. boulardi* and *P. vindemmiae* were the most abundant species in the collection (fig 5).

L. boulardi
Hymenoptera: Figitidae

Trichopria sp.
(Hymenoptera: Diapriidae)

Three families:

- Figitidae
- Pteromalidae
- Diapriidae

P. vindemmiae
Hymenoptera: Pteromalidae

Spalangia sp.
Hymenoptera: Pteromalidae

Fig 4: Diversity of SWD-associated native parasitoids found in Georgia

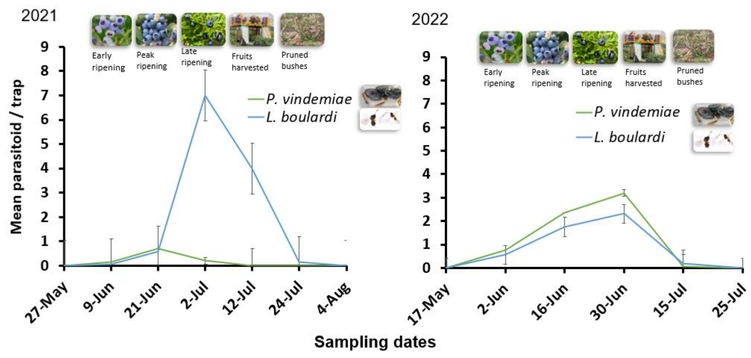


Fig 5: Seasonal abundance of SWD-associated parasitoid in Georgia

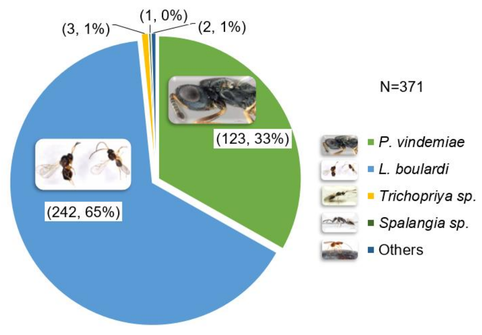


Fig 6: Proportion of SWD- associated parasitoids collected in Georgia

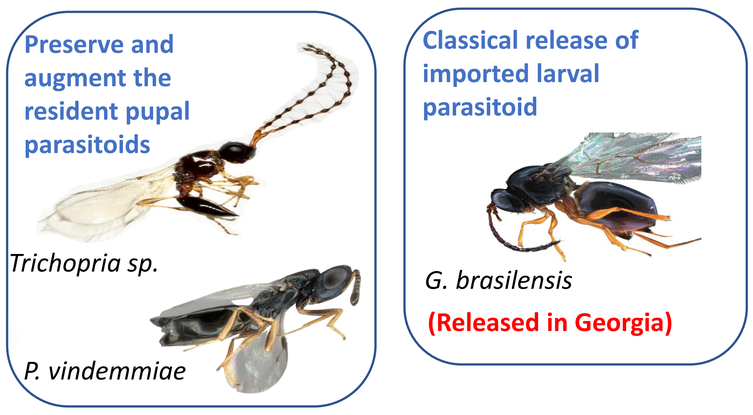
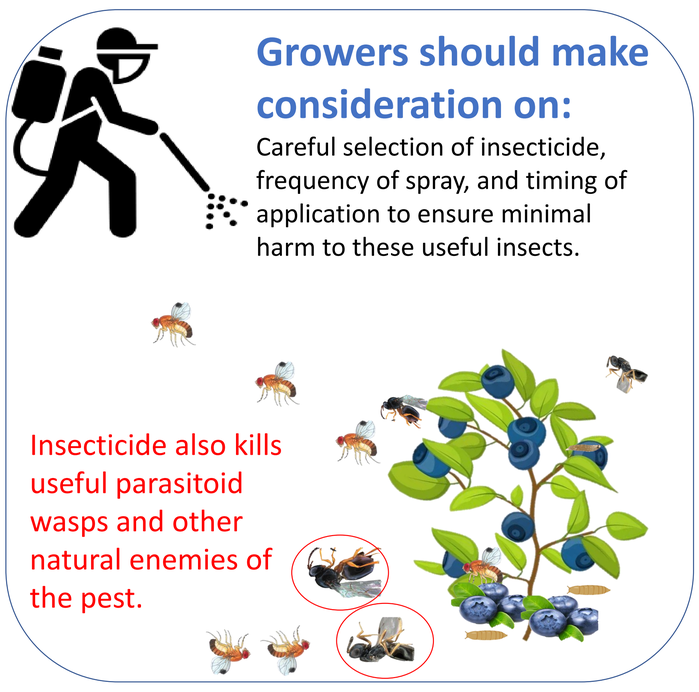


Fig 7: SWD-associated parasitoids used in biocontrol



Acknowledgments

Small Fruit Entomology Lab
Department of Entomology, University of Georgia
All the blueberry growers for allowing their farms to survey.
This research was supported by the Southern SARE Graduate Student Grant Award (GS22-269).

Objective 2: Lethal effects of conventional and organic insecticides on the exotic and resident parasitoids of Spotted-wing Drosophila

Optimizing the insecticide spray that is least harmful to the parasitoids by identifying the suitable pesticide classes, concentration, and application timing matched plays an essential role in planning an effective IPM program of SWD. To achieve this objective, we exposed the parasitoids to nine different insecticides at maximum allowable field application rates and evaluate their lethal effects on the parasitoids.

Methods:

We conducted a laboratory study to assess the lethal effect of commonly used insecticides on parasitoids common in the blueberry growing system at field rates. For this, we selected the two most promising parasitoids of spotted wing drosophila. We exposed each of these parasitoids into a glass vial infested with the field rate of insecticides and observed them until they die.

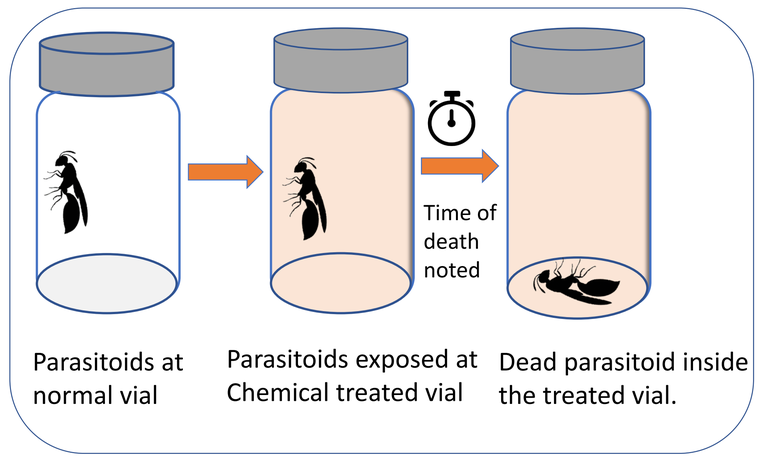


Fig 8: Procedure to test the lethal effect of insecticides on parasitoids

Results:

We observed that at the exposed rates, most parasitoids of both species died within 72 hours of exposure (fig 9 and 10). A general trend that we observed was, the native parasitoids took longer to die compared to the imported parasitoids. This indicates the imported parasitoids are more susceptible to insecticide exposure compared to the resident parasitoids.

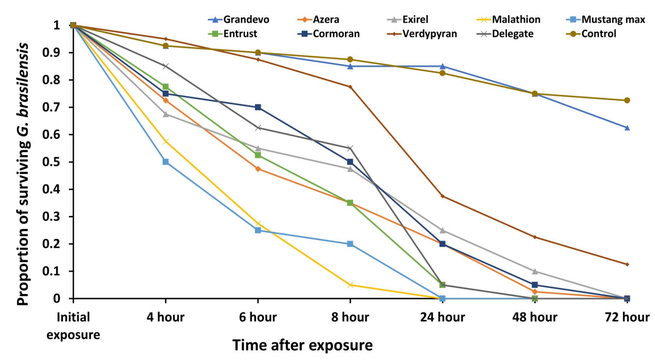


Fig 9: Lethal effect of insecticides on *Ganaspis brasiliensis*

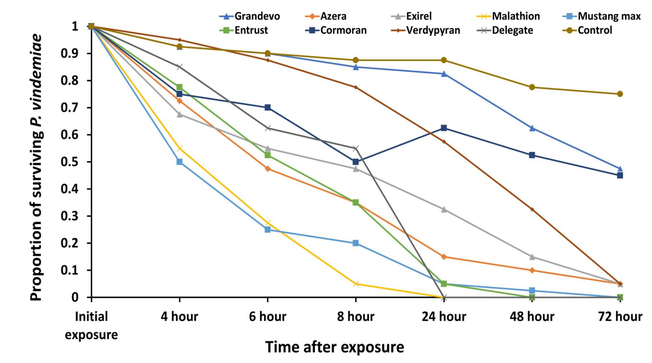


Fig 10: Lethal effect of insecticides *Pachycrepoideus vindemmiae*

Discussion and Conclusion

This study is an attempt to explore and evaluate the presence and distribution of the existing parasitoids of SWD in blueberry production systems in Georgia. This is also an attempt to understand and integrate the newly released exotic natural enemy of an economically important pest to the existing blueberry growing practices in Georgia that contribute towards the long-term economic benefit and builds a resilient production system for the future. Based on our studies, the blueberry growing regions of Georgia have the potential for biocontrol through augmentation of existing natural enemies as well as classical biocontrol via release of imported parasitoids. For them to establish and thrive in the existing system, attempts must be made to give them appropriate habitat and make judicial use of insecticides to benefit from the parasitoids over the long-term.

References:

Goodhue, R. E., Bolda, M., Farnsworth, D., Williams, J. C., & Zalom, F. G. (2011). Spotted wing drosophila infestation of California strawberries and raspberries: economic analysis of potential revenue losses and control costs. Pest management science, 67(11), 1396-1402. doi.org/10.1002/ps.2259

Wiman, N. G., Walton, V. M., Dalton, D. T., Anfora, G., Burrack, H. J., Chiu, J. C.,& Ioriatti, C. (2014). Integrating temperature-dependent life table data into a matrix projection model for *Drosophila suzukii* population estimation. PloS one, 9(9), e106909. doi.org/10.1371/journal.pone.0106909