Can Improved Diet Quality Alleviate Harmful Effects of Pesticides and Viruses in Honey Bees?

Brittney Bailey,[1] Ed Hsieh,[2] and Adam Dolezal[2]
Parkland College, Champaign, Illinois[1]
Department of Entomology, College of Liberal Arts and Sciences, University of Illinois at Urbana-Champaign[2]

GEMS GENOMICS AND ECO-EVOLUTION OF MULTI-SCALE SYMBIOSES

Introduction

- This study investigates interacting effects of viruses and pesticides within honey bees and how improved diet quality can mitigate these effects.
- This experiment allows a multivariate problem which exists in natural conditions of the honey bee community to be observed in a controlled cage bioassay.
- The virus used in this study is the Israeli acute-paralysis virus (IAPV).
- Neonicotinoid thiamethoxam is the pesticide used in both trials shown in the 'Results' section. This experiment has not begun the use of the pyrethroid at this time.

Preliminary Results

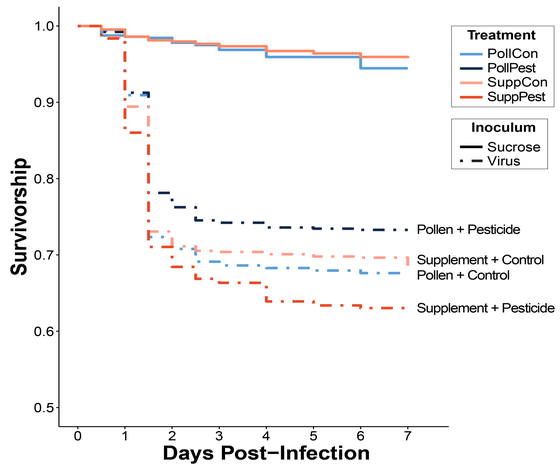

Figure 1: Data used in this figure was collected as a prior experiment as part of a proposal for this study.

- The results found in this preliminary show significant difference in survivorship among bees given the high quality diet compared to bees given the supplement diet when affected by both the pesticide and virus.
  - The survivorship curve suggests that a higher diet quality can mitigate the negative effects of pesticides and viruses.
- Although the data was part of a prior study, the results support continuation of this experiment using different classes of pesticides to decide if this theory is consistently applicable.

Results

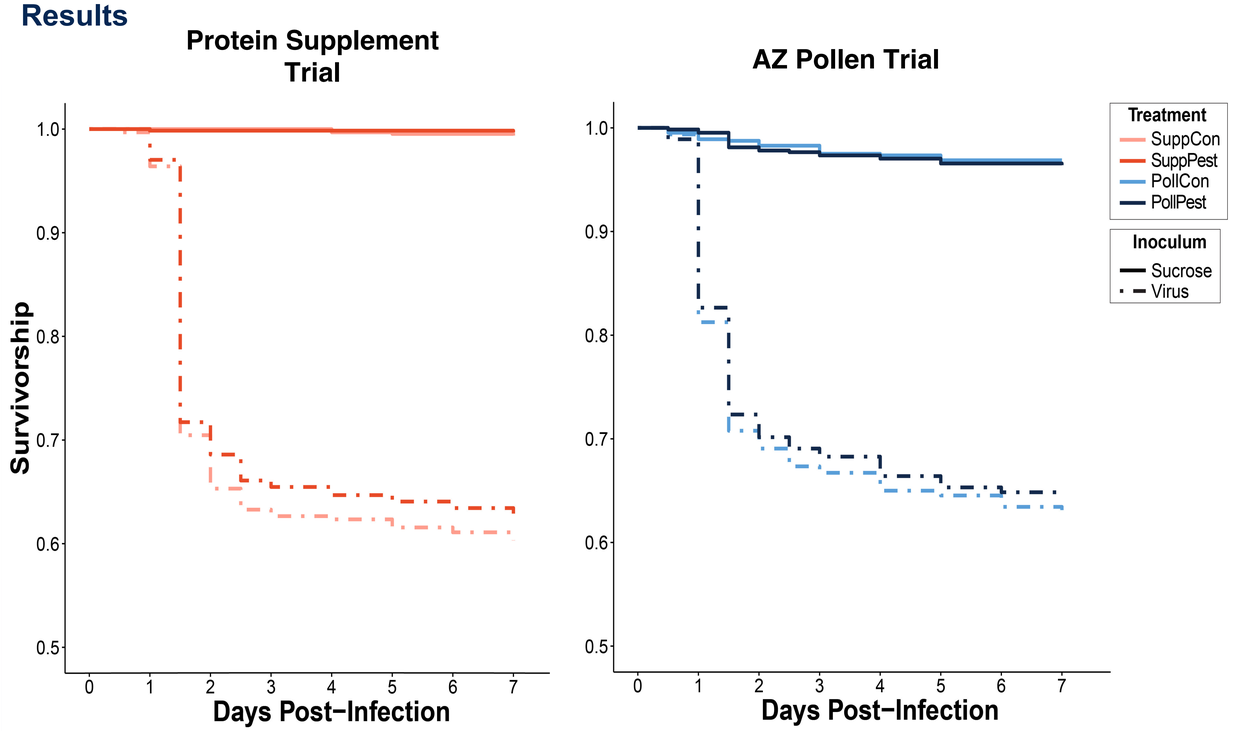

Figure 3: Results yielded from these trials show there was no significance in survivorship between the different diet qualities in honey bees affected by the pesticide and virus. Further experiments will be conducted using a pyrethroid pesticide.

Experimental Design

- This study will test 2 different quality diets on randomized cage treatments in their own trials.
  - Protein supplement diet (MegaBee™)
  - High quality C.C. Pollen Co. High Desert Bee Pollen
- Pesticide concentration used in this experiment is 70ppb, a dose determined by measurements found in field-collected pollen.[1]
  - Using field-collected pollen as reference ensures honey bees in this study experience realistic pesticide conditions.
- A total of 80 cages are each filled with 35 bees and assigned random treatments of the following:

Pesticide dosed diet Sucrose solution	Control diet Sucrose solution
Pesticide dosed diet 1.5% IAPV solution	Control diet 1.5% IAPV solution

- Mortality checks occur every 12 hours for the first 3 days (72 hours post-infection), after which checks take place every 24 hours until the end of the 7-day trial.

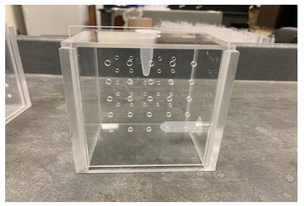

Figure 2: The cube cage model used in this study.

- 3 live bees are sampled from each cage onto dry ice at 24 hours post-infection to check viral titer measurements.
  - The purpose of sampling at 24 hours is because IAPV phenotypes typically present themselves around this time.
  - Mortality data recorded is used to configure a survivorship curve for each treatment, using the statistics produced to determine any significance.

Troubleshooting and Future Work

- Complications with a 1% dose of the IAPV virus caused failure to produce the expected mortality rate among the honey bees.
  - Troubleshooting resolved this issue by choosing to increase the dose to 1.5% after running a dose-response trial.
- Continuation of this experiment will include using the pyrethroid λ-cyhalothrin pesticide in another set of trials.
- Further investigation into different classes of pesticides will help answer if the study is applicable across other categories.
- Measuring viral titer levels will also be done to investigate whether diet quality affects both viral resistance and tolerance.[2]

References

1) Dively, G. P.; Kamel, A. Insecticide Residues in Pollen and Nectar of a Cucurbit Crop and Their Potential Exposure to Pollinators. *J. Agric. Food Chem.* **2012**, *60* (18), 4449–4456.

2) Rutter, L.; Carrillo-Tripp, J.; Bonning, B. C.; Cook, D.; Toth, A. L.; Dolezal, A. G. Transcriptomic Responses to Diet Quality and Viral Infection in Apis Mellifera. *BMC Genomics* **2019**, *20* (1), 412

Acknowledgments

Financial support for the REU program was provided by the National Science Foundation Biological Integration Institutes Program grant NSF #2022049, through the Genomics and Eco-Evolution of Multi-Scale Symbioses (GEMS) Institute at the Carl R. Woese Institute for Genomic Biology at the University of Illinois at Urbana-Champaign.
https://symbiosis.illinois.edu/

Acknowledgement to Ed Hsieh, Adam Dolezal, GEMS REU lead Carla Caceres, and technical and support staff at the Institute for Genomic Biology.

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN