Determining Transfer Rates of Chlorpyrifos from Alfalfa Leaves to Provisions in Alfalfa Leaf Cutting Bee Nests

Calvin Luu, *Utah State University* | Kimberly Hageman, *Utah State University, Research Mentor*

Introduction

Alfalfa Leaf Cutting Bee (ALCB, *Megachile rotundata*) larvae are potentially being exposed to pesticides from their main nutrient source: provisions. It has been hypothesized that the leaves used to build the nests can be a source of pesticide contaminate as residue can transfer into the provisions. Understanding the pesticide exposure to ALCBs is necessary because:

1) Identifying exposure routes of pesticides to solitary bees is important as most wild bee species are solitary bees.[1]
2) ALCBs are being considered as a surrogate species for solitary bees in pesticide risk assessments.[2]

Chlorpyrifos, an organophosphate insecticide, will be used for the transfer tests as it is commonly applied on alfalfa fields.

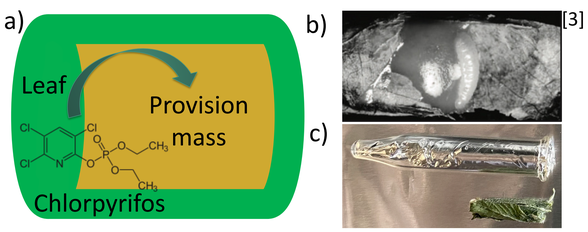

Fig. 1: a) Chlorpyrifos transfer from leaf into provision mass. b) Opened ALCB nest. c) Artificial nest set-up.

Objectives

1) Optimize extraction method for chlorpyrifos from provisions.
2) Determine rate of transfer of chlorpyrifos from leaves into provisions.

Results

Extraction Methods

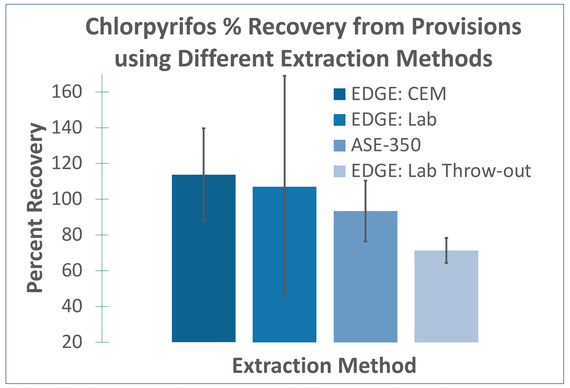

Fig. 2: Percent Recovery of Chlorpyrifos from provisions using three methods of extraction.

1) Spike and recovery experiments for chlorpyrifos from provisions using Accelerated Solvent Extractor (ASE-350) and Energized Dispersive Guided Extraction (EDGE).
2) Use Gas Chromatography Tandem Mass Spectrometry (GC-MS/MS) to quantify percent recovery ratio of chlorpyrifos from extraction methods.

Transfer Experiments

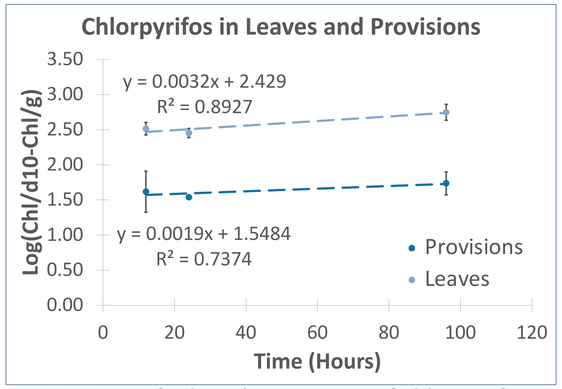

Fig. 3: Quantified peak area ratio of chlorpyrifos and surrogate in leaves and provisions over time.

1) Constructed artificial nests to imitate provision exposure to contaminated leaves over several time periods.
2) Extract provisions using EDGE (CEM) method and leaves using method developed by Kinross et al.[4]
3) Qualitative determination of chlorpyrifos using GC-MS/MS from provisions and leaves.

Discussion

Method Optimization

Three methods were used to determine the best method of extraction for chlorpyrifos from provisions: EDGE with CEM Corp. method, EDGE with lab adapted method, and ASE-350. The recovery for each are method are 114% ± 26%, 107% ± 62% and 93% ± 17%, respectively. The most efficient method was EDGE: CEM and will be used for all provision extractions.

Transfer Experiments

Preliminary data was collected for 12-, 24-, and 96-hour time trials. The ratio of the peak areas for chlorpyrifos and d10-chlorpyrifos was determined to find a qualitative trend. The trend for leaves was slightly positive overtime, which was not expected as it was hypothesized to decrease. The trend for provisions was also slightly positive overtime, which was expected, but more time trials are needed before a transfer rate can be determined as current data sets are not sufficient. Future time trials for 7, 10, and 14 days will be completed.

Conclusions

A method of extraction for chlorpyrifos from provisions was successful with high yields. The transfer experiment data is preliminary; more data is needed to determine a rate of transfer of chlorpyrifos from leaves to provisions.

Study was funded by USU Undergraduate Research and Creative Opportunity Grant and the USDA-ARS Pollinating Insect-Biology, Management, Systematics Research Division.

Citations

[1] Kopit, A.M. and T.L. Pitts-Singer. "Routes of Pesticide Exposure in Solitary, Cavity-Nesting Bees." *Environmental Entomology,* 47(3): 499-510. 4 April 2018.
[2] Sgolastra, F., et al. "Pesticide Exposure Assessment Paradigm for Solitary Bees." *Environmental Entomology,* 48(1): 22-25. 3 December 2018.
[3] Pitts-Singer, T.L. and J.H. Cane. "The Alfalfa Leafcutting Bee, *Megachile rotundata*: The World's Most Intensively Managed Solitary Bee." *Annual Review of Entomology,* 56: 221-237. 30 August 2010.
[4] Kinross, A.D., et al. "Comparison of Accelerated Solvent Extraction (ASE) and Energized Dispersive Guided Extraction (EDGE) for the analysis of pesticides in leaves." *Journal of Chromatography A,* 1627. 13 September 2020.

Calvin Luu (he/him)
Utah State University
Department of Chemistry and Biochemistry
calvin.luu@aggiemai.usu.edu