

Quantifying the exposure and effect of farmer applied pesticides on north - east migratory operations pollinating crops in PA, NJ, ME, and MA.

PI's:

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Introduction:

In the fall of 2006, widespread losses of bees came to be associated with symptoms known as Colony Collapse Disorder (CCD). Colonies rapidly declined, leaving behind few or no adult bees in the hive along with ample food supplies and a large area of brood. In an attempt to investigate the cause of these die offs a multi-factorial analysis of possible causes was initiated (vanEngelsdorp, Pettis, Cox-Foster, Frazier, Tarpy, et al (unpublished)). The role of parasites, pathogens, pesticides and nutrition were investigated. To date no one factor has been isolated as the sole cause of collapse. One limitation of this study, however, was the fact that samples were collected from colonies only once, in essence taking a snap shot of the colony health on the date of collection.

To help address this short coming, a longitudinal study was initiated in 2007, which followed tagged colonies in 3 migratory operations as they moved from Florida up and down the east coast to pollinate a variety of crops (Citrus, high bush blueberries (NJ), low bush blueberries (ME), apples (PA), cucumbers (NJ), squash (NJ), pumpkin(PA)). Samples of pollen, wax, adult bees, and detailed colony measurements were taken each time these colonies were moved to a new crop. While funding some funding has been secure for the analysis of bee samples for pesticide exposure this funding is only part of that needed to do to complete the analysis

To date a total of 45 different agricultural pesticides have been found in the pollen stores of the 92 colonies examined. These include colonies sampled as a part of the initial CCD study. The most frequently detected pesticides are shown in Table 1. While none of these or other pesticides have yet been identified as the sole cause of CCD, it is possible that pesticide contaminated pollen and/or pesticide build-up in the colonies, is one of important factors contributing to CCD and declining bee health.

Table 1. Most Frequent Pesticide Detections in Pollen (2007)

Pesticide	Class ¹	LD50 ² (µg/bee)	LOD ³ (ppb)	Residue (ppb)		Frequency N = 92 (%)
				Range	Mean	
Fluvalinate	PYR	0.88	2	2.4 - 2670	172.5	67
Chlorpyrifos	OP	0.122	0.1	0.1 - 830	55.2	61
Coumaphos	OP	4.63	4	3.9 - 5828	210.8	51
Endosulfan 1+2+SO ₄	CYC	7.87	0.1	0.2 - 54	8.1	34
Atrazine	HERB	97	4	2.7 - 49	17.5	24

Fenpropathrin	PYR	0.05	0.4	0.4 - 17	3.1	20
Metolachlor	HERB	126	2	2.6 - 11	6.7	16
Cyhalothrin (total)	PYR	0.116	0.5	0.5 - 71	10.4	15
Myclobutanil	FUNG	187	2	4.4 - 981	225.8	12
Simazine	HERB	96.7	5	5.2 - 54	20.2	12
Malathion	OP	0.419	0.5	0.9 - 61	11.3	12
Carbendazim	FUNG	50	1	1.7 - 69	9.2	12
Chlorothalonil	FUNG	182	1	30 – 4200	921.0	10
Esfenvalerate	PYR	0.409	1	1.0 - 58	8.5	10

¹CYC = cyclodiene, FUNG = fungicide, HERB = herbicide, OP = organophosphate, PYR = pyrethroid.

²LD50 is ave. honey bee acute toxicity from lit.; bold nos. < LD50

³LOD = limit of detection by GC-MS or LC-MS/MS

Beekeeper Pesticide Analysis Cost Sharing Program

The USDA, National Science Lab in Gastonia NC is capable of screening all hive matrixes for up to 171 pesticides at or near the ppb level. This lab is part of the USDA's Agriculture Marketing Service (AMS) and conducts a program to collect and analyze data about pesticide residue levels in agricultural commodities. In addition, it provides pesticide analytical services to agricultural commodity groups and individual producers at a reasonable cost, typically well-below commercial prices. This data is confidential and the property of the contractor.

Although the AMS cost of analysis is below commercial rates, the analysis of individual samples is costly; analysis for coumaphos and fluvalinate in wax is \$90 per sample, full screening (171 pesticides) in any hive matrices is \$205 per sample.

The funding requested in this proposal will help answer:

1. What pesticides are migratory operations exposed to as they move to different agricultural crops and honey producing areas?
2. What effect does this exposure have on short term and long term colony health and survivorship?

Methods:

Over 80 honey bee colonies representing three migratory beekeeping operations were monitored in 2007. Pollen, wax, and adult bee samples were obtained from hives as they moved to various pollination and honey production sites. Over sixty percent of these colonies died over the course of the study. Some colonies died exhibiting classic CCD symptoms. By determining the levels of pesticides in these operations and individual colonies we can compare the level of exposure and survivorship. Further, the

pesticide data obtained will be correlated with data on parasite loads, presence of disease agents, queen mating diversity, and observations of CCD symptoms.

Also we will compare the variation of pesticide exposure within operations. There has been some anecdotal evidence that bees in the same apiary may forage on different sources, thus individual colonies may have different exposure levels. Analysis of samples should help substantiate this claim.

Pesticide residue analysis will be conducted by the USDA, Agricultural Marketing Service, National Science Laboratory in Gastonia, NC, under the direction of chemist Roger Simonds, The pollen and bee samples will be analyzed for 171 chemicals, concentrating on 60 top priority materials and some metabolites. Metabolites are the breakdown products of pesticides, and some can be more toxic than the parent compound. Wax and brood samples were similarly analyzed.

Potential outcomes:

Correlating pesticide exposure to colony health will help determine the relative risk involved in pollinating crops along the east coast. Identifying risk is the first step in risk mitigation. Such mitigation, could dramatically increase colony survival if indeed pesticide exposure has direct or sub-lethal effect on colonies. In addition, correlating the data generated by this grant with CCD symptoms will aid in the determination of the cause of this devastating disorder. This information will be helpful in determining or eliminating possible causes of CCD and, in the broader sense, colony health. Adding these data to the data from the previously funded work (estimated at \$100,000 or grants and in kind contributions) will have a tremendous multiplying effect on enhancing our knowledge of threats to colony health.

Budget explanation

In all 382 pollen, wax, and adult bee samples were collected during the course of this study. In this project we are requesting to funds to analyze a sub set of these samples. Cost of pesticide residue analysis for 171 chemicals is \$205/ sample.

Adult bee and pollen samples: 25 samples @ \$205 = \$5,125

Sample Shipping: \$ 404

Overhead: \$2,471

Total: \$8,000

A. Salaries and Wages	
Senior Personnel:	
Co-Proj. Director - D. vanEngelsdorp	0
Co-Proj. Director - M. Frazier	0
Total Category I	0
Total Salaries and Wages	0
B. Fringe Benefits	
Category I @ 25.8%	0
Total Fringe Benefits	0
C. Total Salaries, Wages, & Fringe Benefits	
0	
D. Equipment (\$5,000 and greater)	
0	
E. Materials & Supplies	
1. Adult bee and pollen samples: 25 samples @ \$205	5,125
Total Materials & Supplies	5,125
F. Travel	
0	
G. Publication Costs	
0	
H. Computer Costs	
0	
I. Student Assistance/Support	
0	
J. Other Direct Costs	
1. Shipping costs	404
Total Other Direct Costs	404
K. Total Direct Costs	
5,529	
L. Indirect Costs @ 44.7% MTDC	
2,471	
M. Total Project Costs	
8,000	

Budget Notes:

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Estimated salary costs are based on current salary rates (fiscal year 2007-08) escalated approximately 3.5% beginning July 1 of each subsequent year. University policy has been to award salary increases on the basis of merit only.

Fringe Benefits: Rates are computed using the rates of 25.8% applicable to Category I salaries; 15.7% applicable to Category II graduate assistants; 8.2% applicable to Category III non-student wages and fixed-term II salaries; and 0.4% applicable to Category IV student wages for the current fiscal year of July 1, 2007 through June 30, 2008. If this proposal is funded, the rates quoted above shall, at the time of funding, be subject to adjustment for any period subsequent to June 30, 2008 if superseding Government approved rates have been established. The fringe benefit rates are negotiated and approved by the Office of Naval Research, Penn State's cognizant federal agency.

Travel: All travel will be in accordance with University travel regulations. Travel estimates are based on costs that were incurred on previous projects of a similar nature for federal and state agencies.

Indirect Costs (Facilities and Administrative): The F&A rates are negotiated and approved by the Office of Naval Research, Penn State's cognizant federal agency. The predetermined on-campus rate for instruction and continuing education is 47% of Modified Total Direct Costs (MTDC) from July 1, 2007 to June 30, 2008; 47.5% of MTDC from July 1, 2008 to June 30, 2009; and 48% MTDC from July 1, 2009 to June 30, 2010. New awards and new competitive segments with an effective date of July 1, 2007 or later shall be subject to adjustment when superseding Government approved rates are established. Per OMB Circular A-21, the actual F&A rates used will be fixed at the time of the initial award for the duration of the competitive segment.