

# Honey Bees and Pesticides: Recent Research on Toxicity and Routes of Exposure



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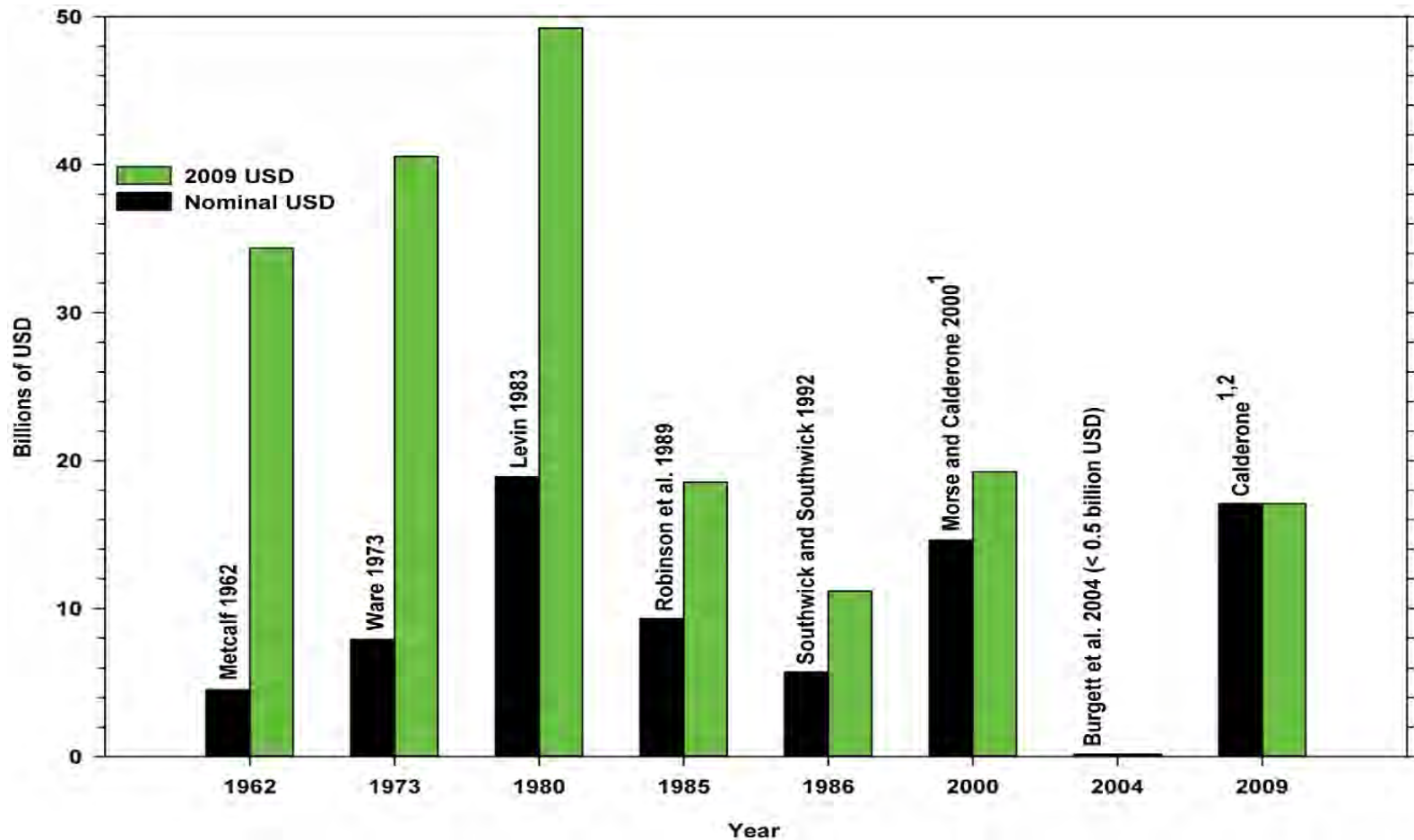


# Talk Outline

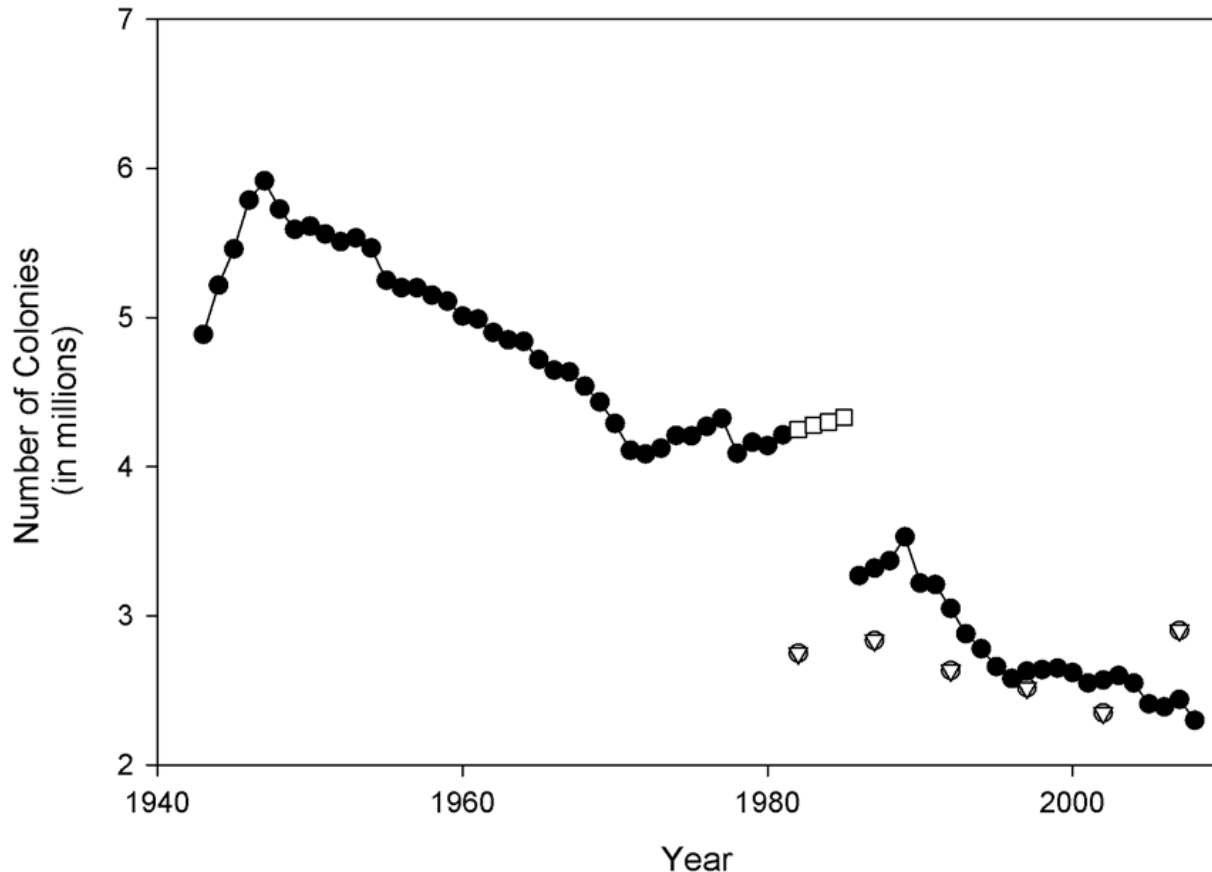
- Background - Why are we interested in how honey bees are affected by pesticides
- A sampling of recent research on honey bee pesticide toxicology
- Some of our recent research on honey bee pesticide exposure



# Estimated Value of Honey Bees to US Agriculture (from Calderone 2012)



# The Number of Honey Producing Colonies is Decreasing



Source: vanEngelsdorp and Meixner in Journal of Invertebrate Pathology (2010)



# What are Possible Causes of Decline in Honey Bees?

- Migratory Stress
- Poor Nutrition
- New Diseases
- Varroa Mites
- Colony Collapse Disorder
- *Pesticides*

# Questions About Pesticides and Bees

- What is the toxicology of pesticide exposure?
  - Acute vs. Chronic (sub-lethal) Effects
  - Synergistic Effects
- What pesticides are honey bees exposed to?
- How does the exposure occur?
- How much of the various pesticides are they exposed to?
- How does the exposure change with time and location?
- Can pesticide exposure be correlated with hive health?



# Recent Research on Toxicity

- Two general areas of recent research
  - 1) Sublethal toxicity of Neonicotinoid Pesticides
    - A newer class of systemic pesticides – residues found throughout the plant – including in the pollen and nectar
    - Pesticide class includes: imidacloprid, thiamethoxam, clothianadin, and dinetofuran
  - 2) Synergistic effects
    - Does exposure to one pesticide affect the toxicity of a second pesticide or pathogen



# Study #1 – Eiri and Nieh in The Journal of Experimental Biology (2012)

- Feed imidacloprid to bees in sucrose at 0.21 or 2.16 ng per bee
- Proboscis extension response: Nectar foraging bees that were exposed needed a higher sugar concentration to respond
- Waggle dancing: Exposed made fewer waggle dances





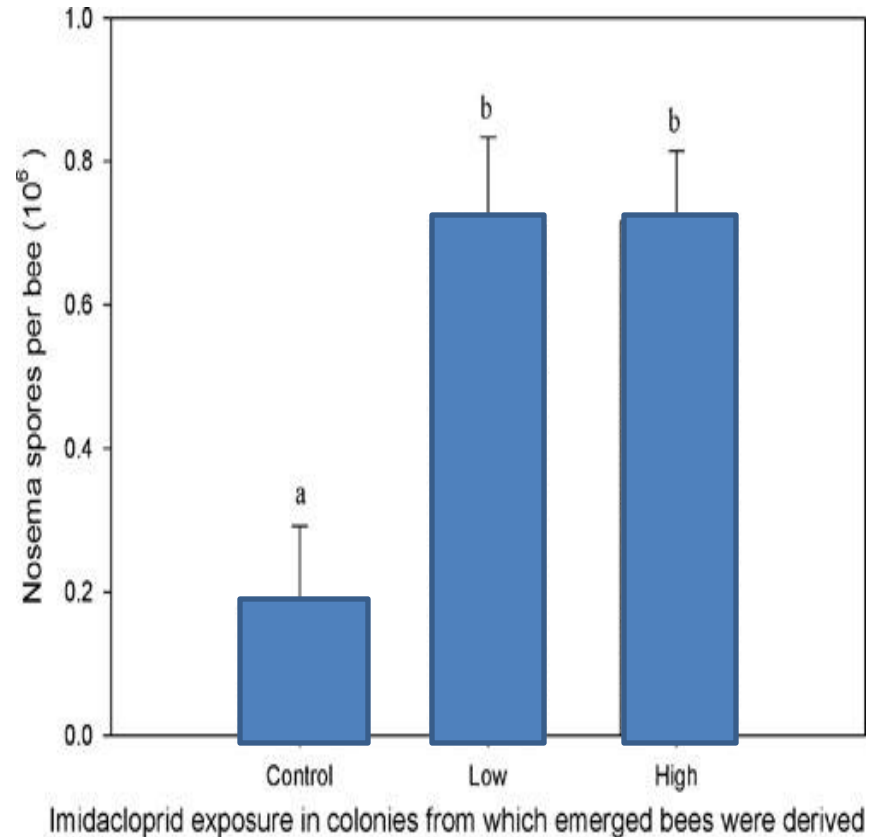
# Study #2 Henry et al. in Science (2012)

- Bees exposed to thiamethoxam (1.34 ng per bee), monitored homing success
- Exposed bees returned less often



# Study # 3- Pettis et al. 2012 in Naturwissenschaften

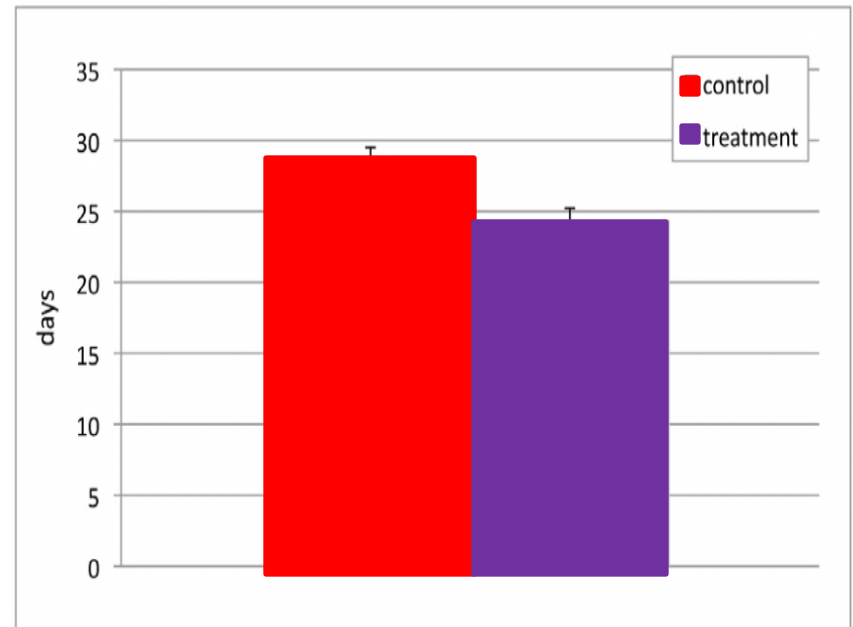
- For 10 weeks feed bees protein patties spiked with either 5 or 20 ppb imidacloprid (sub-lethal level)
- After 5 weeks expose the colonies to *Nosema* (a gut parasite)
- Exposed bees had more spores



# Study #4 Wu et al. in PLoS ONE 2011

- Compare brood reared on comb with high levels of pesticides with brood reared on comb that tested negative for pesticides
- Brood from comb with pesticides emerged later and had shorter lifetimes

- Lifetime in Days



# Exposure Studies



# Measure Pesticides in Pollen Collected by Foraging Honey Bees



Bee Collecting Pollen



Tray of Pollen from Hive



# Two Similar Studies – Similar Results

- Connecticut Pollen
  - Urban, suburban and rural hives
  - Pollen collected twice weekly
  - Pollen analyzed for pesticides by CAES multi-residue LC/MS method
- CAP Pollen (National Study)
  - Seven apiaries: Maine, Pennsylvania, California, Florida, Minnesota, Texas, Washington
  - Pollen collected either weekly or biweekly
  - Pollen analyzed for pesticides by CAES multi-residue LC/MS method



# Importance of Hive Location



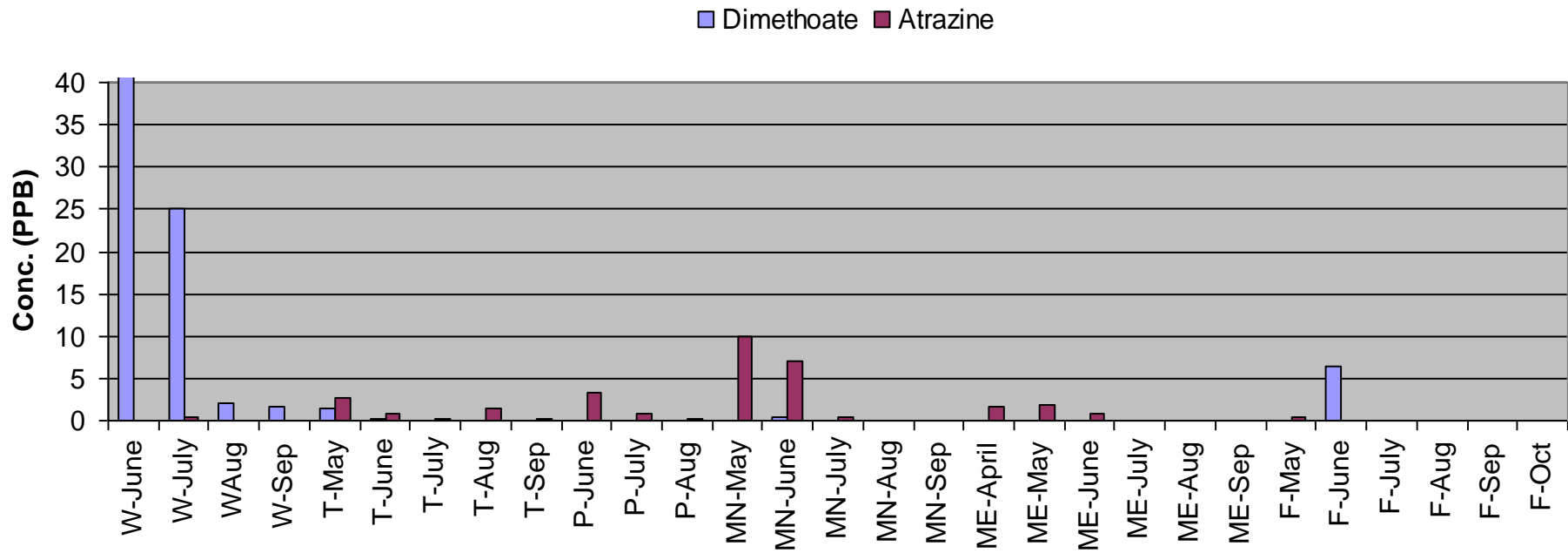
# Variable Pollen Load Brought to Hive on a Single Day Each Type with a Different Pesticide Load





# Pesticide Concentrations Vary with Time and Location

## Example From CAP Study

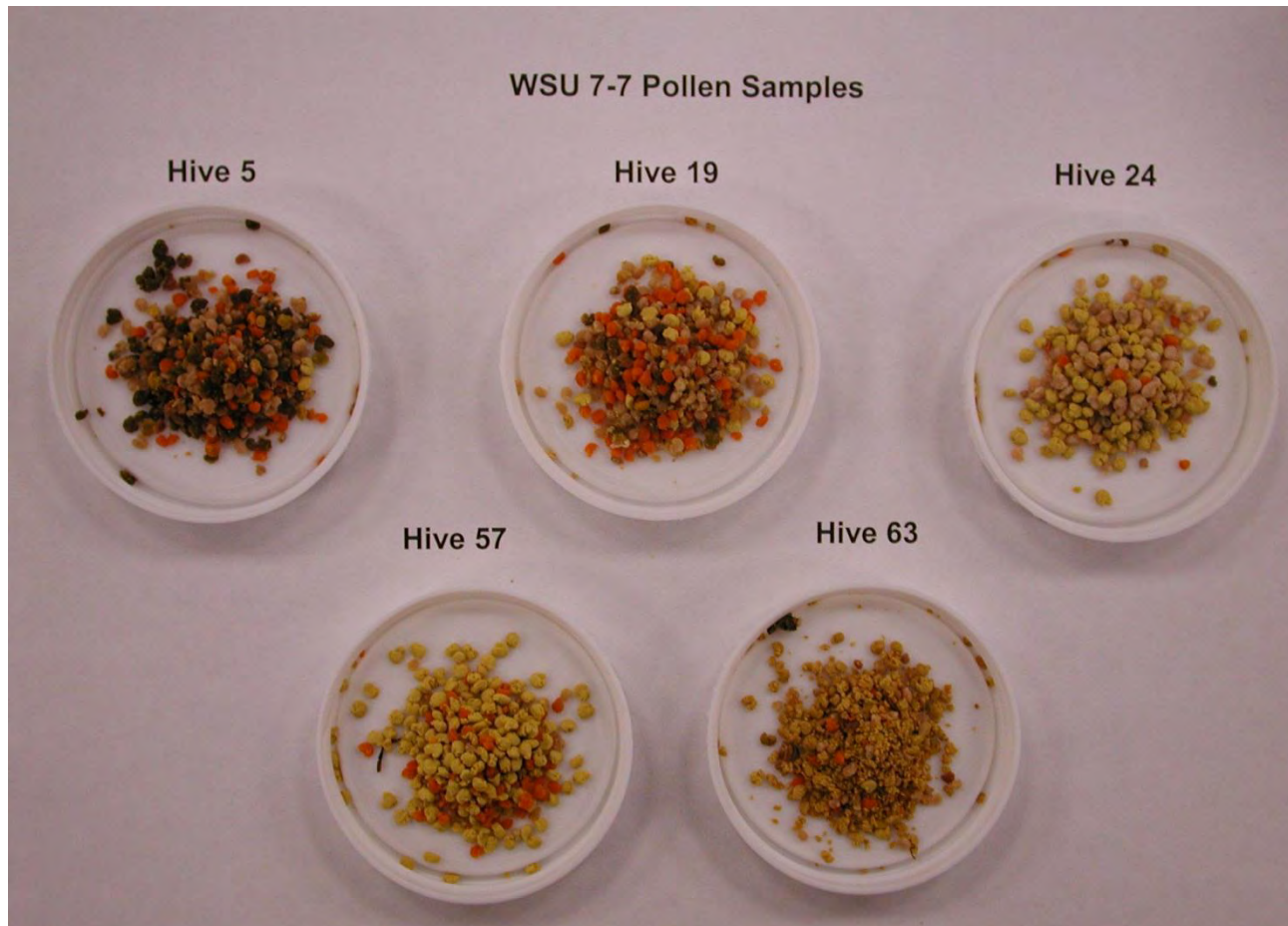


# Pesticide Concentrations Vary with Time and Location

- Example From Connecticut Study
  - In 2009 an orchard location had 12.0 residues per sample; the average of other sites was 5.4 residues per sample
  - All 4 samples from that location had difenconazole and 3 of 4 had myclobutanil; neither of these seen at any of the other hives that year



# Pollen Samples Differ by Hive Even at Same Location and Date



# Exposure Route Studies



# Measuring Neonicotinoid Residues in Squash Nectar and Pollen



Squash bees on pumpkin flower - Liz Andrews, UMass



# What we did:

- Grew squash using standard farming methods
- Applied neonicotinoid insecticides to soil at standard rates
- Collected pollen and nectar from flowers
- Measured pesticides in pollen and nectar



# Collecting pollen and nectar



# What we found:

Insecticide	Average Concentration in Pollen (Overall)	Average Concentration in Nectar (Overall)
Imidacloprid	14 ppb $\pm$ 8	10 ppb $\pm$ 3
Thiamethoxam	12 ppb $\pm$ 9	11 ppb $\pm$ 6
Control	None	None



# Study of a Different Possible Exposure Route



# Pesticide Treated Corn Seed - Enough Pesticide on Each Seed to Kill Thousands of Honey Bees



Photo courtesy of Purdue Entomology Department



# Talc Used to Keep Seed Flowing in Planter



Photo courtesy of Purdue Entomology Department



# Planting Seed

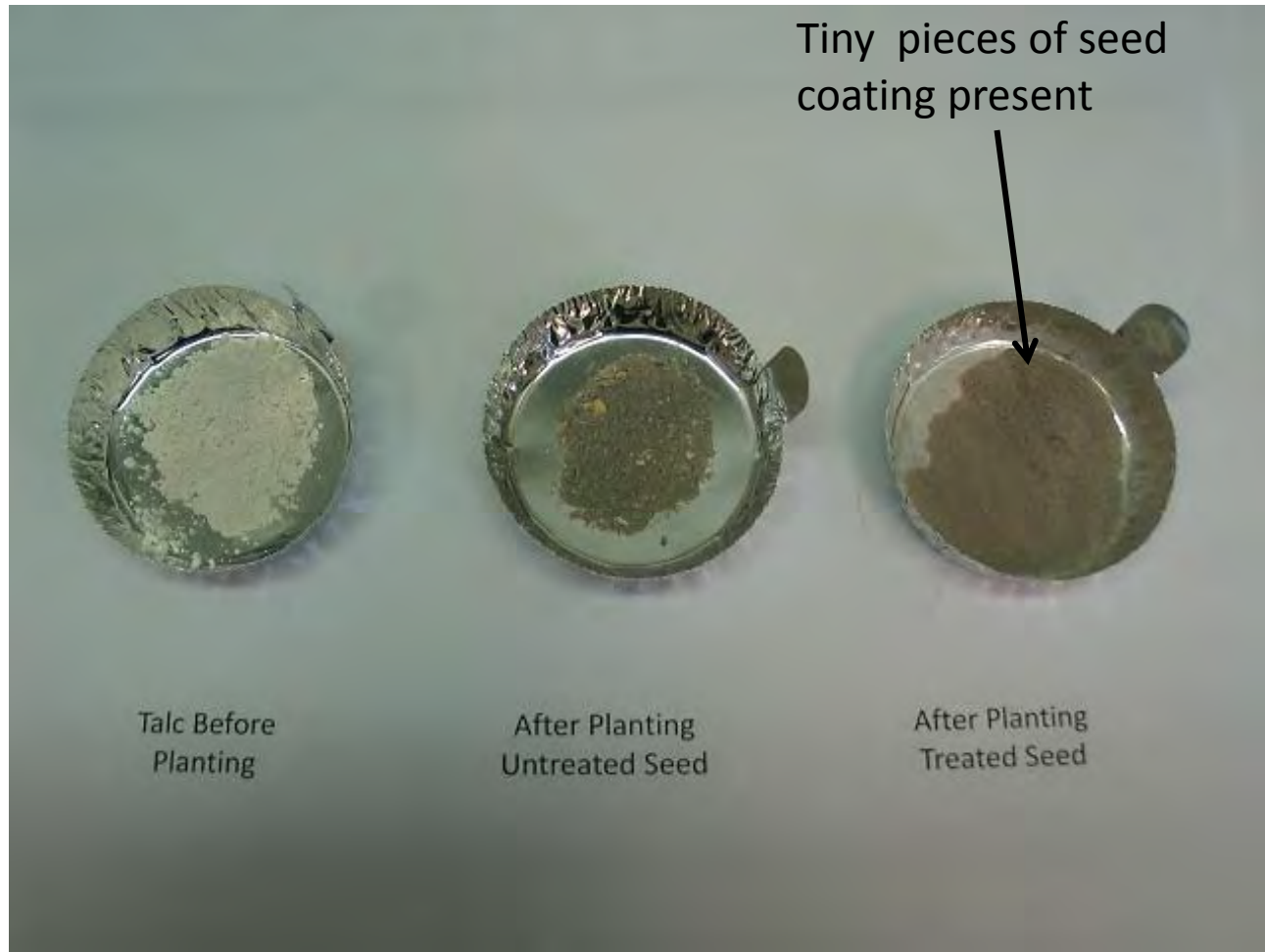


Photo courtesy of Purdue Entomology Department



# Talc Waste from Planter

## Very High Pesticide Concentrations Measured



# Edge of the Cornfield



Photo courtesy of Purdue Entomology Department



# Bee Collecting Dandelion Pollen

## Low Concentrations of Pesticide Measured in Dandelions Near Corn Field



Photo courtesy of Purdue Entomology Department



# Currently Looking at Deposition of Pesticide Contaminated Dust on Dosimeter Slides Placed Around the Field During Planting





# Summary

- Pesticides can affect honey bees
  - Both lethal and sublethal effects have been observed
- Honey bees can be exposed to pesticides in many different ways
  - Take care when using pesticides to try to minimize unintentional exposure



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