Pesticides and pollinators: Summarizing recent research

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Acknowledgements

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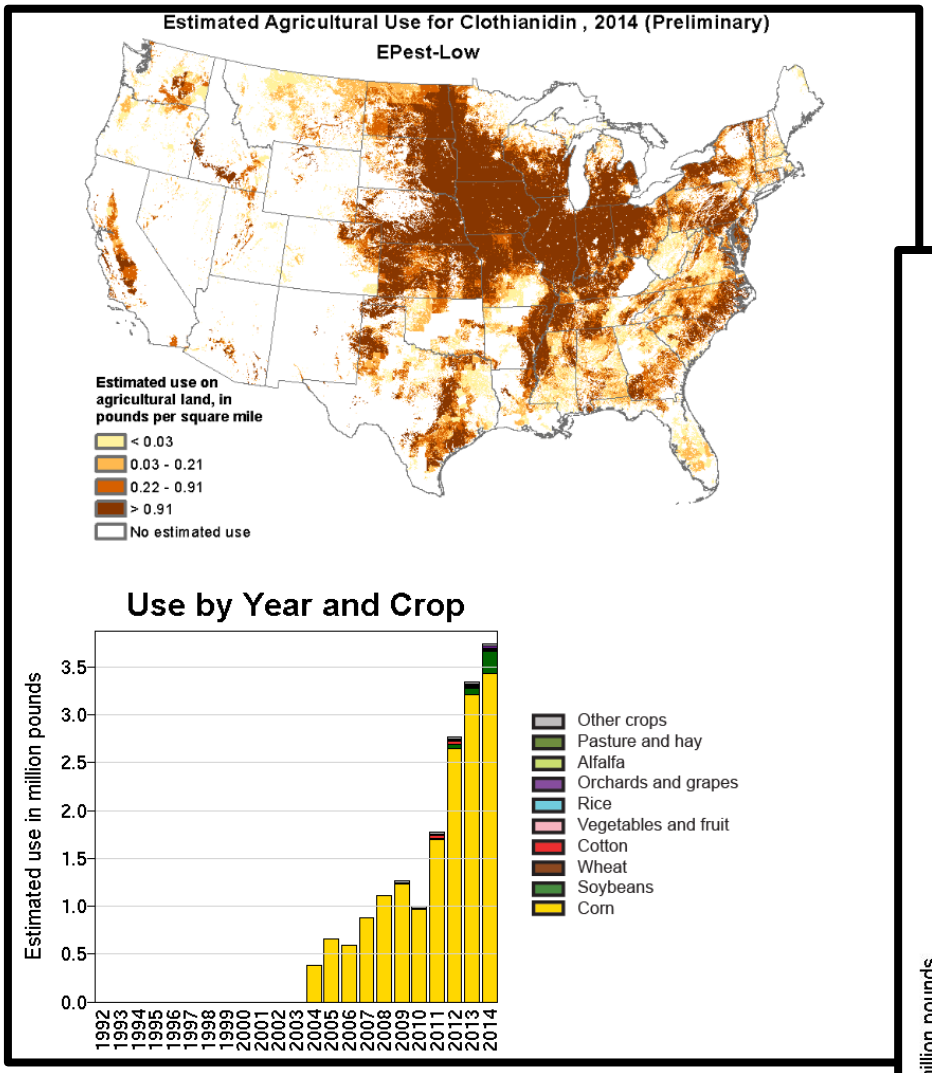
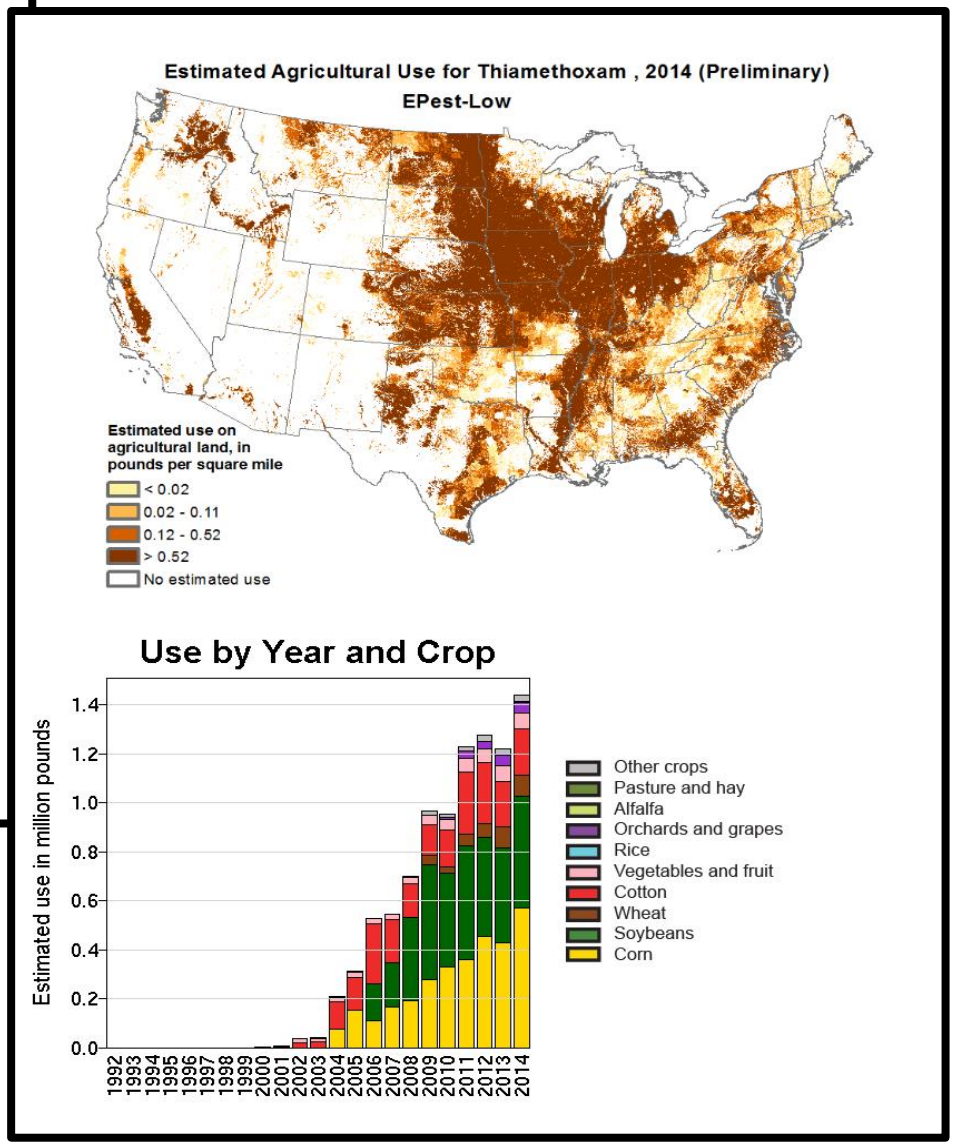
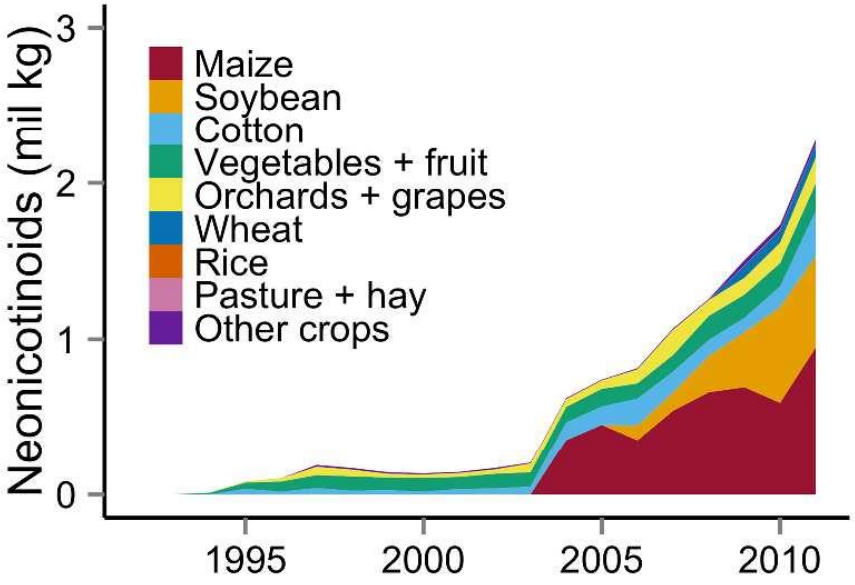
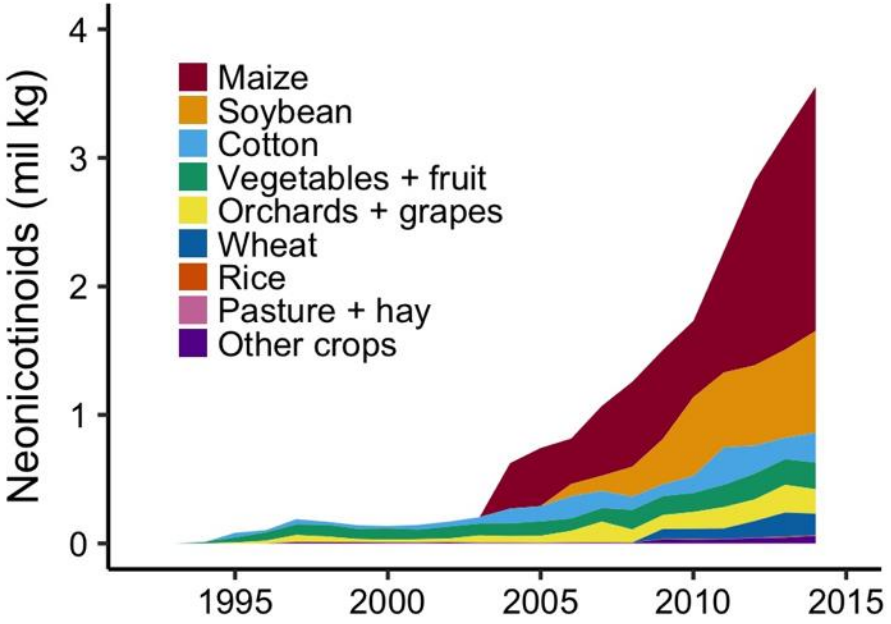
Clothianidin and thiamethoxam use/unit area: ca. 2014





Use rates in corn have doubled since 2012



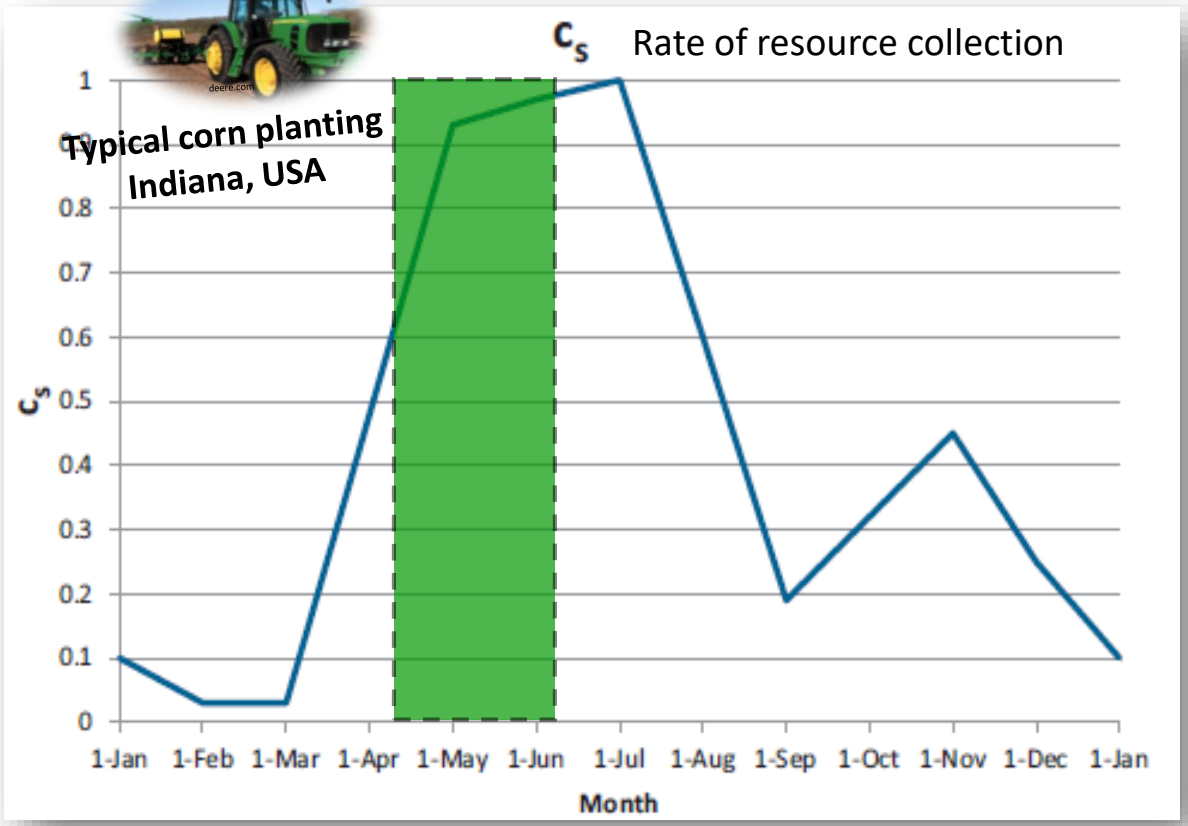


Douglas & Tooker (2015)
Environmental Science & Technology
Based on USGS data, Pesticide National Synthesis Project

Slide courtesy M. Douglas, Penn State Univ.

When bees meet corn: Unfortunate timing of events

Bees are 'charged' in flight!



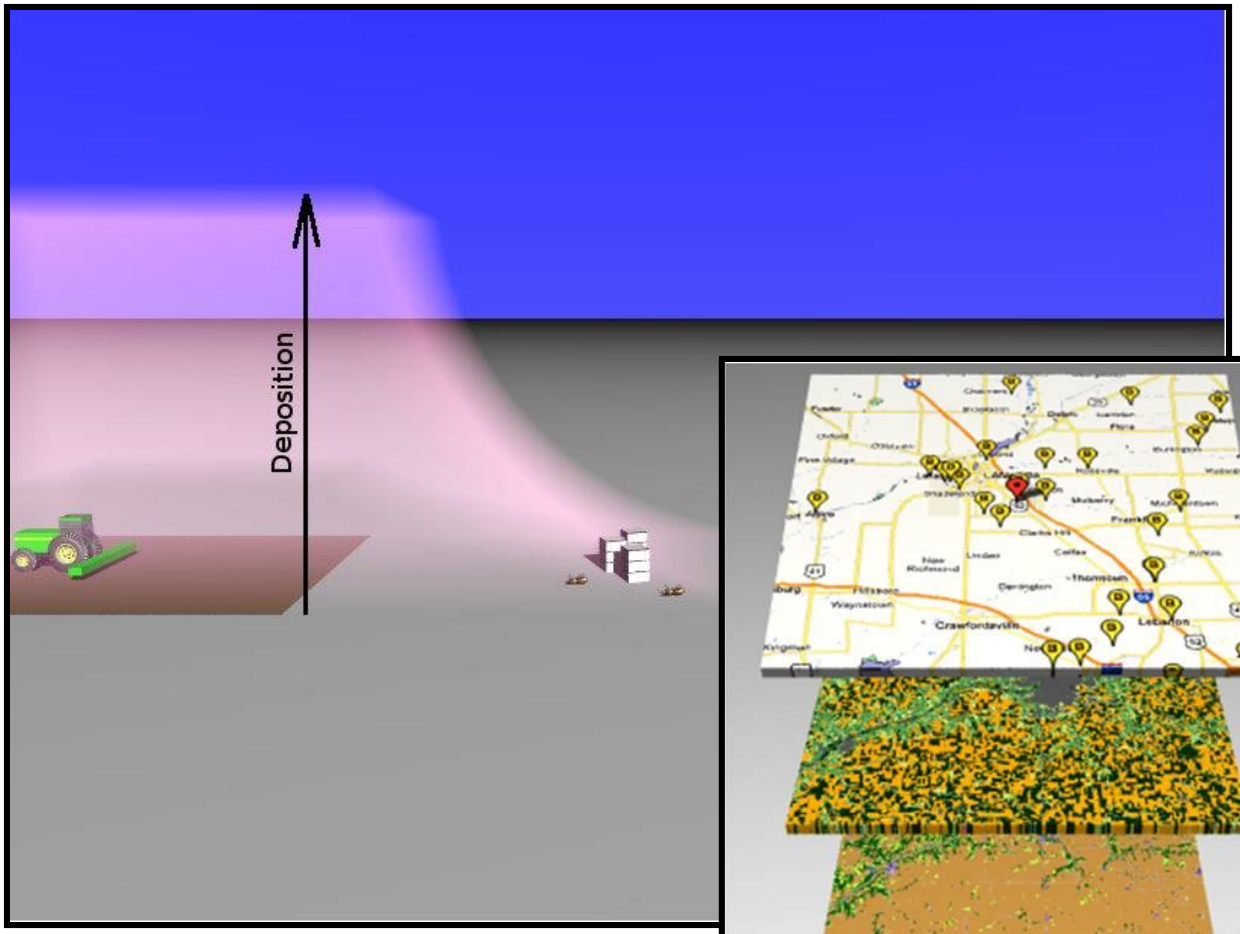
Vaknin et al. 2000

Russell et al. 2013 Ecol. Modelling. https://doi.org/10.1016/j.ecolmodel.2013.06.005

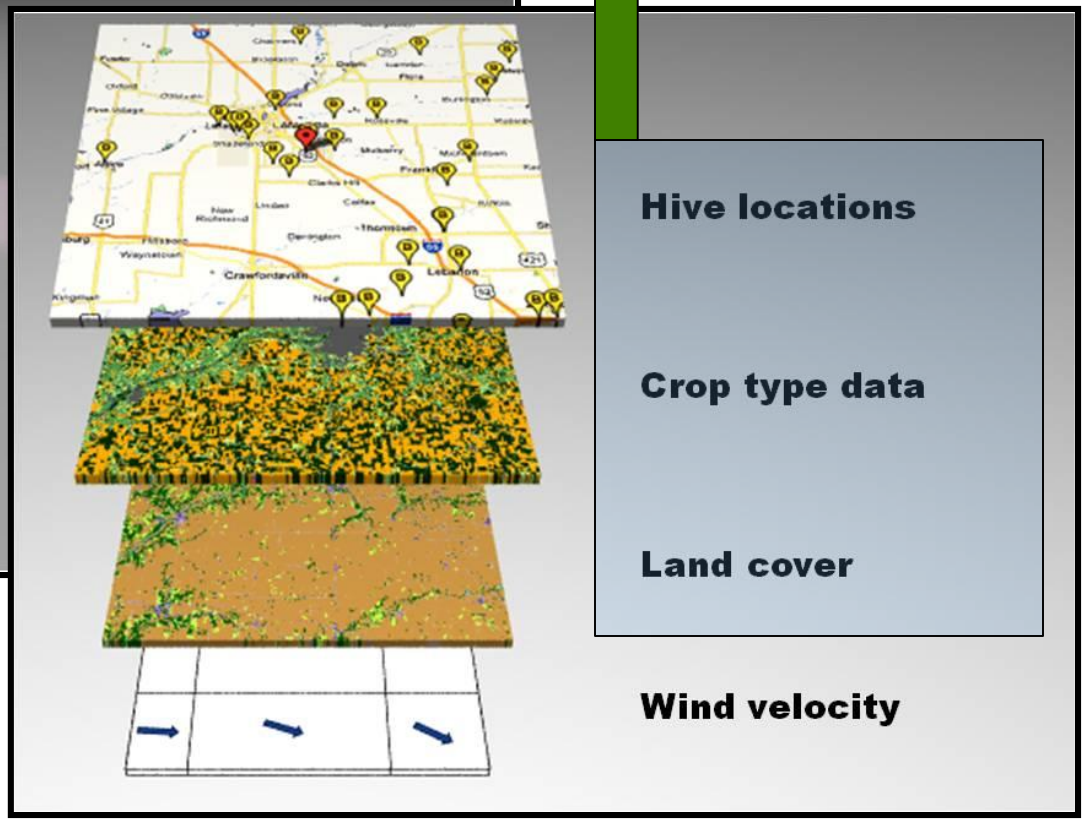
Planting treated seeds requires lubrication (talc/graphite)

Drifting particles are captured as field is planted

Risk map development



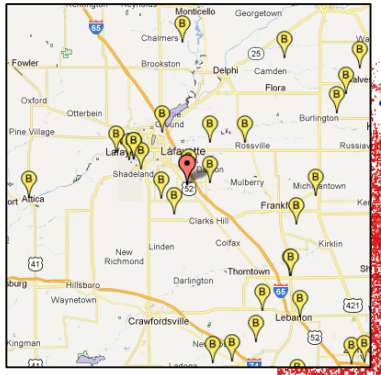
Available at:
Fieldwatch.org
USDA-NASS
USGS

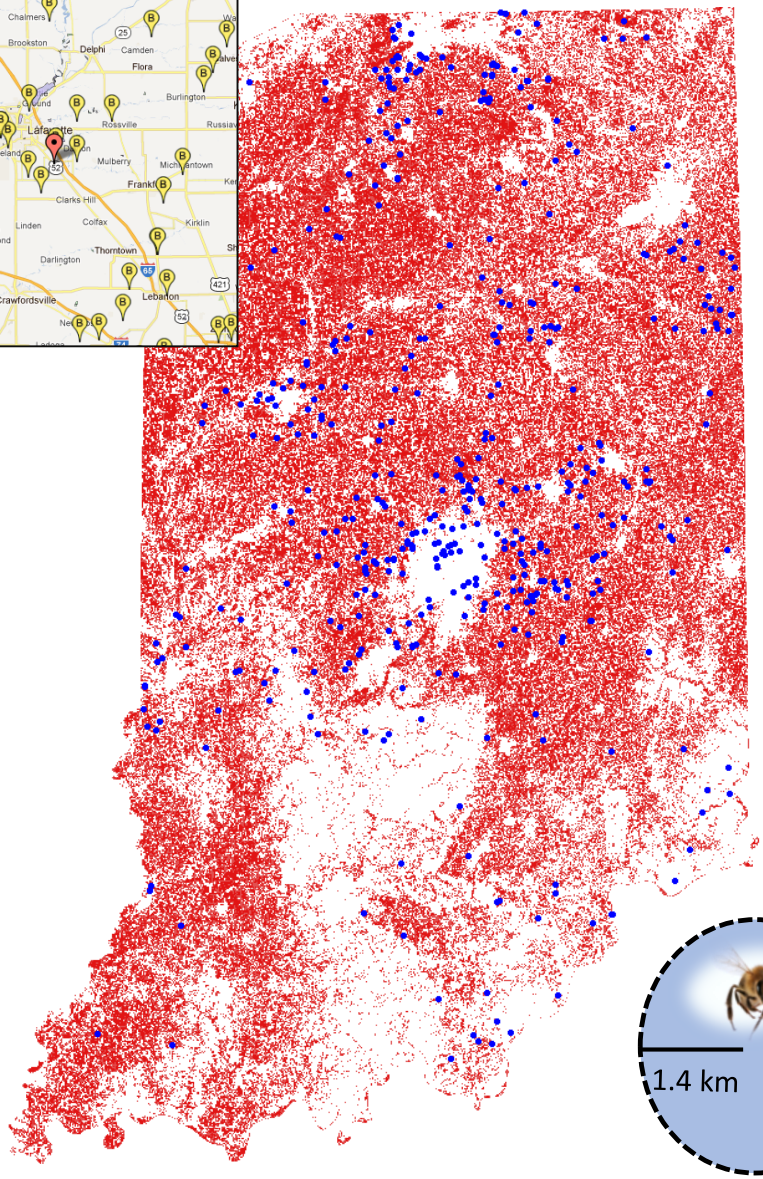


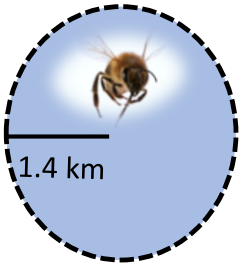
*Krupke et al. 2017. J. Appl. Ecol.
DOI:10.1111/1365-2664.12924

But, foraging bees are *moving* across the landscape… how does this affect estimates?

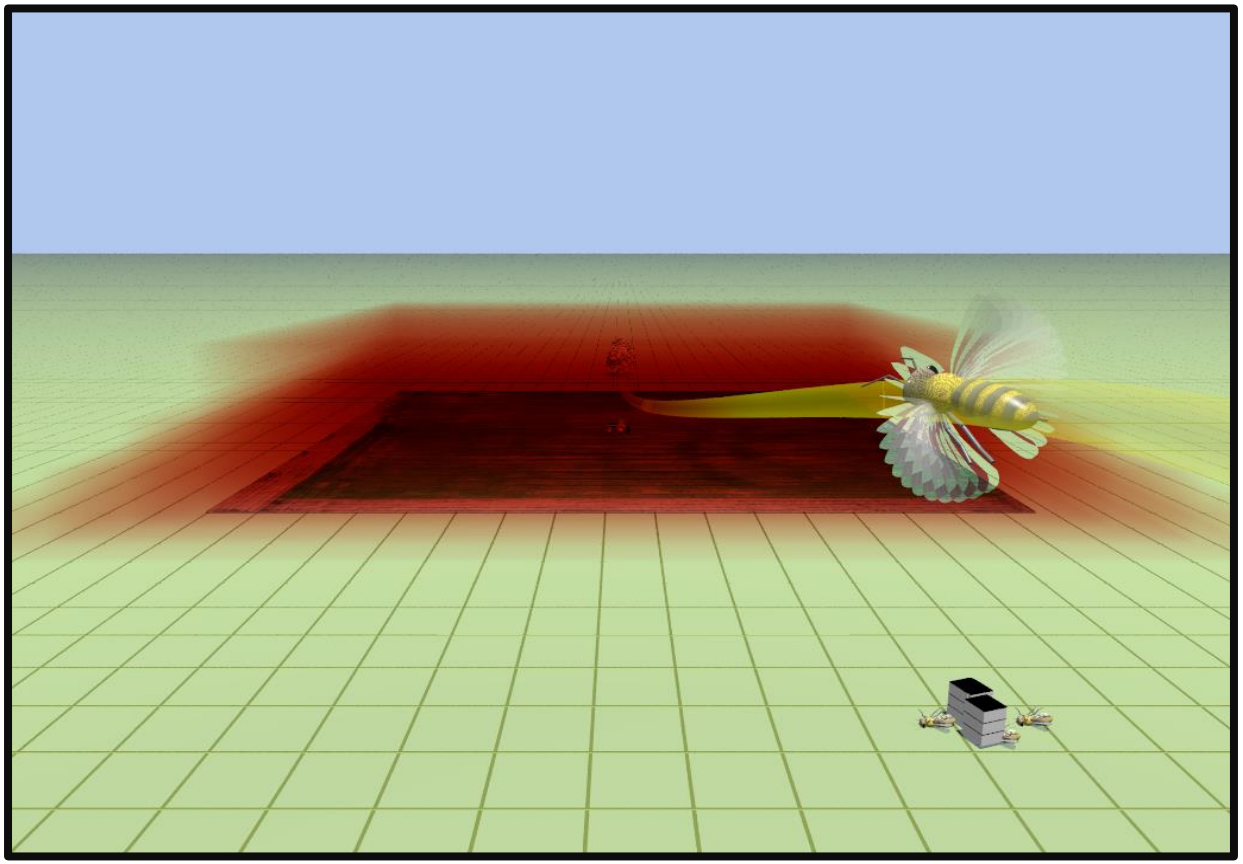
- Assume 1.4 km foraging radius* around each colony
- Assume **no** static charge (i.e. bee surface area 1.05 cm^2 determines deposition)
- Assume no drift beyond 100 m (our farthest sample)







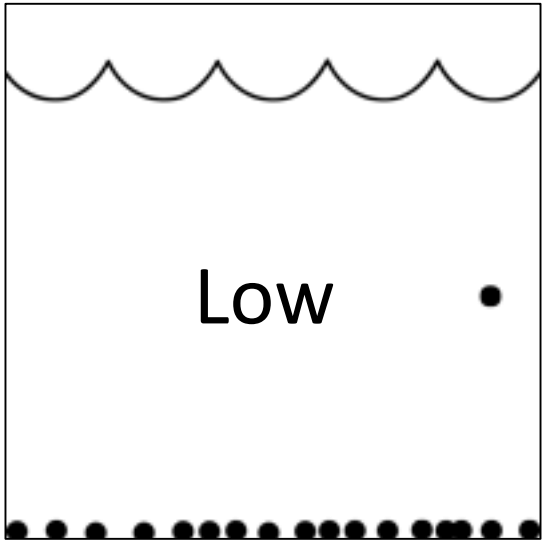
Forager exposure summary



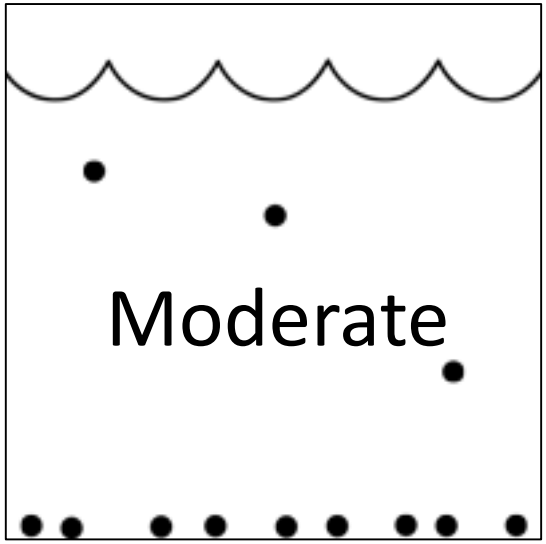
- 94% of Indiana honey bees foraging at planting time will encounter dust during planting, up to 37.4 ng/bee (exceeds contact lethal dose)
- 1.57% of Indiana apiaries are outside deposition zone (assuming no drift beyond 100 m)

Talc/graphite is still primary approach for seed lubrication = No improvement in non-target exposure

Water solubility comparisons



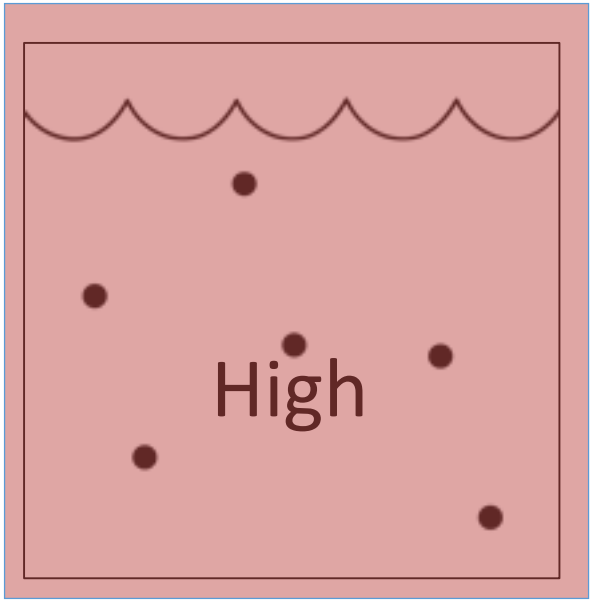
Lambda-cyhalothrin
(Warrior®, pyrethroid insecticide)
0.005 mg/L



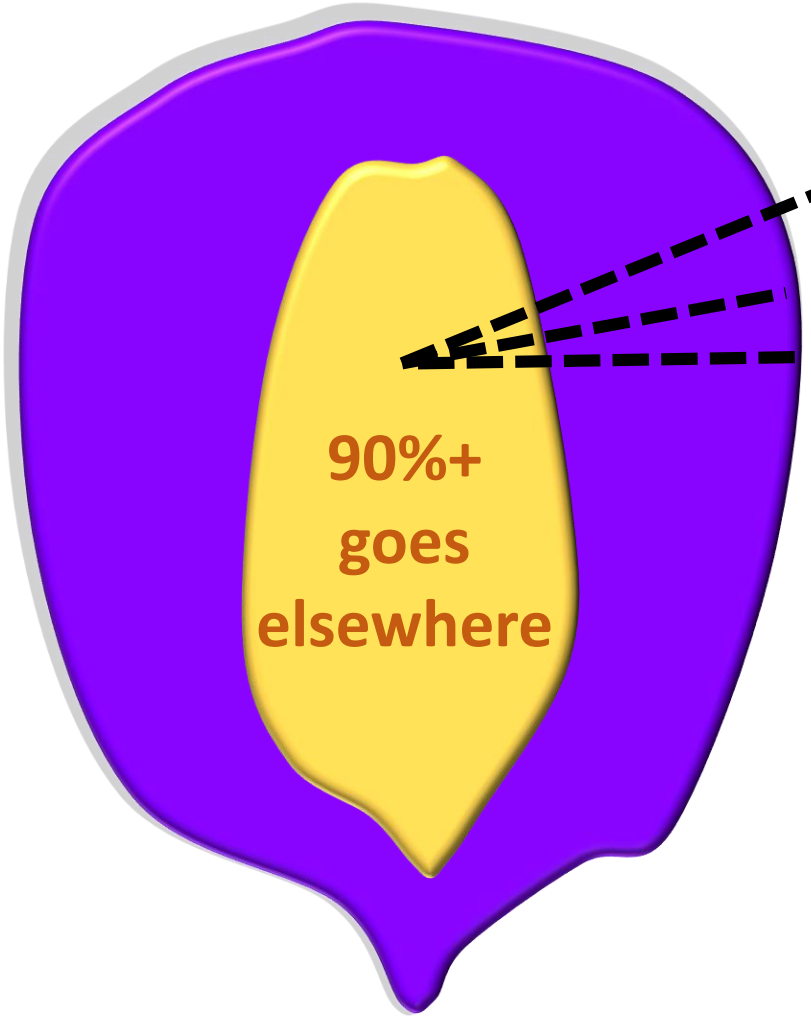
Atrazine
(triazine herbicide)
0.03 mg/L

Clothianidin
(Poncho® ST):
270 mg/L

Thiamethoxam
(Cruiser® ST):
4,100 mg/L



Fate of neonicotinoids applied to corn seeds

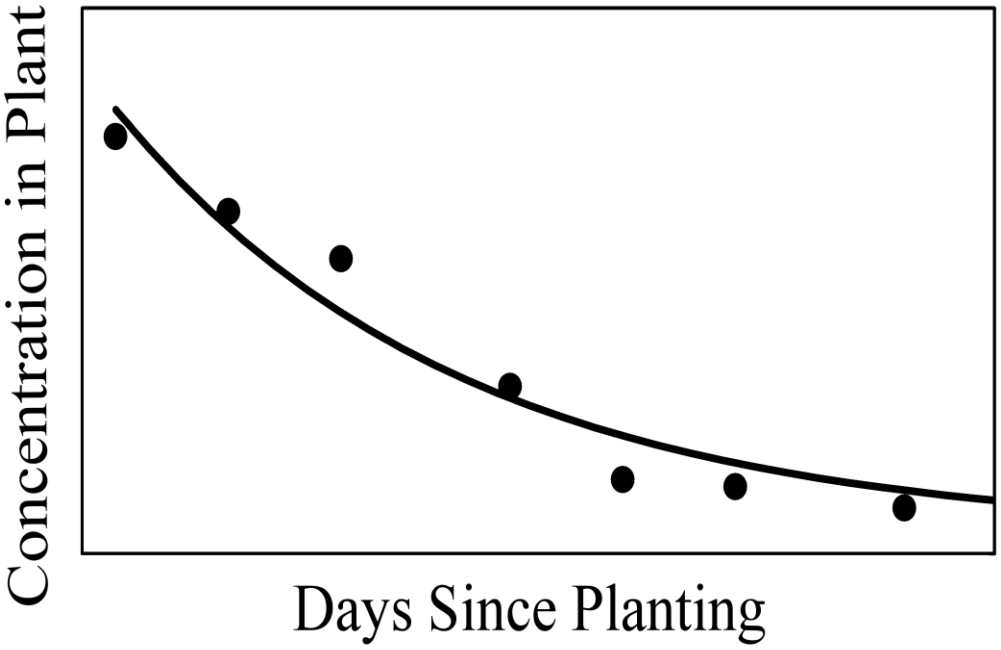


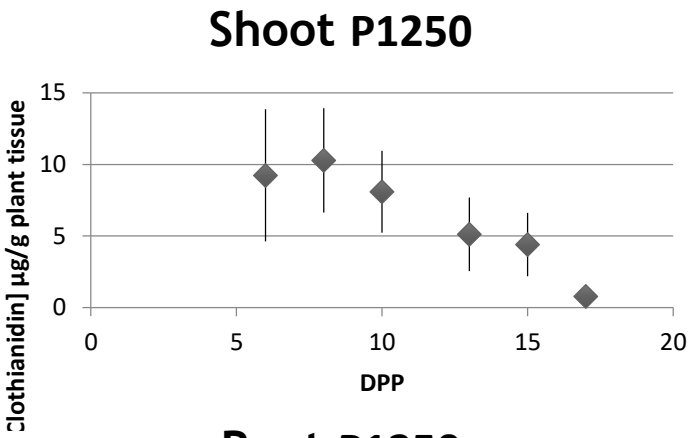
1-2%* taken up by plant

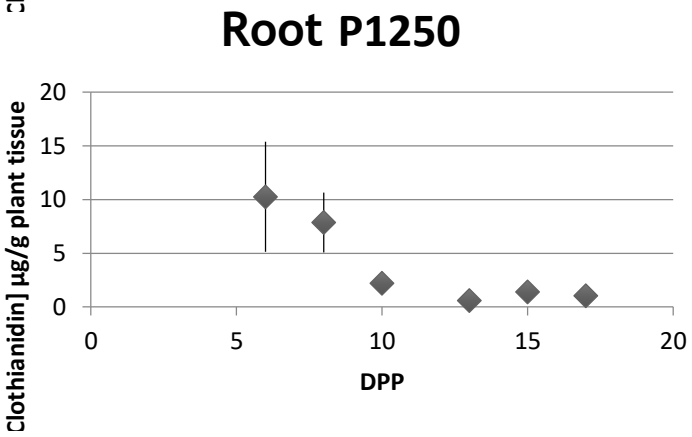
ca. 5%+ lost as dust at planting

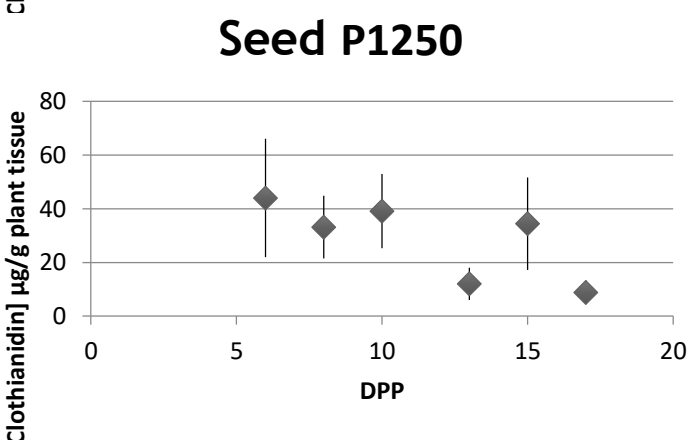
*Alford and Krupke, 2017
PLoS ONE 12(3): e0173836

Neonicotinoid concentrations in plant follow exponential decay curve

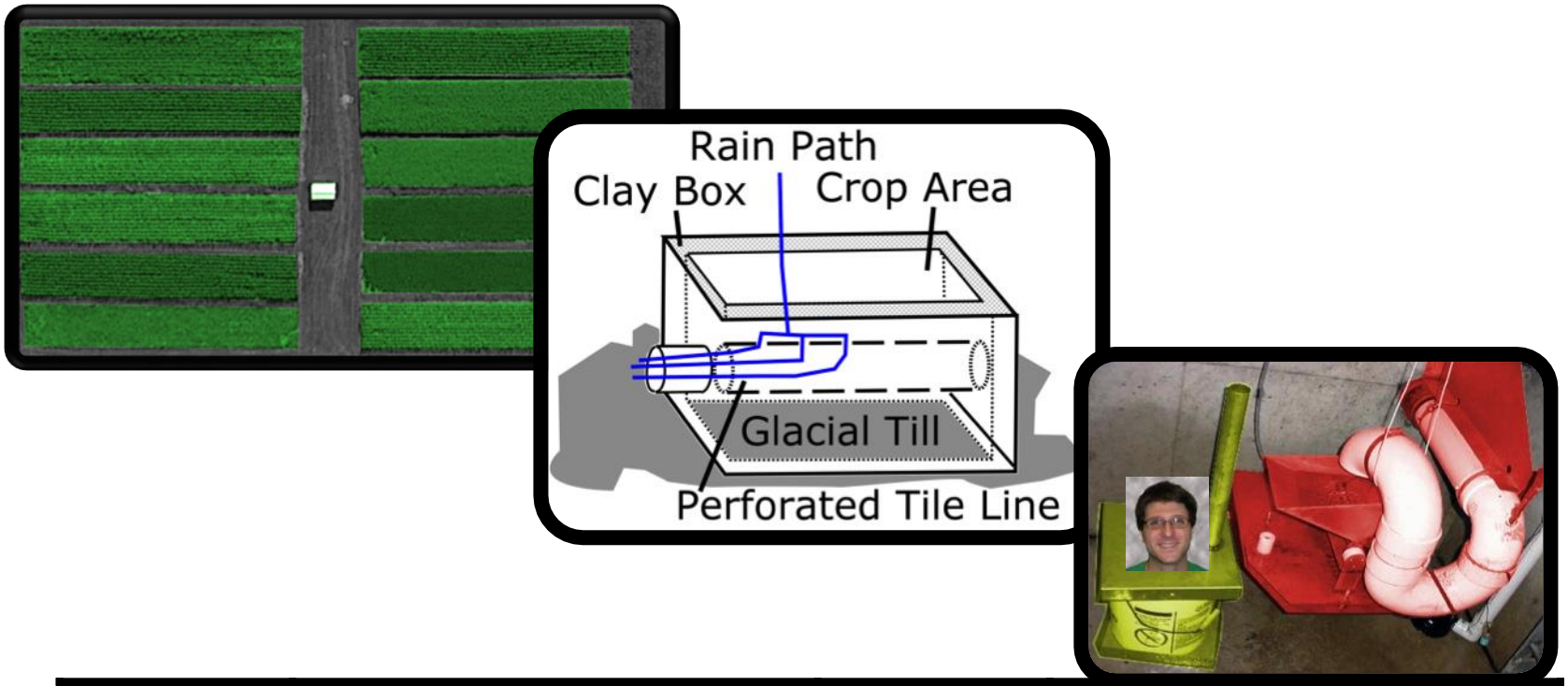




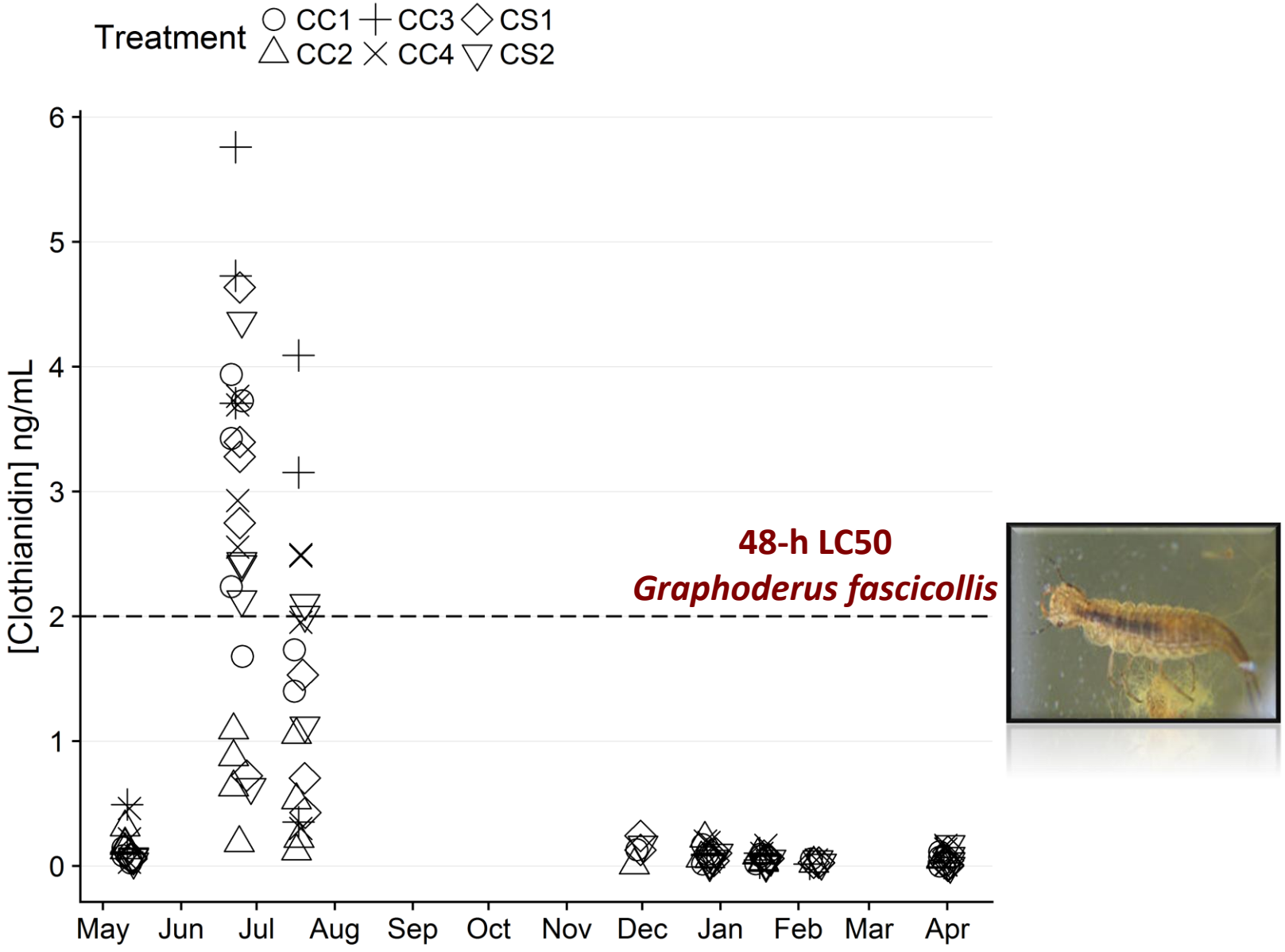




Neonicotinoid fate: Measuring movement in real-time



	Clothianidin±SE (ng/mL)				
Treatment	**6/23/2016**	**7/18/2016**	**Treatment**	**6/23/2017**	**7/18/2017**
CC1	3.2±0.5	1.6±0.2	**CC4**	3.5±0.3	1.8±0.5
CC2	0.7±.2	0.5±0.2	**CS1**	3.5±0.4	0.9±0.3
CC3	4.7±0.6	2.5±1.1	**CS2**	2.8±0.5	1.7±0.3


Treatment
CC1
CC3
CS1
CC2
CC4
CS2
[Clothianidin] ng/mL
0
1
2
3
4
5
6
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
48-h LC50
Graphoderus fascicollis

Summary

- Planter dust remains an issue, likely more so than when first reported
- The vast majority of neonicotinoid applied to corn seeds never enters crop plants
- Neonicotinoid seed treatments are highly mobile via surface and sub-surface water, will move into non-crop pollen and nectar
- Effects on aquatic systems are only beginning to be understood
- No baseline data for vast majority of organisms encountering highest concentrations of field run-off

Solutions:
Begin with reducing environmental loading

- Current use rates far outpace utility/economic benefit, esp. with low commodity prices
- Making untreated corn seed widely available would offer opportunity for correction **and** allow grower choice/comparison

BUT:

- High water solubility, so contaminating ground and surface water is unavoidable…
- Very high toxicity to pollinators = small margins for error in most applications

Neonicotinoid regulations?

- **EU: moratorium on neonicotinoid seed treatments on most crops, first in 2015 and expanded to a ban currently**
- **Ontario, Canada: Require growers to scout fields in year prior to buying seed and confirm pest presence (as of 2016)**
- **Minnesota: Governor issued executive order to limit neonicotinoid use (08/16); no action yet**
- **EPA: Review of conditional registration granted in 2003 continues, decision expected in late 2018?**

The End.