Widespread occurrence of Neonicotinoid insecticides in streams across the U.S.

March 26, 2015
MN Landscape Arboretum

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Neonicotinoids in the News

- Implicated in Colony Collapse Disorder (CCD) in honeybees - worker bees abruptly disappear
- Risk to other pollinators (bumble bees, butterflies)
What are neonicotinoids?

- Neurotoxic insecticides developed to replace OPs and carbamates. Structurally similar to nicotine.

- Active against a broad spectrum of insects
- Potent at low doses
- Provide long term control
- Active systemically (taken up throughout entire plant)

- Strongly bind to insect nAChRs (nearly irreversible).
  - Block nerve receptors in open position
  - Constant neuromuscular stimulation leads to death

- Highly water soluble with long aqueous and soil half-lives.
Many products \(\rightarrow\) Few ingredients

Most widely used class of insecticides worldwide.

**Home use**
- pets: topical
- lawn and garden: foliar spray, granular, tree injection

**Agricultural use**
- row crops: foliar spray, seed treatment
- pasture: granular
Rapid increase in the agricultural use of Neonics

- Use of treated seeds has tripled in last decade.
  - nearly all corn and 1/3 of soybeans
- Almost all clothianidin use is as seed treatments.
Environmental Fate

Imidacloprid

Lethal to insects
including essential pollinators

Spread through environment
Dust from planting
Build-up in soil
Run-off into water sources

Treatment
Foliar spray
Seed treatment
Soil injection

Nationwide sampling (2012-2014)
Results of nationwide study

Neonic Detection
1 or more: 53%
2 or more: 26%
3 or more: 11%
5 or more: 3%

Sand Run Gulch near Parma, ID

Neonic Land Use S. rho
Clothianidin row crops +0.47 (0.003)
Thiamethoxam row crops +0.47 (0.003)
Imidacloprid urban +0.47 (0.003)

Hladik and Kolpin, in prep
Midwest in heart of heavy neonic use
2013 Midwest Neonics Study

Hladik et al., 2014
Most Commonly Detected Neonics

Neonics detected at all 9 sites (and in multiple samples).

Multiple neonics detected in 43 of 79 samples (28 of 29 during May-June).

Levels can exceed chronic toxicity for imidacloprid.
Temporal Results - 2013
- Classic “spring flush” phenomena as herbicides (atrazine)
- Likely association with seed treatments
Streams during elevated flow conditions: IA, 2014

USGS 05412500 Turkey River at Garber, IA

- Median daily statistic (36 years)
- Period of approved data
- Discharge
- Measured discharge

Explanation:
- Regional Study Site
- 0 - 60 Kilometers
- 0 - 60 Miles
### Comparison of 2013 to 2014

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<th>Site</th>
<th>Date</th>
<th>Flow (cfs)</th>
<th>Cloth (ng/L)</th>
<th>Thia (ng/L)</th>
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Streams in an important ecosystem: Chesapeake Bay (2014)

- clothianidin: 59%
- thiamethoxam: 29%
- imidacloprid: 6%

Chronic toxicity levels exceeded in 2 samples (12%)

Transport driven by use and precipitation

21% Ag: 11 ng/L Cloth+Thia
32% Ag: 64 ng/L Cloth+Thia
41% Ag: 93 ng/L Cloth+Thia
Temporal patterns in urban streams: GA

67 samples collected on a fixed schedule
- imidacloprid: 87%
- dinotefuran: 10%
- acetamiprid: 7%

No relation to stream flow
Instream transport: Fourmile Creek (Ankeny, IA)

- Conservative instream transport of neonics along 4.8 km reach.

- Imidacloprid levels in effluent higher compared to clothianidin.
Planting of treated seeds promotes neonic transport

De Perre et al., 2015
Southern Illinois University

Hladik et al., 2014
U.S. Geological Survey
Seed Treatment Paradox

Logic

Touted as a better management practice over broadcast application

- dual action control
  - provides a barrier around seed
  - systemic agent absorbed by new roots

- proactive (preventing infestation will increase yields)

- targeted application (less chemical use compared to broadcasting)
Seed Treatment Paradox

Does seed treatment translate to decreased insecticide use (clothianidin vs chlorpyrifos)?

Individual field scale? Yes
- for 100 acre field, clothianidin use would be 7% that of chlorpyrifos

Statewide scale with ubiquitous seed treatment? No
- 2013 clothianidin use is 99% that of the 2001 chlorpyrifos use
- Similar use but on substantially more crop acres

Millions of acres of prophylactic neonic use in Iowa
Seed Treatment Paradox

Reality

1. At statewide level, does not translate to less use.

2. EPA study found no increase in soybean yields through use of treated seeds.

3. Can unintentionally reduce crop yields
   - slugs unaffected by neonic exposure via treated seeds
   - slugs transmitted toxins to predaceous beetles
   - decreased predaceous beetle population
   - increased slug population
   - reduced soybean yields (Douglas et al., 2015)

4. Contributes to widespread neonics in streams
   - unknown environmental impact
Summary

- Neonics frequently detected in streams across U.S.
  - Can exceed chronic and even acute levels

- Contributions from both urban and Ag use

- Transport in Ag settings driven by use and precip.
  - Current use patterns creating a “spring flush” of neonics in Midwestern streams

- Seed treatments are increasing overall neonic use across the U.S. translating to increased neonic detections in U.S. streams.

- More research needed to understand potential environmental effects from exposures via neonic levels in streams.
Questions?

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