Environmental Fate of Pesticides

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Pesticides and Professionalism

- Public perception of pesticides is still generally negative
- As a professional applicator, it is important to know the risks (toxicity, water contamination, wildlife) when questioned by:
  - Clients, supervisors, general public, media

Pesticide Toxicity

- The greatest danger is to the mixer/applicator!
  - Works with concentrated product
  - Most exposure
  - Accidents happen

Determine Pesticide Toxicity

LD_{50}:

- LD_{50}: Lethal dose to kill 50% of test animals
  - Expressed as mg pesticide/kg body weight (ppm)
  - If LD_{50} = 250, then 250 mg/kg body weight causes death of 50% of test animals (1 oz for 250 lb person)
  - *The lower the number, the greater the toxicity

Read the Label Before Purchasing!

- Signal Words
  - Danger (<50)
  - Warning (50-500)
  - Caution (>500)
- All registered pesticides carry the Signal Word

LD_{50} Values of Turf Herbicides

<table>
<thead>
<tr>
<th>LD_{50}</th>
<th>Signal Word</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>Danger</td>
<td>None</td>
</tr>
<tr>
<td>51-500</td>
<td>Warning</td>
<td>Nicotine</td>
</tr>
<tr>
<td>501-5000</td>
<td>Caution</td>
<td>Copper sulfate</td>
</tr>
<tr>
<td>&gt;5000</td>
<td>Caution</td>
<td>2,4-D, Aspirin, Glyphosate, Siduron</td>
</tr>
<tr>
<td>&gt;7500</td>
<td>Caution</td>
<td>Dicamba, Glyphosate, Siduron</td>
</tr>
</tbody>
</table>
Potential Negative Environmental Effects

1. Improper disposal
2. Volatilization
3. Leaching into groundwater
4. Runoff into surface waters
5. Wildlife

Pesticide Disposal

- Biggest threat to water supplies
- Disposal of:
  - Product
    - Give away
    - Contact local solid waste or environment agcy.
    - 1-800-CLEANUP
  - Product mixture
    - Only mix as much as needed
    - Spray remainder according to label
  - Empty containers
    - Triple rinse, puncture, throw away / recycle

What Happens to Pesticides?

Pesticide Applied

- Photodecomposition
- Drift
- Volatilization
- Runoff
- Plant Uptake & Degradation
- Thatch Adsorption
- Soil Chemistry Reactions and Decomposition
- Leaching

Pesticide Drift

- Physical vs. vapor drift
  - Physical drift controlled by:
    - Shielded boom, nozzle selection, boom height
    - droplet size, nozzle pressure
  - Vapor drift: vapor pressure
    - Salts and acids vs. esters and phenols
    - Increased by:
      - High temperature
      - High winds
      - Low humidity

Pesticide Leaching

Pesticide Solubility

- Solubility >30 ppm prone to leaching

<table>
<thead>
<tr>
<th>Classification</th>
<th>Common name</th>
<th>Trade name</th>
<th>Water solubility (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide</td>
<td>Permethrin</td>
<td>Aero</td>
<td>0.2</td>
</tr>
<tr>
<td>Insecticide</td>
<td>Imidacloprid</td>
<td>Merit</td>
<td>914</td>
</tr>
<tr>
<td>Herbicide</td>
<td>Pendimethalin</td>
<td>Pendulum</td>
<td>1</td>
</tr>
<tr>
<td>Herbicide</td>
<td>MCPP</td>
<td>Mecoprop</td>
<td>660,000</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Thiophanate methyl</td>
<td>Clearys 3336</td>
<td>3.5</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Metalaxyl</td>
<td>Subdue</td>
<td>8,000</td>
</tr>
</tbody>
</table>

Pesticide Soil Adsorption

- $K_{oc} < 300$ are not bound tightly to soil

<table>
<thead>
<tr>
<th>Classification</th>
<th>Common name</th>
<th>Trade name</th>
<th>Soil adsorption ($K_{oc}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide</td>
<td>Permethrin</td>
<td>Astro</td>
<td>86,000</td>
</tr>
<tr>
<td>Insecticide</td>
<td>Imidacloprid</td>
<td>Merit</td>
<td>262</td>
</tr>
<tr>
<td>Herbicide</td>
<td>Pendimethalin</td>
<td>Pendulum</td>
<td>5,000</td>
</tr>
<tr>
<td>Herbicide</td>
<td>MCPP</td>
<td>Mecoprop</td>
<td>20</td>
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<tr>
<td>Fungicide</td>
<td>Thiophanate methyl</td>
<td>Clearys 3336</td>
<td>1,830</td>
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<tr>
<td>Fungicide</td>
<td>Methylthionyl</td>
<td>Subdue</td>
<td>100</td>
</tr>
</tbody>
</table>

Pesticide Persistence

- Half life > 30 d susceptible to leaching

<table>
<thead>
<tr>
<th>Classification</th>
<th>Common name</th>
<th>Trade name</th>
<th>Half life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide</td>
<td>Permethrin</td>
<td>Astro</td>
<td>25</td>
</tr>
<tr>
<td>Insecticide</td>
<td>Imidacloprid</td>
<td>Merit</td>
<td>997</td>
</tr>
<tr>
<td>Herbicide</td>
<td>Pendimethalin</td>
<td>Pendulum</td>
<td>200</td>
</tr>
<tr>
<td>Herbicide</td>
<td>MCPP</td>
<td>Mecoprop</td>
<td>21</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Thiophanate methyl</td>
<td>Clearys 3336</td>
<td>10</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Methylthionyl</td>
<td>Subdue</td>
<td>100</td>
</tr>
</tbody>
</table>

Leaching Potential

- Combination of solubility, adsorption, and persistence

<table>
<thead>
<tr>
<th>Classification</th>
<th>Common name</th>
<th>Trade name</th>
<th>Leaching Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide</td>
<td>Permethrin</td>
<td>Astro</td>
<td>Nonleacher</td>
</tr>
<tr>
<td>Insecticide</td>
<td>Imidacloprid</td>
<td>Merit</td>
<td>Leacher</td>
</tr>
<tr>
<td>Herbicide</td>
<td>Pendimethalin</td>
<td>Pendulum</td>
<td>Nonleacher</td>
</tr>
<tr>
<td>Herbicide</td>
<td>MCPP</td>
<td>Mecoprop</td>
<td>Leacher</td>
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<td>Fungicide</td>
<td>Thiophanate methyl</td>
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<td>Nonleacher</td>
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<td>Fungicide</td>
<td>Methylthionyl</td>
<td>Subdue</td>
<td>Leacher</td>
</tr>
</tbody>
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Potential Leaching Potential (PLP) Index

http://www.turf.files.ncsu.edu/articles/tf0051.aspx

Pesticide Runoff

- Pesticides w/ similar characteristics as those prone to leaching
  - Avoid wettable powders in sensitive areas
- Site characteristics
  - Impermeable surfaces (fine textures, compaction)
  - Severe slopes
  - Minimal vegetation
- Heavy rain following app.

USGA Pesticide Fate Studies

- 10 research projects at 11 universities
  - Pesticide leaching
  - Pesticide runoff
  - Nutrient leaching
  - Nutrient runoff

USGA Research Results Overview

- Turf more effective filter than cropland
  - Thatch effectively adsorbs pesticides
- Fertilizer & pesticides show little potential to contaminate surface and groundwater
  WHEN USED PROPERLY (label)
- Ongoing research w/ various soil types and climates & newer products
Pesticide Effects on Wildlife

- Potential danger determined by laboratory LC₅₀ (fish) or LD₅₀ (birds) values
- In sensitive areas select products with low wildlife toxicity
- Utilize pesticides with low runoff potential
- Utilize buffer strips

Unmown, buffer strips provide excellent protection of surface water from pesticides and nutrients

Need Pesticide Data?
Conclusions

• Many pesticides have the potential to harm the environment if not used correctly

• Risk is minimized by following the label and selecting products that are not prone to leaching nor hazardous to wildlife when in sensitive areas