INSTITUTE FOR
Ag Professionals

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MCPR Trade Show

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Atrazine and Acetochlor

BMPs

Ron Struss

MDA

Roger Becker

University of Minnesota
Pesticide Movement and Water Quality
Summary of processes for determining site-specific potential for surface runoff and leaching of pesticides

- Solubility in Water
- Adsorption to Soil
- Half-life in Soil
- Erodibility
- Slope
- Flooding/Ponding
- OM/CEC Layer Depths
- Depth to Water Table
- Hydro. Group

Pesticide Rating

Soil Rating

Pesticide/Soil Matrix

Potential 1, 2, or 3 for Surface Runoff or Leaching

Change of Practices if Needed at Field Site
# Potential Pesticide Loss to Leaching Matrix

<table>
<thead>
<tr>
<th>Soil Leaching Rating</th>
<th>Pesticide Leaching Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>High</td>
<td>Potential 1</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Potential 1</td>
</tr>
<tr>
<td>Nominal</td>
<td>Potential 2</td>
</tr>
</tbody>
</table>

- **High Probability of Water Pollution**: Red
- **Possibility of Water Pollution**: Yellow
- **Low Probability of Water Pollution**: Green

*1989 Bulletin*

*University of Minnesota Extension*
Soil Factor Terminology

- Hydrologic group
- Depth to high water table
- Surface layer depth
- Depth to >6”/hr permeability layer
- Slope
- OM / CEC
- Depth to bedrock
Pesticide Factor Terminology

- Solubility in water
- Soil Adsorption $K_{oc}$
- Half-life in soil
Pesticide Factor Terminology

**Solubility in water**

Higher values allows:

- More leaching through soil and movement off crop residue
- Less movement off-site attached to soil sediment
- More movement off-site in solution in specific cases
**Pesticide Factor Terminology**

**Soil Adsorption \( K_{oc} \)**

- Tendancy to bind to soil

**Ratio of:**

- Bound to Soil / Remaining in Solution

- Higher Values =

  - Stronger binding to organic matter and clays
Pesticide Factor Terminology

**Soil Adsorption** $K_{oc}$

- Higher values
  - Less leaching
  - Increase off-site movement with soil sediments
**Pesticide Factor Terminology**

*Half-life*

- Time required to degrade to 1/2 the previous amount
- Not the same as biological activity to crops or target pests
What Is Persistence?

Chemical 1/2 Life (Chemical Persistence)
- Time for 1/2 to degrade
- Soil bound, Microbial, Photolysis, Hydrolysis, Plant Uptake

Herbicidal Persistence (Biological Activity)
- Time where activity is 'seen'
  - Biological persistence generally longer value than chemical 1/2 life
  - Chemical persistence often much longer
<table>
<thead>
<tr>
<th>Year</th>
<th>Unit</th>
<th>Value</th>
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<tbody>
<tr>
<td>1950</td>
<td>ppm</td>
<td>1,000,000</td>
</tr>
<tr>
<td>1960</td>
<td>0.5 ppm</td>
<td>2,000,000</td>
</tr>
<tr>
<td>1965</td>
<td>ppb</td>
<td>1,000,000,000,000</td>
</tr>
<tr>
<td>1975</td>
<td>ppt</td>
<td>1,000,000,000,000,000</td>
</tr>
<tr>
<td>1983</td>
<td>ppq</td>
<td>1,000,000,000,000,000,000</td>
</tr>
</tbody>
</table>

*The Non-Zero Concept*
What Are They Anyway?

*Parts per million, billion, trillion*

- 1 acre furrow slice ~ 2 million lbs.

- 1 quart of Treflan (1 lb ai)
  incorporated 6" across:

• 1 acre = 1 ppm

• 1,000 acres = 1 ppb

• 1,000,000 acres = 1 ppt
Herbicide Degradation Curves
Half-life Example

ATRAZINE CONC. – 60 day 1/2 life (ppb)

DAYS AFTER APPLICATION

HERB. RATE (lb ai/A)

ATRAZINE 2.0
Herbicide Degradation Curves
Half-life Example

ATRAZINE CONC. – 60 day 1/2 life (ppb)

DAYS AFTER APPLICATION

ATRAZINE 2.0

HERB. RATE (lb a.i./A)
Herbicide Degradation Curves
Rate Response

HERBICIDE CONC. (ppb)

DAYS AFTER APPLICATION

HERB. RATE (lb ai/acre)

ATRAZINE 3.0
ATRAZINE 2.0
ATRAZINE 1.0

~ 50 days per increment
Herbicide Degradation Curves
Rate vs. Persistence

HERB. RATE (lb ai/A)
- ATRAZINE 2.0
- TORDON 0.5
- PURSUIT 0.063
- GLEAN 0.008
- IMPACT?

HERBICIDE CONC. (ppb)

DAYS AFTER APPLICATION

1989
EPA Pesticide ‘Red Flags’

- Half-life in soil: > 21 days
- Solubility in water: > 30 ppm
- Adsorption to soil: $K_{oc} < 300 - 500$
  $K_d < 5$, usually < 1
- Charge: Negative
- Hydrolysis 1/2 life: > 25 wks
- Photolysis 1/2 life: > 1 wk
- Henry's Law Constant: < 0.1 atm/m$^3$ mol

Consider interactions
USDA NRCS WinPST
(Windows Pesticide Screening Tool)
# Herbicide Properties

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Sol. (ppm)</th>
<th>Adsorb (Koc)</th>
<th>1/2 (Days)</th>
<th>Leach</th>
<th>Runoff</th>
<th>Sol.</th>
<th>Adsorb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetochlor</td>
<td>223*</td>
<td>150</td>
<td>14</td>
<td>Inter</td>
<td>Inter</td>
<td>Low</td>
<td></td>
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<tr>
<td>Alachlor</td>
<td>240</td>
<td>170</td>
<td>15</td>
<td>Inter</td>
<td>Inter</td>
<td>Low</td>
<td></td>
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<tr>
<td>Dimethenamide</td>
<td>1174</td>
<td>160</td>
<td>20</td>
<td>Inter</td>
<td>Inter</td>
<td>Low</td>
<td></td>
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<tr>
<td>Metolachlor</td>
<td>530</td>
<td>200</td>
<td>90</td>
<td>High</td>
<td>High</td>
<td>Inter</td>
<td></td>
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<tr>
<td>Isoxaflutole</td>
<td>3.5</td>
<td>147</td>
<td>3</td>
<td>Low</td>
<td>Inter</td>
<td>Low</td>
<td></td>
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<tr>
<td>Nicosulfuron</td>
<td>22000</td>
<td>30</td>
<td>21</td>
<td>High</td>
<td>Inter</td>
<td>Low</td>
<td></td>
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<tr>
<td>Pendimethalin</td>
<td>0.3</td>
<td>5000</td>
<td>90</td>
<td>Low</td>
<td>Inter</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Topramezone</td>
<td>15000</td>
<td>100</td>
<td>160</td>
<td>High</td>
<td>High</td>
<td>Inter</td>
<td></td>
</tr>
<tr>
<td>Glyphosate</td>
<td>900000</td>
<td>24000</td>
<td>47</td>
<td>V</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

*Values in red exceed EPA 'Red Flag' guidelines

WinPST Pesticide Properties Database Ver. 11/01/06

1/2 life > 21 days
Sol > 30 ppm
Adsorb $K_{oc} < 300 - 500$
Atrazine Evolution, Sierk MDA

Labeled 1958
EPA special review 1988
RUP 1990
• 12" corn cutoff
• 4 lb ai to 3 max corn
• Noncrop 40 lb ai to 10
1992Atrazine
• Set-backs
• max 2.5 lb ai corn

1996 setbacks tile-terraced fields
w/ standpipes
Acetochlor

- Labeled 1994
- 40 products w/ MN registrations
- 16 solo
- 24 package mixtures
- 2005 25% acreage
- Suspected human carcinogen dropped in 2007
Acetochlor RUP

• Do not apply to the following soils if ground water depth is $\leq 30$ ft.

• Soil texture O.M.
  • Sands < 3%
  • Loamy sands < 2%
  • Sandy loams < 1%

• Limits use in MN
RR Corn introduced 1998
SUs by 2005 were 12%

Minnesota Corn Herbicide Use Data

- Corn PRE
- % Glyphosate
- Acetochlor lb ai/a

RR Corn introduced 1998
SUs by 2005 were 12%
Figure 1: Pounds of acetochlor active ingredient (a.i.) sold in Minnesota (MDA)

Note: Specifics on sales of pesticide products in Minnesota can be obtained from http://www.mda.state.mn.us/chemicals/pesticides/useandsales.htm.
Surface Water Protection

Change products

• Dilution solution

Use less of the same product

• Reduced rates, planned programs
• Banding

Keep those used in place

What's 'good for soil conservation

Is 'good' for pesticide pollution reduction
Surface Water Protection BMPs

Soil Conservation

• Crop residue
• Surface roughness
• Contours
• Buffer strips
• Waterways
Surface Water Protection BMPs

Pesticide Conservation

• Banding
• Reduced rates
• Incorporation
• POST applications
Surface Water Protection BMPs

Pesticide Conservation

• Banding and reduced rates
  – Reduced environmental risk esp. short term following application
  – May not be proportional
    • Little gained for persistent products after critical period
  – Reduces costs, may increase management risk but often can reduce management risk
Herbicide Best Management Practices (BMPs) for Minnesota

Jeffrey L. Gunsolus
Weed Scientist

Crop Pest Management Short Course

November 2002

University of Minnesota
Evaluation of Best Management Practices (BMP) Rates of Atrazine Tank Mixed with Broadleaf Herbicides in Rochester, MN

Lisa M. Behnken, Ryan P. Miller, Fritz R. Breitenbach, and Jeffery L. Gunsolus, Extension Professor, University of Minnesota
DUAL II MAG (PRE)
CALLISTO without and with AATREX (EPOST)

5/31/2007

124 bu/A vs 159 bu/A

6/12/2007
Conclusions

The addition of soil applied BMP rates of atrazine tank mixed with s-metolachlor had no full-season effect on broadleaf weed control or corn grain yield.

Postemergence BMP rates of atrazine had a significant effect on giant ragweed weed control with all paired comparisons.

Common lambsquarters and common waterhemp control were similar for mesotrione and mesotrione plus atrazine treatments.

Common lambsquarters and common waterhemp control were statistically lower with the flumetsulam & clopyralid and dicamba alone treatments when compared to the flumetsulam & clopyralid plus atrazine and dicamba plus atrazine treatments.
Conclusions

Corn grain yields were statistically higher for the mesotrione plus atrazine and flumetsulam & clopyralid plus atrazine treatments when compared to their non-atrazine partners.

The corn yield for dicamba and dicamba plus atrazine comparison was not statistically different.
Future Work

• Repeat trial in 2007
• Looking for economical replacements for atrazine to achieve equivalent weed control and yield
• Crop Safety and off target safety, tank contamination
Additional Resources
Pesticide Wise Screening Tool

Basic Properties and Risks

Pesticide Name: Metolachlor (ANSI)
Other Names: Metolachlor (ANSI)

Solubility (ppm): 530
Adsorption (KOC): 200
Half-life (day): 90.00
Human Tox: VERY LOW
Fish Tox: VERY LOW
Leaching: HIGH
Runoff: INTERMEDIATE

Risk
Pesticides and Water Quality

Pesticides applied in your home and landscape affect our creeks, rivers, and oceans!

- How are pesticides affecting water quality?
- How do pesticides get into our creeks and rivers?
- What are safer alternatives to pesticides?

Illustrations by Celeste Rusconi
Questions?

Discussion?