Reducing crop injury from soil-applied herbicides
- The Dirty Dozen & Other Stuff -

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In the Northern Great Plains there is growing interest in shifting from the traditional wheat- fallow system to a more diversified one.
Indeed, the number of acres growing in “alternative” crops has been growing exponentially.
Rethinking Montana Agriculture

This shift in crops forces us to modify our approach to weed management
Rethinking Weed Management

- Herbicide persistence restricts rotational crops
In Montana the risk of carryover and herbicide injury due to soil applied herbicides is particularly large because:

- Soils with high pH (7.8-8.1) and low organic matter < 1.5%
- Dry conditions
- Cold winters
## Rotation Restrictions of Herbicides Used in “Alternative” Crops

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Wheat</th>
<th>Barley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prowl</td>
<td>4 mos.</td>
<td>4 mos.</td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 mos.</td>
<td>9.5 mos.</td>
</tr>
<tr>
<td>Sencor</td>
<td>8 mos.</td>
<td>8 mos.</td>
</tr>
<tr>
<td>Sonalan (2 pt or 7.5 lb/a)</td>
<td>1 growing season</td>
<td>2 growing seasons</td>
</tr>
<tr>
<td>Sonalan (3 pt or 11 lb/a)</td>
<td>2 growing seasons</td>
<td>2 growing seasons</td>
</tr>
</tbody>
</table>
Restrictions for Herbicides Used in Wheat

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Peas, Lentils, Chickpeas</th>
<th>Canola, Mustard</th>
<th>Sunflower, Safflower</th>
<th>Expected Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ally</td>
<td>34 mos. *</td>
<td>34 mos.*</td>
<td>34 mos.*</td>
<td>3 yrs.</td>
</tr>
<tr>
<td>Amber</td>
<td>34 mos. *</td>
<td>34 mos.*</td>
<td>34 mos.*</td>
<td>3 - 4 yrs.</td>
</tr>
<tr>
<td>Assert</td>
<td>15 mos.</td>
<td>15 mos.</td>
<td>10 mos.</td>
<td></td>
</tr>
<tr>
<td>Canvas at 1 pack/5a</td>
<td>34 mos. *</td>
<td>34 mos.*</td>
<td>22 mos.</td>
<td>3 yrs.</td>
</tr>
<tr>
<td>Canvas at 1 pack/10a</td>
<td>22 mos.</td>
<td>22 mos.</td>
<td>10 mos.</td>
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</tr>
<tr>
<td>Curtail</td>
<td>18 mos.</td>
<td>10.5 mos.</td>
<td>10.5 mos.</td>
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<tr>
<td>Curtail M</td>
<td>18 mos.</td>
<td>12 mos.</td>
<td>12 mos.</td>
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<tr>
<td>Finesse</td>
<td>36 mos. *</td>
<td>36 mos.*</td>
<td>36 mos.*</td>
<td>3-4 yrs.</td>
</tr>
<tr>
<td>Glean</td>
<td>36 mos. *</td>
<td>36 mos.*</td>
<td>36 mos.*</td>
<td>3-4 yrs.</td>
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<tr>
<td>Peak</td>
<td>22 mos.</td>
<td>22 mos.</td>
<td>22 mos.</td>
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</tr>
<tr>
<td>Stinger</td>
<td>18 mos.</td>
<td>10.5 mos.</td>
<td>10.5 mos.</td>
<td></td>
</tr>
<tr>
<td>Tordon</td>
<td>36 + mos.*</td>
<td>36 + mos.*</td>
<td>36 + mos.</td>
<td>3-6 yrs.</td>
</tr>
</tbody>
</table>

* indicates a field bioassay is required before the rotational crop can be seeded
Rethinking Weed Management

✓ Herbicide persistence restricts rotational crops
  - Herbicide carryover reduces profitability
Everest + Ally in 2002

Lentil on winter wheat stubble
Triangle, July 2, 2003

Photo Courtesy P. Miller
Spartan injury
Pea field in North Central MT
July 4, 2004

Photo Courtesy P. Miller
Chickpea Plots
June 19, 2003
Photo Courtesy P. Miller
Pea field in north central MT
July 4, 2004
Photo Courtesy P. Miller
Thus, to successfully grow alternative crops we need to minimize the risk of injury to subsequent crops.

To do so, we must understand what happens with the herbicide after application
Herbicides can have different fates in the environment:

- Plant Uptake and Crop Removal
- Volatilization
- Photodecomposition
- Runoff
- Microbial Degradation
- Adsorption
- Chemical Degradation
- Leaching

Herbicides
Due to the importance of crop injury due to soil applied herbicides, we have assessed the risk carryover on different crops and herbicides

**Goal:**

- Determine the best way to maximize the benefits of soil-applied herbicides while avoiding herbicide carryover and crop injury
12 Crops X 11 Herbicides
Post Experimental Farm, MSU

- **Crops**
  - *Oilseeds* = canola, flax, sunflower, camelina
  - *Pulses* = pea, lentil, chickpea, fenugreek
  - *Cereals* = spring wheat, barley, triticale, canaryseed

- **Herbicides**
  - Control (no herbicide)
  - Tordon (*picloram*, 0.0234 lb ai/a)
  - Assert (*imazamethabenz*, 0.47 lb ai/a and 0.94 lb ai/a)
  - Beyond (*imazamox*, 0.75 oz ai/a)
  - Maverick (*sulfosulfuron*, 0.5 oz ai/a and 1 oz ai/a)
  - Finesse (*chlorosulfuron + metsulfuron*, 0.3 oz ai/a and 0.6 oz ai/a)
  - Spartan (*sulfentrazone*, 2.25 oz ai/a)
The experiment consisted in 3 reps. In each rep we established 12 crops and 10 herbicides.
<table>
<thead>
<tr>
<th>Herbicide</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
</table>

Applied in fall 2004
# 12 Crops X 10 Herbicides

Post Experimental Farm, MSU

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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</tbody>
</table>

Planted in Spring 2005 & 06
# Herbicides

<table>
<thead>
<tr>
<th>Product</th>
<th>Site of Action</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tordon</td>
<td>Growth regulator</td>
<td>Pyridine</td>
</tr>
<tr>
<td>Assert</td>
<td>ALS</td>
<td>Imidazolinone</td>
</tr>
<tr>
<td>Beyond</td>
<td>ALS</td>
<td>Imidazolinone</td>
</tr>
<tr>
<td>Maverick</td>
<td>ALS</td>
<td>SU</td>
</tr>
<tr>
<td>Finesse</td>
<td>ASL</td>
<td>SU</td>
</tr>
<tr>
<td>Spartan</td>
<td>PPO inhibitor</td>
<td>Triazolinone</td>
</tr>
</tbody>
</table>
# Crops & Herbicides

<table>
<thead>
<tr>
<th>Product</th>
<th>Canola</th>
<th>Camelina</th>
<th>Pea</th>
<th>Lentil</th>
<th>S. Wheat</th>
<th>Barley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tordon</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Assert</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Beyond</td>
<td>No*</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No*</td>
<td>No</td>
</tr>
<tr>
<td>Maverick</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Finesse</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Spartan</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

* To be used only in Clearfield varieties
Methods

- Fall 2004: herbicide application
- Spring 2005: plot seeding
- Summer – Fall 2005: visual estimates of crop injury
- Fall 2005: plot harvest
- NO HERBICIDES WERE APPLIED IN FALL 2006
- Spring, Summer & Fall 2006: repeat 2005 procedures
Canola

Yield (lb/ac @ 12% moisture)

2005


* = Different from untreated at p < 0.05

2006

Camelina

2005

Yield (lb/ac @ 12% moisture)

2006

Yield (lb/ac @ 12% moisture)

* = Different from untreated at p < 0.05
Camelina
However, Spartan applied as Pre-emergence in Spring Inhibits Camelina Emergence

Photo: Steve King
Pea

Yield (lb/ac @ 12% moisture)

2005

2006

* = Different from untreated at p < 0.05
Pea

Untreated

Finesse

Maverick

Tordon
Lentils

![Graph of 2005 yield comparison between treated and untreated crops.]

![Graph of 2006 yield comparison between treated and untreated crops.]

* = Different from untreated at p < 0.05
\* = Different from untreated at p < 0.05
S. Wheat

- Untreated
- Spartan
- Assert
- Finesse
Barley

Yield (lb/ac @ 12% moisture)

2005

2006

* = Different from untreated at p < 0.05
Barley

- Untreated
- Assert
- Finesse
- Maverick
What About the Rest of Montana?
What About the Rest of Montana?

- At 7 sites in Montana we selected one field
- Within each field we established 3 reps
- One herbicide (Spartan) at 6 rates
- 3 crops
General view of one of our field sites
Results

• No differences in crop yield in all sites but in Havre

* = Different from control at p < 0.05
Results

- No association of yield reduction and organic matter, bulk density, or N, P, K content
**pH and Herbicide Solubility**

Influence of pH on Sulfentrazone Solubility

- 

<table>
<thead>
<tr>
<th>pH</th>
<th>Solubility (µg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td></td>
</tr>
</tbody>
</table>

Slide courtesy S. Tutt, FMC
Spartan Damage in Sunflower

Avoiding Herbicide Carryover

- Apply herbicides accurately
Avoiding Herbicide Carryover

Broadcast vs. banded
Avoiding Herbicide Carryover

- Incorporate herbicides uniformly
- Plant under ideal conditions
Take Home Message

• Keep good records
• Read the label
• Farm soils, not fields
• Special thanks to Perry Miller, Jeff Holmes, and Ed Davis

• Montana Noxious Weed Trust Fund