Efficacy and safety of new herbicides on the horizon

Joe DiTomaso
UC Davis
Aminopyralid (Milestone®)
Treatments

- Untreated check
- Aminopyralid (Milestone* herbicide)
  - 2, 2.5, 3, 3.5, 4, 5 and 7 fl oz/A
- Clopyralid (Transline* herbicide)
  - 4, 8, and 10 fl oz/A
- Picloram (Tordon* 22K herbicide)
  - 16 and 32 fl oz/A

All treatments with 0.25% v/v Activator 90 or X-77 surfactant
Plots 10 x 20 ft, applied at 20 GPA, replicated 3 or 4 times at each site
10 ft boom with six 8002 nozzles, 30 psi, CO₂ backpack sprayer

* Trademark of Dow AgroSciences LLC
Combined result of aminopyralid on yellow starthistle control in year of treatment
(from studies in Oregon, Washington, Idaho and California)

<table>
<thead>
<tr>
<th></th>
<th>Percent control</th>
</tr>
</thead>
<tbody>
<tr>
<td>oz ae/A</td>
<td></td>
</tr>
<tr>
<td>oz prod/A</td>
<td></td>
</tr>
<tr>
<td>Aminopyralid</td>
<td>0.5 0.63 0.75 0.88 1 1.25 1.75</td>
</tr>
<tr>
<td></td>
<td>1.5 3</td>
</tr>
<tr>
<td>Clopyralid</td>
<td>2 2.5 3 3.5 4 5 7</td>
</tr>
<tr>
<td></td>
<td>4 8</td>
</tr>
<tr>
<td>Picloram</td>
<td>3.4 6.8</td>
</tr>
<tr>
<td></td>
<td>16 32</td>
</tr>
</tbody>
</table>

LSD (0.05) = NS
Control of yellow starthistle with aminopyralid in Yreka, CA
Treated on March 11, 2005, evaluated June 20, 2005

Percent control

oz ae/A  0.75  1.2  1.75  1.5  3.8  4 oz
oz prod/A  3    5    7    4    10
Aminopyralid
Clopyralid
Chlorsulfuron

LSD (0.05) = NS
Effect of treatment timing on yellow starthistle control in Davis, California

Treatments from Nov 2002 to March 2003, final evaluation in July 2003

* LSD (P=0.05)
Artichoke thistle
*(Cynara cardunculus)*
Artichoke thistle control, Solano County

Control (%)
0 20 40 60 80 100

Evaluated
6/9 6/27 8/8

3 oz/A 5 oz/A 7 oz/A Transline 10 oz/A Roundup 4 qt/A
aminopyralid
Artichoke thistle control with aminopyralid
Control of artichoke thistle with aminopyralid and other herbicides

Solano County
Treated 3/31/05
Evaluated 8/8/05
Russian knapweed (*Acroptilon repens*)
Control of Russian knapweed at two sites in Lassen County

**Treated 10/17/03**
- Untreated
- 1 oz/A
- 2 oz/A
- 3 oz/A
- 4 oz/A
- 5 oz/A
- Tordon
- Transline

Control (%)
0 20 40 60 80 100

- Rated 6/04
- Rated 6/05

**Treated 6/10/04**
- Untreated
- 1 oz/A
- 2 oz/A
- 3 oz/A
- 4 oz/A
- Tordon
- Transline

Control (%)
0 20 40 60 80 100

- Rated 7/05

**Notes:**
- Tordon 32 oz/A
- Transline 16 oz/A
- + 2,4-D
October treatment
One year after treatment
Scotch thistle (*Onopordum acanthium*)
Treatment timing
Scotch thistle control, Modoc County.
Treatments applied 5/26/05; evaluated 7/27/05.
Aminopyralid toxicology

Toxicology

- Acute LD$_{50}$ >5,000 mg/kg
- Dermal LD$_{50}$ >5,000 mg/kg
- Reduced risk classification
  - Practically non-toxic to birds, mammals, fish, honeybees, earthworms, aquatic invertebrates
  - No carcinogenic, teratogenic or mutagenic effects. No birth defects, neurological or endocrine problems or adverse reproductive effects
Aminopyralid environmental fate

- **Soil**
  - Microbial degradation
  - $T_{1/2} = 35$ days
  - Limited movement in soil
  - No degradation products accumulate

- **Water**
  - $T_{1/2} = 0.6$ days
  - Low groundwater contamination potential

- **Air**
  - Low vapor pressure, low risk of volatilization
Imazapic (Plateau®)
Downy brome (cheatgrass) 
(*Bromus tectorum*)

Red brome 
(*Bromus madritensis* ssp. *rubens*)

Ripgut brome 
(*Bromus diandrus*)

Medusahead 
(*Taeniatherum caput-medusae*)

Barb goatgrass 
(*Aegilops triuncialis*)
Acres of western states infested with major invasive species

<table>
<thead>
<tr>
<th>Species</th>
<th>Acres infested (x million)</th>
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<tbody>
<tr>
<td>Downy brome</td>
<td>56.0</td>
</tr>
<tr>
<td>Yellow starthistle</td>
<td>14.8</td>
</tr>
<tr>
<td>Canada thistle</td>
<td>7.1</td>
</tr>
<tr>
<td>Sericea lespedeza</td>
<td>5.5</td>
</tr>
<tr>
<td>Spotted knapweed</td>
<td>5.2</td>
</tr>
<tr>
<td>Musk thistle</td>
<td>4.7</td>
</tr>
<tr>
<td>Leafy spurge</td>
<td>3.7</td>
</tr>
<tr>
<td>Saltcedar</td>
<td>3.7</td>
</tr>
<tr>
<td>Medusahead</td>
<td>2.4</td>
</tr>
<tr>
<td>Perennial pepperweed</td>
<td>2.0</td>
</tr>
<tr>
<td>Diffuse knapweed</td>
<td>1.8</td>
</tr>
<tr>
<td>Russian knapweed</td>
<td>1.2</td>
</tr>
</tbody>
</table>
Perennial grass tolerance and annual grass control with imazapic applied preemergence

<table>
<thead>
<tr>
<th>Rate (oz/A)</th>
<th>% Control</th>
<th>% Stand vigor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medusahead Bulbous bluegrass Downy brome</td>
<td>Intermediate wheatgrass Pubescent wheatgrass Squirreltail</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>94</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>94</td>
<td>78</td>
</tr>
<tr>
<td>4</td>
<td>99</td>
<td>94</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>88</td>
</tr>
<tr>
<td>8</td>
<td>100</td>
<td>94</td>
</tr>
</tbody>
</table>
## Effect of imazapic on native plants and exotic annual grasses at 4 oz/A (1 oz ae/A) preemergence

<table>
<thead>
<tr>
<th>Native tolerance</th>
<th>Exotic annual grass susceptibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Bromus carinatus (G)</td>
<td>* Ripgut brome (<em>Bromus diandrus</em>) (G)</td>
</tr>
<tr>
<td>* Elymus elymoides (G)</td>
<td>* Soft brome (<em>Bromus hordeaceus</em>) (G)</td>
</tr>
<tr>
<td>* Elymus trachycaulus (F)</td>
<td>* Red brome (<em>Bromus rubens</em>) (G)</td>
</tr>
<tr>
<td>* Festuca idahoensis (G)</td>
<td>* Italian ryegrass (<em>Lolium multiflorum</em>) (G)</td>
</tr>
<tr>
<td>* Hordeum brachyantherum (G)</td>
<td>* Barb goatgrass (<em>Aegilops triuncialis</em>) (F)</td>
</tr>
<tr>
<td>* Hordeum californicum (G)</td>
<td>* Wild oat (<em>Avena fatua</em>) (F)</td>
</tr>
<tr>
<td>* Leymus triticoides (G)</td>
<td>* Hare barley (<em>Hordeum murinum</em>) (F)</td>
</tr>
<tr>
<td>* Eschscholzia californica (G)</td>
<td>* Rattail fescue (<em>Vulpia myuros</em>) (F)</td>
</tr>
<tr>
<td>* Grindelia hirsuta (G)</td>
<td>* Medusahead (<em>Taeniatherum caput-medusae</em>) (F)</td>
</tr>
<tr>
<td>* Annual legumes (G)</td>
<td></td>
</tr>
</tbody>
</table>

* G = Grasses, F = Forbs
Control of medusahead with imazapic

April application    Nov application

% Cover

Plateau rate per acre
Response of tilled and untilled plots to imazapic

**Bare ground (%)**
- Untilled: \( R^2 = 0.92, P < 0.0001 \)
- Tilled: \( R^2 = 0.91, P < 0.0001 \)

**Annual grass cover (%)**
- Untilled: \( R^2 = 0.71, P = 0.0001 \)
- Tilled: \( R^2 = 0.87, P < 0.0001 \)
## Summer medusahead cover after first year treatments

<table>
<thead>
<tr>
<th>County</th>
<th>Fresno Co.</th>
<th>Yolo Co.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated check</td>
<td>50 a</td>
<td>79 a</td>
</tr>
<tr>
<td>Burn only</td>
<td>1 c</td>
<td>11 c</td>
</tr>
<tr>
<td>Treated 1 oz ae/A</td>
<td>3 c</td>
<td>74 a</td>
</tr>
<tr>
<td>Treated 3 oz ae/A</td>
<td>4 c</td>
<td>45 b</td>
</tr>
<tr>
<td>Burned, treated 1 oz ae/A</td>
<td>0 c</td>
<td>2 c</td>
</tr>
<tr>
<td>Burned, treated 3 oz ae/A</td>
<td>0 c</td>
<td>0 c</td>
</tr>
</tbody>
</table>
Imazapyr (Habitat®)

Aquatic registration of imazapyr. Other formulations include Arsenal®, Chopper®, and Stalker®
Herbicide treatment techniques for emerged plants

- Broadcast applications
- Directed treatments
- Rope wick applications
- Cut stump
- Basal bark
- Hack-and-squirt (stem injection)
Control of saltcedar with imazapyr and combinations with glyphosate

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate</th>
<th>Month</th>
<th>% Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Foliar</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>imazapyr (Arsenal)</td>
<td>1 lb ae/A</td>
<td>Sept</td>
<td>90</td>
</tr>
<tr>
<td>imazapyr</td>
<td>1 to 2%</td>
<td>June-Sept</td>
<td>80-99</td>
</tr>
<tr>
<td>imazapyr + glyphosate</td>
<td>0.5 + 0.5%</td>
<td>Aug-Sept</td>
<td>92-99</td>
</tr>
<tr>
<td><strong>Rope Wick to Saplings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>imazapyr</td>
<td>0.13%</td>
<td>early season</td>
<td>92</td>
</tr>
<tr>
<td>imazapyr + glyphosate</td>
<td>0.13 + 0.25%</td>
<td>early season</td>
<td>90</td>
</tr>
<tr>
<td>glyphosate</td>
<td>0.5%</td>
<td>early season</td>
<td>5</td>
</tr>
<tr>
<td><strong>Cut Stump</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>imazapyr</td>
<td>12 oz/gal water</td>
<td>growing season</td>
<td>good</td>
</tr>
</tbody>
</table>
Biology and Control of Tree-of-heaven

(Ailanthus altissima)
Ailanthus cut stump treatment with imazapyr
Imazapyr and imazapic toxicology

Toxicology
- Acute LD$_{50}$ > 5,000 mg/kg
- Dermal LD$_{50}$ > 2,000 mg/kg
- Category IV, Caution label
  - Practically non-toxic to shrimp, birds, fish, earthworms, mammals
  - No carcinogenic, mutagenic or teratogenic effects. No birth defects or adverse reproductive effects
Imazapyr and imazapic environmental fate

- Soil
  - Microbial degradation
  - $T_{1/2} = 25-142$ days imazapyr
  - $T_{1/2} = 120$ days imazapic
  - Limited movement in soil (top 12-20 inches)
  - No degradation products accumulate

- Water
  - $T_{1/2} = 1-2$ days
  - Low groundwater contamination potential

- Air
  - Low vapor pressure, low risk of volatilization