Management Strategies for Herbicide Resistant Horseweed

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Yakima, WA
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Horseweed
(*Conyza canadensis*)

Hairy fleabane
(*Conyza bonariensis*)
As of 10/06; 311 Biotypes (183 species)

The chronological increase in unique cases of herbicide-resistant weeds worldwide

Source: Dr. Ian Heap
www.weedscience.org
ACCase Inhibitors (diclofop - Hoelon)
Als Inhibitors (chlorsulfuron – Telar, Glean)
Dinitroanilines (trifluralin - Treflan)
Triazines (simazine – Princep)
Synthetic Auxins (2,4-D)
Ureas, Amides (diuron - Direx)
Bipyridiliums (paraquat - Gramoxone)
Glycines (glyphosate - Roundup)

Source: Dr. Ian Heap
www.weedscience.org
## Herbicide resistant weeds in WA (9 biotypes)

<table>
<thead>
<tr>
<th>Weed</th>
<th>Situation</th>
<th>Herbicide</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common groundsel</td>
<td>Nurseries</td>
<td>PS II inhibitors (simazine)</td>
<td>1970</td>
</tr>
<tr>
<td>Russian thistle</td>
<td>Wheat</td>
<td>ALS inhibitors (chlorsufuron)</td>
<td>1987</td>
</tr>
<tr>
<td>Yellow starthistle</td>
<td>Roadsides</td>
<td>Synthetic auxins (picloram)</td>
<td>1988</td>
</tr>
<tr>
<td>Kochia</td>
<td>Cereals, Wheat</td>
<td>ALS inhibitors (chlorsufuron)</td>
<td>1989</td>
</tr>
<tr>
<td>Wild oat</td>
<td>Wheat</td>
<td>ACCase inhibitors (diclofop)</td>
<td>1991</td>
</tr>
<tr>
<td>Italian ryegrass</td>
<td>Wheat</td>
<td>ACCase inhibitors (diclofop)</td>
<td>1991</td>
</tr>
<tr>
<td>Powell Amaranth</td>
<td>Mint</td>
<td>PS II inhibitors (terbacil)</td>
<td>1992</td>
</tr>
<tr>
<td>Prickly lettuce</td>
<td>Cereals, Wheat</td>
<td>ALS inhibitors (chlorsufuron)</td>
<td>1993</td>
</tr>
<tr>
<td>Spiny sowthistle</td>
<td>Lentils, Wheat</td>
<td>ALS inhibitors (imazamox, thifensulfuron)</td>
<td>2000</td>
</tr>
</tbody>
</table>
Herbicide resistant weeds in CA
(16 biotypes)

<table>
<thead>
<tr>
<th>Weed</th>
<th>Situation</th>
<th>Herbicide</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common groundsel</td>
<td>Asparagus</td>
<td>PS II (Aatrex)</td>
<td>1981</td>
</tr>
<tr>
<td>Perennial ryegrass</td>
<td>Roadside, Railways</td>
<td>ALS (Oust)</td>
<td>1989</td>
</tr>
<tr>
<td>Smallflower umbrella sedge</td>
<td>Rice</td>
<td>ALS (Londax)</td>
<td>1993</td>
</tr>
<tr>
<td>California arrowhead</td>
<td>Rice</td>
<td>ALS (Londax)</td>
<td>1993</td>
</tr>
<tr>
<td>Russian thistle</td>
<td>Roadside</td>
<td>ALS (Glean, Telar, Oust)</td>
<td>1994</td>
</tr>
<tr>
<td>Wild oat</td>
<td>Barley, Wheat</td>
<td>Pyrazoliums (Avenge)</td>
<td>1996</td>
</tr>
<tr>
<td>Redstem</td>
<td>Rice</td>
<td>ALS (Londax)</td>
<td>1997</td>
</tr>
<tr>
<td>Ricefield bulrush</td>
<td>Rice</td>
<td>ALS (Londax)</td>
<td>1997</td>
</tr>
<tr>
<td>Late watergrass</td>
<td>Rice</td>
<td>ACCase &amp; Lipid syn. (Puma, Bolero Clincher)</td>
<td>1998</td>
</tr>
<tr>
<td>Rigid ryegrass</td>
<td>Almond</td>
<td>Glycine (Roundup)</td>
<td>1998</td>
</tr>
<tr>
<td>Long-leaved loosestrife</td>
<td>Rice</td>
<td>ALS (Londax)</td>
<td>2000</td>
</tr>
<tr>
<td>Barnyardgrass</td>
<td>Rice</td>
<td>ACCase &amp; Lipid syn. (Puma, Bolero, Clincher)</td>
<td>2000</td>
</tr>
<tr>
<td>Early watergrass</td>
<td>Rice</td>
<td>ACCase &amp; Lipid syn. (Puma, Bolero, Clincher)</td>
<td>2000</td>
</tr>
<tr>
<td>Littleseed canarygrass</td>
<td>Onion</td>
<td>ACCase (Prism, Fusilade, Poast, Puma)</td>
<td>2001</td>
</tr>
<tr>
<td>Smooth crabgrass</td>
<td>Rice</td>
<td>Syn. Auxins (Facet, Paramount)</td>
<td>2002</td>
</tr>
<tr>
<td>Horseweed</td>
<td>Ditch bank</td>
<td>Glycine (Roundup)</td>
<td>2005</td>
</tr>
</tbody>
</table>
Glyphosate-resistant horseweed in the USA

- DE (2000)
- KY (2001)
- TN (2001)
- IN (2002)
- MD (2002)
- NJ (2002)
- OH (2002)
- AK (2003)
- MS (2003)
- NC (2003)
- CA (2005)

International Survey of Herbicide Resistant Weeds
Source: www.weedscience.org
How did herbicide resistant horseweed evolve in CA?

What are we learning in CA?

How are we managing it and how might you benefit in WA from our experience?
How did herbicide resistant horseweed evolve in CA?
2005 - Glyphosate-resistant horseweed.

It was first confirmed along an irrigation district canal system that was treated repeatedly with glyphosate over several years.
Glyphosate resistant timing study
(UC KAC – 2005)
"R" Biotype Response to Glyphosate

"S" Biotype Response to Glyphosate
Is this a sign of glyphosate resistance?
What were some of the factors that likely contributed to the problem?
Poor raisin prices, urban encroachment, and reduced inputs led to very weedy fields and lots of seed.
Lack of funds to support roadside, canal, and other spraying increased spread of seed.
**Increased regulation**

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine</td>
<td>Aatrex</td>
</tr>
<tr>
<td>Simazine</td>
<td>Princep</td>
</tr>
<tr>
<td>Bromacil</td>
<td>Hyvar-X</td>
</tr>
<tr>
<td>Diuron</td>
<td>Karmex, Direx</td>
</tr>
<tr>
<td>Prometon</td>
<td>Pramitol</td>
</tr>
<tr>
<td>Bentazon</td>
<td>Basagran</td>
</tr>
<tr>
<td>Norflurazon</td>
<td>Solicam</td>
</tr>
</tbody>
</table>

This map is for reference only. To confirm whether or not the property you are treating is located within a ground water protection area, please check with the Fresno County Agricultural Commissioner’s office.
Herbicide use in trees and vines in California in 1993 and 2003

A change in herbicide use patterns.

California Department of Pesticide Regulation, 2003
Summary of contributing factors:

1. Heavy reliance on a single herbicide approach.
2. Multiple applications made to the same plants.
3. Increased regulation on important preemergents.
4. Reduced expenditures on right-of-ways.
5. Lots of available seed.
What are we learning in CA?
Horseweed stage of growth and herbicide dose are important.

"S" Biotype Response to Glyphosate

% Survival

5-8 leaf 11-15 leaf 18-21 leaf 4" bolted 12" bolted

Unt 1 lb ai/A 2 lb ai/A 4 lb ai/A
Horseweed emergence and growth may be more complicated than we thought.

- Spring emerging horseweed
- Fall emerging horseweed
- Spring emerging hairy fleabane
- Fall emerging hairy fleabane

- Spring emergence
- Bolting
- Flowering
- Seed dispersal
- Winter survival
- Fall emergence
- Seed dispersal
The biology characteristics of horseweed make it a good candidate for resistance.

1. Annual that produces 200,000+ seeds/plant.
2. Seed may not require dormancy.
3. Seeds germinate close to or on the soil surface.
4. Adapts to varying conditions (genetic variability).

Other characteristics:

1. Wind disseminated ¼ mile or more.
2. Seed survival may be <3 years.
3. Does it cross with hairy fleabane?
Herbicide characteristics conducive to herbicide resistance development:

- Single site of action (MOA).
- Broad-spectrum weed control.
- Long soil-residual activity.
Cultural practices conducive to herbicide resistance development:

- Complete reliance on herbicides.
- Mono cropping.
- Limited or no cultivation.
- Weeds escaping treatments are not removed.
- Repeated use of herbicides with the same MOA.
How are we managing it in CA and how might you benefit in WA from our experience?
We brought in people to share thoughts of how to manage it in the valley.
1. Postemergence herbicide mgt.

Treatment timing is absolutely critical for success.

"S" Biotype Responce to Glyphosate

% Survival

5-8 leaf 11-15 leaf 18-21 leaf 4" bolted 12" bolted

Unt 1 lb ai/A 2 Lb ai/A 4 lb ai/A

<18-21 leaves
Use rates and product combinations that work for the given situation, and alternate treatments if resistance is suspected.

<table>
<thead>
<tr>
<th>Postemergents</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D + glyphosate (1.5 + 2)</td>
<td></td>
</tr>
<tr>
<td>2,4-D (1.5)</td>
<td></td>
</tr>
<tr>
<td>Banvel (0.5)</td>
<td></td>
</tr>
<tr>
<td>Rely (1-1.5)</td>
<td></td>
</tr>
<tr>
<td>Gramoxone Inteon (0.75)</td>
<td></td>
</tr>
<tr>
<td>Roundup, Glyphomax, etc (2)</td>
<td></td>
</tr>
<tr>
<td>Shark (0.031)</td>
<td></td>
</tr>
</tbody>
</table>
How much glyphosate do I use?

<table>
<thead>
<tr>
<th>Product</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touchdown Hitech</td>
<td>42 floz</td>
</tr>
<tr>
<td>Roundup Weathermax</td>
<td>47 floz</td>
</tr>
<tr>
<td>Touchdown Total</td>
<td>50 floz</td>
</tr>
<tr>
<td>Roundup Original</td>
<td>64 floz</td>
</tr>
<tr>
<td>Roundup PRO</td>
<td>64 floz</td>
</tr>
<tr>
<td>Glyphomax</td>
<td>64 floz</td>
</tr>
<tr>
<td>Touchdown</td>
<td>70 floz</td>
</tr>
</tbody>
</table>

*Amount of glyphosate needed for 2 lb ai/Acre*
Use nozzles that give thorough coverage.

TJ

OC

Adjust spray height in the field to overlap approximately 30% of each edge of pattern.

<table>
<thead>
<tr>
<th>Spray Angle</th>
<th>Spray Height 20° Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>65°</td>
<td>22 - 24&quot;</td>
</tr>
<tr>
<td>80°</td>
<td>17 - 19&quot;</td>
</tr>
<tr>
<td>110°</td>
<td>15 - 18&quot;</td>
</tr>
</tbody>
</table>
XP BoomJet® Boomless Flat Spray Nozzle

Boomless Flat Spray Nozzle - NEW

Features

- Unique orifice geometry produces wide spray pattern while maintaining superior distribution across entire width.
- Pre-orifice design minimizes drift.
- Extra wide spray pattern—up to 18.5 feet (5.5 meters)—using a single nozzle.
- Removable polymer pre-orifice.
- Acetal or stainless steel construction for excellent chemical resistance.
- Recommended spray pressure range: 20–60 PSI (1.5–4 bar).
- NPT or BSPT (male) threads for easy installation.
- Color-coding for easy capacity identification.

Other Details

- **Typical Applications:**
  - Boomless field spray applications.
  - Roadside and right-of-way applications.
  - End row spraying.
  - Orchard spraying.
  - De-icing applications.
  - Forestry.

TeeJet® Agricultural Spray Products
2. Preemergent herbicide mgt.

Treat for fall and winter emergence.

- Spring emerging horseweed
- Fall emerging horseweed
- Spring emerging hairy fleabane
- Fall emerging hairy fleabane

- Flowering
- Seed dispersal
- Bolting
- Fall emergence
- Winter survival
Incorporate preemergents into the program at least every 2\textsuperscript{nd} or 3\textsuperscript{rd} year. If possible, obtain a permit if in a GWPA. We’re also recommending tank-mixes where appropriate.
Preemergent herbicides for horseweed management:

<table>
<thead>
<tr>
<th>T&amp;V</th>
<th>Rate/A</th>
<th>ROW/NC</th>
<th>Rate/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chateau</td>
<td>12 oz*</td>
<td>Karmex/Direx</td>
<td>2.5 lb</td>
</tr>
<tr>
<td>Gallery T&amp;V</td>
<td>10 oz</td>
<td>Princep</td>
<td>2.5 lb</td>
</tr>
<tr>
<td>Goal</td>
<td>6 pt</td>
<td>Oust XP</td>
<td>2 oz</td>
</tr>
<tr>
<td>Krovar</td>
<td>3 lb (2X)</td>
<td>Telar</td>
<td>2 oz</td>
</tr>
<tr>
<td>Karmex/Direx</td>
<td>2.5 lb</td>
<td>T&amp;O</td>
<td>Rate/A</td>
</tr>
<tr>
<td>Princep</td>
<td>2.5 lb</td>
<td>Broadstar</td>
<td>150 lb</td>
</tr>
<tr>
<td>Solicam</td>
<td>3 lb</td>
<td>Gallery</td>
<td>1 lb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Snapshot TG</td>
<td>150 lb</td>
</tr>
</tbody>
</table>
3. Other strategies:

Don’t let these weeds go to seed. Use methods to get rid of them before flowers are produced. Getting rid of escapes will help prevent the spread of biotypes that may become resistant.
Use cultivation when plants are small. Do not use mowing for control. Mowing and other damage encourages additional branching to occur, making control with herbicides less effective.
Disturbing the soil surface in the fall/early-winter may reduce amount of emergence the following spring. Horseweed and fleabane seed do not emerge from deeper than a few millimeters.
Recognize resistance early:

Herbicide choice?

Was it sprayed?

Sprayer pattern?

Obvious escapes?
Managing resistant horseweed:

- Use good IPM (don’t get locked into a single approach).
- Watch the use of those SU’s.
- Use preemergents at least every 2\textsuperscript{nd} or 3\textsuperscript{rd} year. Split treatments for fall and spring emergence when possible.
- Treat horseweed/fleabane when they have <21 leaves.
- Use cultivation (not mowing) to control >90% of the weeds.
- Scout areas for patches or single plants that escape treatment and can’t be explained, then remove them.
- Be a good neighbor - “1 years seeding is worth 7 years weeding”.
Thank You!

International Survey of Herbicide Resistant Weeds
www.weedscience.org

Herbicide Handbook
WSSA

http://wric.ucdavis.edu
http://ucipm.ucdavis.edu
http://cefresno.ucdavis.edu