Multiple Mechanisms of Action for Managing Cleavers (*Galium spp.*) in Canola Systems And Field Peas

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Top 25 Weed Species
2014-15 Weed Survey
Leeson, 2015

*Average density in occurrence fields
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Cudweed species</td>
<td>1</td>
<td>-30</td>
<td>23</td>
<td>67</td>
<td>104</td>
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<tr>
<td>Willowherb species</td>
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<td>-30</td>
<td>101</td>
<td>72</td>
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<tr>
<td>Spiny annual sow-thistle</td>
<td>15</td>
<td>10</td>
<td>6</td>
<td>33</td>
<td></td>
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<tr>
<td>Cleavers</td>
<td>-26</td>
<td>28</td>
<td>14</td>
<td>10</td>
<td>26</td>
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<tr>
<td>Broad-leaved plantain</td>
<td>-4</td>
<td>-4</td>
<td>-7</td>
<td>47</td>
<td>32</td>
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<tr>
<td>Foxtail barley</td>
<td>7</td>
<td>-1</td>
<td>7</td>
<td>9</td>
<td>22</td>
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<tr>
<td>Round-leaved mallow</td>
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<td>5</td>
<td>16</td>
<td>0</td>
<td>22</td>
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<tr>
<td>Barnyard grass</td>
<td>3</td>
<td>11</td>
<td>-3</td>
<td>10</td>
<td>21</td>
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<tr>
<td>Dandelion</td>
<td>-13</td>
<td>22</td>
<td>3</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Flax</td>
<td>22</td>
<td>-8</td>
<td>5</td>
<td>-7</td>
<td>12</td>
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<tr>
<td>Narrow-leaved hawk's-beard</td>
<td>-11</td>
<td>2</td>
<td>9</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Wheat</td>
<td>-2</td>
<td>6</td>
<td>11</td>
<td>-4</td>
<td>11</td>
</tr>
<tr>
<td>Chickweed</td>
<td>7</td>
<td>-5</td>
<td>-3</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Canada thistle</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>-1</td>
<td>6</td>
</tr>
<tr>
<td>Shepherd's-purse</td>
<td>7</td>
<td>-3</td>
<td>-6</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Kochia</td>
<td>-12</td>
<td>16</td>
<td>5</td>
<td>-7</td>
<td>2</td>
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</tbody>
</table>
Cleavers in Canola

- Highly competitive at low densities
- Seed is difficult to remove from canola seed
- Significantly affect canola grading
- Increase harvest difficulty
- Predicted to be a high risk for glyphosate resistance
HT Herbicide Systems Used in Trials

• Glyphosate
  – Registered for cleavers control on plants up to 15cm

• Glufosinate ammonium
  – Variable Efficacy

• Imazamox + Imazapyr (Ares)
  – Group 2 resistance
Herbicide A or B used alone

Herbicide A and B rotated

Tank-mix of Herbicide A and B

Frequency of Resistant Individuals (%)

Generations
Effect of Number of MOA’s used per year on probability of Glyphosate Resistant Waterhemp Illinois and Proportion of Glyphosate Resistant Seed

From: Evans et al. Pest Mgt. Sci. 2015
Potential Herbicides

• Quinclorac
  – Group 4

• Clomazone
  – Group 13
  – Preplant, soil activated
Clomazone

- Trade name: Command
- Bleaching herbicide (Group 13)
- Soybean, cotton, rice, tobacco, vegetables
  - Submission to PMRA for use prior to seeding canola, field pea (?)
- Typically soil applied – PRE
- Susceptible seedlings emerge but are bleached and after a few days become necrotic
Clomazone

• Highly volatile
  – Current formulation is micro-encapsulated to reduce vapor drift.

• Persistence
  – Short to moderate persistence / microbial degradation
    – Soil ½ life = 5 to 60 days

• No HR biotypes reported to date.
Field Trial Methodology

- Separate trials for each herbicide system (Liberty-link, Roundup-Ready, Clearfield)
- RCBD with 8 treatments
- Four reps
- 5 site-years (Scott, Saskatoon, and Rosthern)
# Field Trial – Treatment List

<table>
<thead>
<tr>
<th></th>
<th>Treatment Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control (untreated check)</td>
</tr>
<tr>
<td>2</td>
<td>HT Standard</td>
</tr>
<tr>
<td>3</td>
<td>Quinclorac alone (100g ai/ha) + Merge Adjuvant (0.5v/v)</td>
</tr>
<tr>
<td>4</td>
<td>Clomoaone Alone (120g ai/ha)</td>
</tr>
<tr>
<td>5</td>
<td>Clomoazone (120g ai/ha) FB quinclorac (100g ai/ha) + Merge Adjuvant (0.5v/v)</td>
</tr>
<tr>
<td>6</td>
<td>HT Standard (as above) FB quinclorac (50g ai/ha) + Merge Adjuvant (0.5 v/v)</td>
</tr>
<tr>
<td>7</td>
<td>Clomoazone (120g ai/ha) HT Standard (as above)</td>
</tr>
<tr>
<td>8</td>
<td>Clomoazone (120g ai/ha) FB HT STandard (as above) + quinclorac (50g ai/ha) + Merge Adjuvant (0.5 v/v)</td>
</tr>
</tbody>
</table>

*FB = followed by*
Cleavers biomass in glufosinate tolerant canola (2013 & 2014)

Note: Means with the same letter in the same row are not significantly different (P>0.05). The multi-treatment comparisons using Tukey method. SEM = standard error of mean.
Cleavers biomass in glyphosate tolerant canola
(2013 & 2014)

Note: Means with the same letter in the same row are not significantly different (P>0.05). The multi-treatment comparisons using Tukey method. SEM = standard error of mean.
Cleavers biomass in imidazolinone tolerant canola (2013 & 2014)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Biomass (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsprayed</td>
<td>36 ± 0.5</td>
</tr>
<tr>
<td>Ares</td>
<td>18 ± 0.5</td>
</tr>
<tr>
<td>Qunclorac</td>
<td>7 ± 0.5</td>
</tr>
<tr>
<td>Clomazone</td>
<td>22 ± 0.5</td>
</tr>
<tr>
<td>Clom/Ares</td>
<td>10 ± 0.5</td>
</tr>
<tr>
<td>Clom/Ares/Quin</td>
<td>3 ± 0.5</td>
</tr>
<tr>
<td>Ares/Quin</td>
<td>4 ± 0.5</td>
</tr>
<tr>
<td>Clom/Ares/Quin</td>
<td>2 ± 0.5</td>
</tr>
</tbody>
</table>

Note: Means with the same letter in the same row are not significantly different (P>0.05). The multi-treatment comparisons using Tukey method. SEM = standard error of mean.
Cleaver contamination in glufosinate tolerant canola (2013 & 2014)
Cleaver contamination in glyphosate tolerant canola (2013 & 2014)
Cleaver contamination in imidazolinone tolerant canola (2013 & 2014)

% Cleaver contamination

Treatment

- Unsprayed
- Imazamox/Imazethapyr
- Quinclorac
- Clomazone
- Clom+Quin
- Imi+Quin
- Clom+Imi
- Clom+Imi+Quin

www.usask.ca
Effects of herbicide treatment on yield in glufonsiate tolerant canola 2013 & 2014

Note: Means with the same letter in the same row are not significantly different (P>0.05). The multi-treatment comparisons using Tukey method. SEM = standard error of mean.
Effects of herbicide treatment on yield in glyphosate tolerant canola 2013 & 2014

Note: Means with the same letter in the same row are not significantly different (P>0.05). The multi-treatment comparisons using Tukey method. SEM = standard error of mean.
Effects of herbicide treatment on yield in imidazolinone tolerant canola 2013 & 2014

Note: Means with the same letter in the same row are not significantly different (P>0.05). The multi-treatment comparisons using Tukey method. SEM = standard error of mean.
Clomazone on Cleavers
Symptoms from clomazone (Command) on Brassica – Group 13
Symptoms from clomazone (Command) on *Brassica* – generally transient
Clomazone Symptoms

Clomazone Injury to Wheat
Ken Sapsford
Command 200 g
Herbicide Layering in Pulses

• Using both pre- and post-emergent herbicides of different modes of action to reduce risk of weed resistance and improve overall weed control.

• Have focused on controlling Group 2 resistant cleavers on soils with organic matter > 5%
Herbicide Layering in Pulses

• Pre- is a short or medium-term residual product
  – Concept is to reduce weed population for in-crop application
  – Resistance is a numbers game, reduce the numbers, reduce selection pressure.

• Ideal is to use different herbicide groups, 3 to 4 MOA in the crop
Pulses

• Pre-
  – Edge – Group 3; Fortress – Group 3 & 8
  – Authority, Valterra, Heat – Group 14
  – Focus – Group 15

• Post-
  – Odyssey, Pursuit – Group 2
  – Viper – Group 2 & 6
Group 2 Resistant Cleavers Control
Rosthern 2014

- Edge
- Heat
- Authority Low
- Authority High
- Command Low
- Command Med
- Command High
- Viper
- Basagran
- Edge fb Heat
- Edge fb Authority
- Edge fb Viper
- Heat fb Viper
- Authority High fb Viper
- Command Low fb Viper
- Command Med fb Viper
- Command High fb Viper
Group 2 Resistant cleavers control Rosthern 2015

- Authority 210
- Authority 280
- Command Low
- Command Med
- Command High
- Basagran 0.4X
- Basagran 1.0X
- Viper
- Authority 210 fb Bas 0.4X
- Authority 280 fb Bas 0.4X
- Command Low fb Bas 0.4X
- Command Med fb Bas 0.4X
- Command High fb Bas 0.4X

% Visual Control
Group 2 Resistant cleavers seed production Rosthern 2015
Conclusions

• Benefits to using Multiple Mechanisms of Action for managing cleavers in canola
  – Short-term economics?
  – Are farmers willing to spend more money on weed control to help prevent a future problem?

• Herbicide layering still in conceptual stage; more research required to quantify potential benefits.
Glyphosate-resistant Russian thistle found in Montana

By Montana State University on Mar 4, 2016 at 3:46 p.m.
Acknowledgements
Weeds Crew 2015