An innovative approach to managing weeds in oats

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Rationale

• Weed management is a challenge for oat producers
  • Reduced plant stands
  • Reductions in yield and quality
  • Downgrading of sample
Rationale

- Wild Oat
  - Most problematic weed in oat production
  - #2 most abundant on Prairies
  - Cannot be selectively removed from oat
Rationale

• Kochia
  • Highly competitive
  • Spreading rapidly
  • #10 most abundant on Prairies
  • Herbicide resistance
    • Group 4 resistance in USA
Glyphosate-resistant Kochia

- 17 GR kochia populations confirmed in SK
- 2 in MB
- Multiple resistant
  - Gr 2 – SU’s

Beckie et al., 2015
Rationale

• Increasing multiple herbicide resistance in kochia and wild oat
• Limited herbicide options in oat
  • Kochia – can use Group 4’s but:
    • Dicamba and fluroxypyr resistance in MT and ND
• Integrated weed management is necessary
  • Few control options for both species
“MANY LITTLE HAMMERS”

- Using multiple tactics to manage weeds
- None of individual control measures provide acceptable control on their own
Treatments – IWM in oat

- Rotation – O-O-O-O-O; O-C-O-P-O; O-C-B-P-O
- Oat Cultivar: Short (‘Summit’); Tall (‘CDC Seabiscuit’)
- Seeding Rate (oat only) – 1X or 2X (200 or 400 seeds m\(^{-2}\))
  - Summit – 1.5 and 3.0 bu/ac; Seabiscuit – 2.0 and 4.0 bu/ac
- Row Spacing – narrow (20 cm) or wide (40 cm)
  - All crops in all years
- Treatments applied to same plots year after year – cumulative treatment effects (5 year)
Experimental Procedures

• Kernen Crop Research Farm (Saskatoon) and AAFC Indian Head, 2013-2018
• Wild oat and kochia planted at 100 seeds/m²
• Split-plot, 4 reps/site
• Fertilizer applied @ 100% soil test recommendations
• Herbicides specific to each crop
  • Minimal effects on kochia and wild oat
Oat Yield – Row Spacing

**Saskatoon**

- Row Spacing (cm): 20
  - Oat yield kg/ha: ~700 kg/ha
- Row Spacing (cm): 40
  - Oat yield kg/ha: ~300 kg/ha
  - Reduction: 11%

**Indian Head**

- Row Spacing (cm): 20
  - Oat yield kg/ha: ~300 kg/ha
- Row Spacing (cm): 40
  - Oat yield kg/ha: ~300 kg/ha
  - Reduction: 10%
Oat Yield – Seeding Rate

Saskatoon

~ 470 kg/ha
7%

Indian Head

~ 285 kg/ha
10%
Wild Oat Fecundity - Row Spacing

### Saskatoon
- Row Spacing (cm): 20, 40
- Seeding rate (seeds/m²): ~525 seeds/m²
- 30% decrease

### Indian Head
- Seeding rate (seeds/m²): ~1935 seeds/m²
- 82% increase
Wild Oat Fecundity - Seeding Rate

Saskatoon

- ~1375 seeds/m²
- Seeding rate (seeds/m²)
  - 200: 3000 seeds/m²
  - 400: 2000 seeds/m²
  - 51% decrease

Indian Head

- ~603 seeds/m²
- Seeding rate (seeds/m²)
  - 200: 4500 seeds/m²
  - 400: 3000 seeds/m²
  - 20% seeding rate
Wild Oat Contamination - Saskatoon

40 to 20 cm rows = 0.75X reduction
200 to 400 = 1.5X reduction
Both factors = 3X reduction
But sometimes you need a big hammer!

Screening for new herbicide options in oat

Drew Weibel
Experimental Procedure

2 Sites- 4 Site Years
- Scott, Saskatoon

RCBD- 4 replications

I. Kochia Control

- Kochia density: 100 plants m\(^{-2}\)
  - Broadcast and rolled, no crop

II. Crop Tolerance

CDC Seabiscuit: 300 plants m\(^{-2}\) 1x & 2x herbicide rates
## Treatment Applications

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Trade Name</th>
<th>Rate (1x) (g a.i. ha⁻¹)</th>
<th>Rate (2x) (g a.i. ha⁻¹)</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>--</td>
<td>---</td>
<td>---</td>
<td>--</td>
</tr>
<tr>
<td>Sulfentrazone</td>
<td>Authority</td>
<td>150</td>
<td>300</td>
<td>14</td>
</tr>
<tr>
<td>Fluthiacet-methyl</td>
<td>Cadet</td>
<td>4</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Flumioxazin</td>
<td>Valtera</td>
<td>110</td>
<td>220</td>
<td>14</td>
</tr>
<tr>
<td>Acifluorofen</td>
<td>Blazer</td>
<td>296</td>
<td>592</td>
<td>14</td>
</tr>
<tr>
<td>Bentazon + 2,4-D</td>
<td>Basagran + 2,4-D</td>
<td>475</td>
<td>950</td>
<td>6</td>
</tr>
<tr>
<td>Florasulam &amp; Bromoxynil</td>
<td>Benchmark</td>
<td>5 + 280</td>
<td>10 + 560</td>
<td>(2,6)</td>
</tr>
<tr>
<td>Pyrasulfotole &amp; Bromoxynil</td>
<td>Infinity</td>
<td>31 + 170</td>
<td>62 + 340</td>
<td>27</td>
</tr>
<tr>
<td>Topramezone</td>
<td>Impact</td>
<td>12.5</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Tembotrione</td>
<td>Laudis</td>
<td>90</td>
<td>180</td>
<td>27</td>
</tr>
</tbody>
</table>
Kochia Control

The diagram illustrates the effect of various herbicides on biomass (kg/ha) for two periods: 2012-2013 and 2013-2014. The herbicides tested include Sulfentrazone, Acifluorfen, Bentazon + 2,4-D, Tembotrione, Topramezone, Flumioxazin, Fluthiacet-methyl, Floxasulam & Bromoxynil, Pyrasulfotole & Bromoxynil. The data shows a significant reduction in biomass for the treated herbicides compared to the control.
2014 Oat Biomass

*Standard error (SE) bars

Herbicide
2014 Oat Grain Yield

*Standard error (SE) bars
2014 Oat Test Weights

![Graph showing test weights for various herbicides at different rates.](image)

- Test Weights (kg/ha)
  - Control
  - Pyrasulfotole & Bromoxynil
  - Sulfentrazone
  - Florasulam & Bromoxynil
  - Fluthiacet-methyl
  - Bentazon + 2,4-D
  - Flumioxazin
  - Acifluorfen
  - Topramezone
  - Tembotrine

- 1x Rate
- 2x Rate

*Standard error (SE) bars
And sometimes you need a new hammer!

Can seed treatment enhance competitive ability?
Shade Avoidance

- Seeds and seedlings can detect their neighbours
  - Red:Far-red light ratio
- Adjust morphology as a result
  - **Shade avoidance**
    - apical dominance
    - increased branching
    - reduced root:shoot
    - lost yield

Swanton, 2013
R:FR effects (shading)

Arabidopsis (a)  
Brassica rapa (b)

shade avoiding species

Franklin and Whitelam, 2005
Seed treatments may alter the view

- Thiamethoxam treated corn (Afifi et al., 2014)
  - Enhanced corn germination
  - Negated anticipated morphological shade avoidance response

- Can we use seed treatments to mitigate competition between oat and wild oat?
2 sets of experiments

Greenhouse
- Plants grown to
  - three leaf stage
  - full maturity
- 22/16 °C
- Turf-face
- RCBD- 6 reps

Phytotron
- early competition under cool temperatures
- Plants harvested at three leaf Stage
- 12/10° C
- Turf-Face
- RCBD-6 reps
Treatments

Seed Size
- Small (15-23 mg)
- Large (24-32 mg)

Seed Treatment - 1.5x rate
- Thiamethoxam (Cruiser 5SF)
- Pyraclostrobin (Xenium 700)
- Combination of both treatments
- Uncoated control

Competition
- Wild Oat present (4 plants/pot)
- Oat monoculture
# Results - Phytotron

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Root</th>
<th>Shoot</th>
<th>R: S</th>
<th>Final Emergence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (S)</td>
<td>1</td>
<td>&lt;0.0001***</td>
<td>&lt;0.0001***</td>
<td>0.5048</td>
<td>&lt;0.0001***</td>
</tr>
<tr>
<td>Seed Treatment (ST)</td>
<td>3</td>
<td>0.0709</td>
<td>0.0193**</td>
<td>0.8049</td>
<td>0.9967</td>
</tr>
<tr>
<td>Competition (C)</td>
<td>1</td>
<td>0.0113*</td>
<td>0.1009</td>
<td>0.0211*</td>
<td>0.6823</td>
</tr>
<tr>
<td>S X ST</td>
<td>3</td>
<td>0.1247</td>
<td>0.0332*</td>
<td>0.452</td>
<td>0.9925</td>
</tr>
<tr>
<td>ST X C</td>
<td>3</td>
<td>0.6485</td>
<td>0.5725</td>
<td>0.6363</td>
<td>0.9979</td>
</tr>
<tr>
<td>S X C</td>
<td>1</td>
<td>0.7253</td>
<td>0.1109</td>
<td>0.0234*</td>
<td>0.8060</td>
</tr>
<tr>
<td>S X ST X C</td>
<td>3</td>
<td>0.9238</td>
<td>0.9980</td>
<td>0.4373</td>
<td>0.9925</td>
</tr>
<tr>
<td>Run (R)</td>
<td>1</td>
<td>0.2345</td>
<td>0.1434</td>
<td>0.5325</td>
<td>0.8923</td>
</tr>
<tr>
<td>R X S</td>
<td>1</td>
<td>0.3809</td>
<td>0.2764</td>
<td>0.8781</td>
<td>0.3438</td>
</tr>
<tr>
<td>R X ST</td>
<td>3</td>
<td>0.5431</td>
<td>0.8712</td>
<td>0.3757</td>
<td>0.6432</td>
</tr>
<tr>
<td>R X C</td>
<td>1</td>
<td>0.6245</td>
<td>0.1753</td>
<td>0.5793</td>
<td>0.9743</td>
</tr>
</tbody>
</table>

* ** *** significant at the 0.05, 0.01, and 0.001 significant levels, respectively.
Biomass - Phytotron

Biomass (g)

<table>
<thead>
<tr>
<th></th>
<th>Root Biomass</th>
<th>Shoot Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Seed</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Small Seed</td>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>

www.usask.ca
Biomass - Phytotron

The diagram shows the comparison of shoot biomass (g) for different seed sizes and treatments.

- **LARGE** Seed Size:
  - THI: A
  - PRY: A
  - CMB: AB
  - Control: B

- **SMALL** Seed Size:
  - THI: B
  - PRY: B
  - CMB: A
  - Control: B
# Results - Greenhouse

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Root (g)</th>
<th>Shoot (g)</th>
<th>R: S (%)</th>
<th>Final Emergence (GDH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>1</td>
<td>&lt;0.0001***</td>
<td>&lt;0.0001***</td>
<td>0.7735</td>
<td>&lt;0.0001***</td>
</tr>
<tr>
<td>ST</td>
<td>3</td>
<td>0.8547</td>
<td>0.6995</td>
<td>0.7147</td>
<td>0.7153</td>
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<tr>
<td>C</td>
<td>1</td>
<td>0.022*</td>
<td>0.0024*</td>
<td>0.8926</td>
<td>0.2488</td>
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<tr>
<td>S X ST</td>
<td>3</td>
<td>0.4431</td>
<td>0.3882</td>
<td>0.1239</td>
<td>0.8402</td>
</tr>
<tr>
<td>ST X C</td>
<td>3</td>
<td>0.8394</td>
<td>0.114</td>
<td>0.3968</td>
<td>0.9712</td>
</tr>
<tr>
<td>S X C</td>
<td>1</td>
<td>0.4022</td>
<td>0.6758</td>
<td>0.1442</td>
<td>0.1863</td>
</tr>
<tr>
<td>S X ST X C</td>
<td>3</td>
<td>0.2506</td>
<td>0.2640</td>
<td>0.9987</td>
<td>0.8902</td>
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<tr>
<td>Run (R)</td>
<td>1</td>
<td>0.3509</td>
<td>0.2345</td>
<td>0.3129</td>
<td>0.3012</td>
</tr>
<tr>
<td>R X S</td>
<td>1</td>
<td>0.3981</td>
<td>0.4297</td>
<td>0.3812</td>
<td>0.3660</td>
</tr>
<tr>
<td>R X ST</td>
<td>3</td>
<td>0.2815</td>
<td>0.9275</td>
<td>0.7252</td>
<td>0.4087</td>
</tr>
<tr>
<td>R X C</td>
<td>1</td>
<td>0.7251</td>
<td>0.4820</td>
<td>0.9761</td>
<td>0.1923</td>
</tr>
</tbody>
</table>

*, **, ***, significant at the 0.05, 0.01, and 0.001 significant levels, respectively.
Results - Greenhouse

![Graph showing biomass comparison between Large Seed and Small Seed.

- **Root Biomass**
  - Large Seed: Value A
  - Small Seed: Value B

- **Shoot Biomass**
  - Large Seed: Value A
  - Small Seed: Value B
Preliminary Conclusions

• Lower seeding rates, wide row spacing exacerbate wild oat problems
  • Magnitude depends on wild oat density

• Effect of combining all practices?
  • Could be multiplicative (1+1=3), synergism

• Potential new herbicide options for kochia control?
  • Cadet® (Fluthiacet-methyl, (14))
  • Infinity® (pyrasulfotole (27) + bromoxynil (6))

• Potential for seed treatments to influence competitive ability
Use of glyphosate as a pre-harvest management tool in oat
Acknowledgements