IWM in a HT Canola World

Manitoba Agronomists – Dec. 15, 2010
From the Past…

• “Time and again our best efforts to improve Nature have foundered on some factor we failed to consider” – Allan Savory *Holistic Resource Management* (1988)

• “Repeating a successful practice is not a problem in the world of assembly lines and machines, where all ‘genotypes’ are defined. But living systems with inherently high levels of variation and diversity rapidly adapt to repeated practices. Adaptation is more difficult when practices are diverse.” – Harker *Weed Sci. 52:183* (2004)

• “In the U.S. we are putting 150 Million Pounds of Glyphosate on 100 Million Acres of Cropland every year. What do you think is going to happen?” – John Wilcut, NC State (2007)
GR Palmer Amaranth in Tennessee
- Let’s talk “Selection Pressure”

- 4 fields of continuous cotton for $\geq 6$ yr (Steckel et al. 2008 Weed Technol. 22:119-123)

- Herbicide regime
  - Preseed Burn-off: Gly (0.84 kg/ha) + dicamba
  - 1$^{\text{st}}$ In-crop: Gly (0.84 kg/ha) – early POST
  - 2$^{\text{nd}}$ In-crop: Gly (0.84 kg/ha) – prior to 5 leaves
  - 3$^{\text{rd}}$ In-crop: Gly (0.84 kg/ha) + diuron – POST-directed (PD)
  - Some years – 4$^{\text{th}}$ In-crop: Gly (0.84 kg/ha) + diuron PD

- All 4 fields with 2x to 4x rate Palmer amaranth resistance to glyphosate

- Palmer amaranth populations in Georgia are confirmed resistant to 12x rates of glyphosate (Culpepper et al. 2006 – Weed Sci. 54:620-626) – much more in 2010!
Glyphosate- Resistant Weeds – USA
December 13, 2010 – adapted from: www.weedscience.org

- *Amaranthus palmeri* (Palmer Amaranth)
- *Amaranthus tuberculatus* (syn. rudis) (Tall Waterhemp)
- *Kochia scoparia* (Kochia)
- *Ambrosia artemisiifolia* (Common Ragweed)
- *Lolium multiflorum* (Italian Ryegrass)
- *Lolium rigidum* (Rigid Ryegrass)
- *Conyza bonariensis* (Hairy Fleabane)
- *Sorghum halepense* (Johnsongrass)
- *Ambrosia trifida* (Giant Ragweed)
- *Poa annua* (Annual Bluegrass)
- *Conyza canadensis* (Horseweed)
- *Eleusine indica* (Goosegrass)
1st – Real IWM

- Is NOT tank-mixing herbicides (the “other IWM”)
- Is NOT rotating herbicide modes of action (the “other IWM”)
- Is NOT applying PRE herbicides before POST herbicides (the “other IWM”)

- Is using non-herbicide tools in addition to herbicides (Real IWM)
HT Canola IWM...

• Careful seeding & fertilizing…
• Using competitive crop cultivars…
• Early TWR…
• Crop diversity & rotation…
• Combining optimal agronomics…
• Careful harvesting…
Careful Seeding...
Lacombe – 2007
Emergence: plants/m²

Seeding Rate: 150 seeds/m²

Hybrid = 71-45 RR
OP = 34-65 RR

LSD (0.05) = 18
3465 RR (OP)

4 mph – 1 cm

4 mph – 4 cm

7 mph – 1 cm

7 mph – 4 cm
Canola Emergence & IWM?

Hybrid
4 mph
1 cm

Hybrid
4 mph
4 cm

IWM is careful seeding

A 2nd Herbicide Application is much more likely to be needed here…

June 7 (April seeded)
Careful Fertilizing During Seeding Barley Cover - June 20, 2002

Trt 13; Plot 113  22%
90 kg/ha N in seed row

Trt 17; Plot 117  78%
90 kg/ha N pre plant band

(seeding rate = 300 seeds/m², seeding date = May 20)
Wild Oat Response to N placement
- 90 kg/ha N in seed row

See also Figure 1 - O’Donovan et al. (2008) Crop Sci. 48:1569–1574

22% vs. 78% Cover  967 vs. 192 kg/ha wo biomass

Poor N placement increased wild oat biomass 5 fold
Some weeds that don’t like a crop canopy…

*Arenaria serpyllifolia*
Thyme-leaved sandwort
*(Caryophyllaceae)*

*Cerastium holosteoides*
Moused-eared chickweed
*(Caryophyllaceae)*

*Veronica arvensis*
Corn speedwell
*(Scrophulariaceae)*
## Seed Germination (%) – 3 Light Qualities

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Light</th>
<th>Dark</th>
<th>Red-light depleted*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arenaria serpyllifolia</td>
<td>Thyme-leaved sandwort</td>
<td>95</td>
<td>65</td>
<td>1</td>
</tr>
<tr>
<td>Cerastium holosteoides</td>
<td>Mouse-eared chickweed</td>
<td>94</td>
<td>93</td>
<td>27</td>
</tr>
<tr>
<td>Veronica arvensis</td>
<td>Corn speedwell</td>
<td>94</td>
<td>89</td>
<td>1</td>
</tr>
</tbody>
</table>

King. 1975. New Phytol. 75:87-90

*Petri dishes wrapped in *Tilia x europaea* leaves (simulate a crop canopy)
Dandelion Germination - with 2 light sources

- rhubarb, rye, barley, dense currant, and wild shrubs canopies
Cultivar Differences…

Both plots treated with - imazethapyr / imazamox at 3-4 Leaf pairs

Leafy – ’Grande’

Semi-leafless – ’Carrera’

Crop Competition Study…

- Rapid crop growth limits resource availability to weeds
- Strong crop competition minimizes herbicide inputs and enhances herbicide performance (IWM)
- Hybrid canolas compete more strongly with weeds than open pollinated cultivars (Harker et al. 2003, Zand & Beckie 2002) and could rival barley as a competitor
- OBJECTIVE: Determine species/cultivars and the environmental conditions that favor rapid resource capture and strong crop competition with weeds
Materials & Methods

• Direct Seeding Experiment (Conserva-Pak) at 4 AAFC sites (Lacombe, Lethbridge, Beaverlodge, Scott) in 2006-2008 and at U of S (Saskatoon) in 2007-2008

• Several different types of spring canola (seed rate 150 seeds/m$^2$) were compared to the spring cereals (seed rate 300 seeds/m$^2$) barley, wheat, triticale and rye.

• Cultivated oat was seeded across all plots to simulate a weed infestation and to ensure relatively uniform “weed” densities across plots.

• The experiment was designed as a randomized complete block with 4 replications. Plot size = 3.7 x 15 m
Species / Varieties

1. ‘45H21’ RR hybrid canola (Brassica napus)
2. ‘InVigor 5020’ LL hybrid canola (B. napus)
3. ‘45H72’ CF hybrid canola (B. napus)
4. ‘3465’ RR OP canola (B. napus)
5. ‘AC Excel’ OP canola (B. napus)
6. ‘Westar’ OP canola (B. napus)
7. ‘ACS-C7’ synthetic canola (B. rapa)
8. ‘Vivar’ spring barley (Hordeum vulgare)
9. ‘AC Metcalfe’ spring barley (H. vulgare)
10. ‘Superb’ HRS spring wheat (Triticum aestivum)
11. ‘AC Foremost’ CPS spring wheat (T. aestivum)
12. ‘Pronghorn’ spring triticale (X Triticosecale)
13. ‘Gazelle’ spring rye (Secale cereale)
Oat BM at Maturity versus Crop BM at Maturity

Lethbridge

\[ y = -0.3816x + 3460.7 \]

\[ R^2 = 0.6974 \]
Oat Biomass at Maturity – Scott

LSD = 805

- No Crop
- Canola Synthetic - ACS-C7
- Canola Hybrid InVigor 5020 - LL
- Canola Hybrid 45H72 - CF
- Canola Hybrid 45H21 - RR
- Canola Hybrid 45H21 - RR
- Canola OP 3465 - RR
- Canola OP - Westar
- Canola OP - Excel
- Barley - Metcalfe
- Barley - Vivar
- HRS Wheat - Superb
- Triticale - Pronghorn
- CPS Wheat - Foremost
- Rye - Gazelle

(kg/ha)
Oat Biomass at Maturity – Lacombe

LSD = 692

(kg/ha)
Crop Competition Rank – Top 5 – Least **Monocot** Weed biomass @ Maturity

Bea 2007 (dry) → Lac 2007 (wet)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Bea 2007</th>
<th>~Sco 2007</th>
<th>Lac 2007</th>
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<tbody>
<tr>
<td>1</td>
<td>Bar-Met 1149</td>
<td>Bar-Met 1954</td>
<td>Bar-Met 3538</td>
</tr>
<tr>
<td>2</td>
<td>Bar-Viv 1290</td>
<td>Rye-Gaz 2238</td>
<td>Rye-Gaz 4001</td>
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<td>3</td>
<td>Rye-Gaz 1331</td>
<td>Bar-Viv 2245</td>
<td>Bar-Viv 4171</td>
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<tr>
<td>4</td>
<td>Tri-Pro 1444</td>
<td>Tri-Pro 2588</td>
<td>Tri-Pro 4967</td>
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<tr>
<td>5</td>
<td>Hyb-LL 1500</td>
<td>Hyb-LL 2812</td>
<td>Whe-HRS 5508</td>
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</tbody>
</table>
Crop Competition **Rank – Top 5**
– Least **Dicot** Weed biomass @ Maturity
**Sas 2008** (warm) → **Bea 2007** (cool)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Sas 2008</th>
<th>~Sco 2007</th>
<th>Bea 2007</th>
</tr>
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<tr>
<td></td>
<td></td>
<td>g m$^{-2}$</td>
<td>g m$^{-2}$</td>
</tr>
<tr>
<td>1</td>
<td>Bar-Met</td>
<td>5</td>
<td>Bar-Viv</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>86</td>
</tr>
<tr>
<td>2</td>
<td>Bar-Viv</td>
<td>5</td>
<td>Bar-Met</td>
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<tr>
<td></td>
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<td></td>
<td>92</td>
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<tr>
<td>3</td>
<td>Rye-Gaz</td>
<td>13</td>
<td>Hyb-LL</td>
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<tr>
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<td></td>
<td>96</td>
</tr>
<tr>
<td>4</td>
<td>Hyb-LL</td>
<td>18</td>
<td>Rye-Gaz</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>113</td>
</tr>
<tr>
<td>5</td>
<td>Tri-Pro</td>
<td>20</td>
<td>Hyb-RR</td>
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<td></td>
<td>148</td>
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</table>
Lacombe Plots
- “Cool/Moist” Site-Year – July 24, 2006

‘Vivar’ Barley
Lacombe Plots
- “Cool/Moist” Site-Year – July 24, 2006

IWM is planting competitive cultivars

‘45H21’ RR Canola Hybrid
Early TWR

Field-Scale Confirmation
CCC Agronomists
Means of 10 western Canada locations
CCC Agronomists - large-scale plots (9 x 122 m) in grower fields
Waiting to Spray…
$ lost / half section

<table>
<thead>
<tr>
<th>Leaf</th>
<th>$650/t</th>
<th>$250/t</th>
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</thead>
<tbody>
<tr>
<td>6-7</td>
<td>35744</td>
<td>16985</td>
</tr>
<tr>
<td>3-5</td>
<td>13748</td>
<td>6533</td>
</tr>
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</table>

$ Lost

$650/t
$250/t
Waiting for the last Flush?
You may have just flushed your yield!

IWM is early TWR
Combining Optimal Agronomics
ICM Crop Health - Factors

- 3 Locations: Lacombe, Beaverlodge, Brandon
- Rotation – Continuous Barley or B-C-B-P
- Varieties/Cultivars
  - Short (‘Peregrine’ or ‘Vivar’)
  - Tall (‘AC Bacon’ or ‘AC Lacombe’)
- Seeding Rate – 1X or 2X (200 or 400 seeds/m²)
- Herbicide Rate – ¼, ½, or 1X (ACCase or ALS)
- Treatments applied to same plots year after year – cumulative treatment effects
Year 5
Wild Oat BM – Maturity – ¼ X Rate – 2005

200 to 400 = 3X reduction
Short to Tall = 2X reduction
Both factors = 8X reduction
All factors = 70X reduction

LSD (0.05) = 614

1 + 1 + 1 > 3
IWM is combining optimal agronomics

- Short
- 200 seeds
- B-B-B-B-B
- ¼ Rate

- Tall
- 400 seeds
- B-C-B-P-B
- ¼ Rate

August 23, 2005
# IWM is More Rotational Diversity

<table>
<thead>
<tr>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
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<tbody>
<tr>
<td>RR Canola</td>
<td>Wheat</td>
<td>LL Canola</td>
<td>Wheat</td>
<td>RR Canola</td>
</tr>
<tr>
<td>LL Canola</td>
<td>Barley</td>
<td>LL Canola</td>
<td>Barley</td>
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<td>Barley</td>
<td>Peas</td>
<td>Wheat</td>
<td>RR Canola</td>
</tr>
<tr>
<td>LL Canola</td>
<td>Early Silage</td>
<td>Early Silage</td>
<td>Winter Wheat</td>
<td>RR Canola</td>
</tr>
<tr>
<td>LL Canola</td>
<td>Early Silage</td>
<td>Winter Trit.</td>
<td>Early Silage</td>
<td>RR Canola</td>
</tr>
<tr>
<td>LL Canola</td>
<td>Fall Rye</td>
<td>Peas</td>
<td>Winter Trit.</td>
<td>RR Canola</td>
</tr>
<tr>
<td>LL Canola</td>
<td>Early Silage</td>
<td>Peas</td>
<td>Winter Trit.</td>
<td>RR Canola</td>
</tr>
<tr>
<td>LL Canola</td>
<td>Alfalfa</td>
<td>Alfalfa</td>
<td>Alfalfa</td>
<td>RR Canola</td>
</tr>
</tbody>
</table>

**8 Locations:** 6 Western Canada, Ontario, Quebec
• How much is left on the ground?
• How much goes in and then out of the combine?
• How many seeds will volunteer to be a weed?

• IWM is careful harvesting!
Vacuuming can be fun!
Seed # Losses – 2010
– Total Losses in Swathed Fields

# seeds/m²

Field #
Bushel Losses – 2010
– Total Losses in Swathed Fields

Field #

bu/ac

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Seed # Losses
– Straight-Cut

Field #

# seeds/m2

1 2 3 4 5 6 7

0 2000 4000 6000 8000 10000 12000
Bushel Losses
– Straight-Cut

Bu/ac vs Field #

Field #

1 2 3 4 5 6 7

bu/ac
Summary

- Using different herbicides is NOT IWM
- Seeding and fertilizing carefully is IWM
- Growing competitive cultivars is IWM
- Crop rotation is IWM
- Combining optimal agronomics is IWM
- Harvesting carefully is IWM

- Even HT canola hybrids benefit from IWM!
Thank you!

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