Glyphosate: Timing of Preharvest Applications and Understanding Pesticide Maximum Residue Limits (MRL’s)

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Outline

1. Maximum Residue Limits
2. Timing of Pre-Harvest Glyphosate
3. Update on Glyphosate Resistant Weeds
Maximum Residue Limits (MRL’s)

1. Residue expected when using “good agricultural practices” – and recommended rates
2. NOT a human dosage, NOT a safe limit for consumption
3. MRLs are combined with consumption of food to measure against acceptable daily intake (risk cup) over a lifetime
4. All Foods (MRL X Quantity Consumed)~ ADI
Pre-harvest Interval

- Pre-harvest Interval (PHI) is the time between the last application of the pesticide and harvest. PHI values are usually given in days.

- Harvest is the cutting of the crop or removal of the produce from the plant. It includes swathing, straight combining or grazing.
Pre-harvest interval (PHI) for various insecticides registered in canola

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>PHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cygon / Lagon</td>
<td>21</td>
</tr>
<tr>
<td>Decis</td>
<td>7</td>
</tr>
<tr>
<td>Lorsban</td>
<td>21</td>
</tr>
<tr>
<td>Malathion</td>
<td>7</td>
</tr>
<tr>
<td>Matador</td>
<td>7</td>
</tr>
<tr>
<td>Monitor</td>
<td>10</td>
</tr>
</tbody>
</table>
Canadian Glyphosate MRLs

- Beans: 2 ppm
- Lentils: 4 ppm*
- Wheat/Peas: 5 ppm
- Canola: 10 ppm

*20 years of cargo analysis; 1.2-3.7 ppm
### EU vs. Canada - MRLs

<table>
<thead>
<tr>
<th></th>
<th>Europe</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beans</td>
<td>2 ppm</td>
<td>2 ppm</td>
</tr>
<tr>
<td>Lentils</td>
<td>0.1 ppm</td>
<td>4 ppm</td>
</tr>
<tr>
<td>Wheat/Peas</td>
<td>10 ppm</td>
<td>5 ppm</td>
</tr>
<tr>
<td>Canola</td>
<td>10 ppm</td>
<td>10 ppm</td>
</tr>
</tbody>
</table>
Proper timing of pre-harvest glyphosate

- Grain moisture should be less than 30%
- Cereals – hard dough stage – a thumbnail impression remains on seed
Physiological Maturity of Wheat

Figure 1. Wheat spikes before (left) and at (right) physiological maturity.

Figure 2. Cross-section of wheat kernel showing presence of pigment strand at base of crease. Lower image shows dark color of the physiologically mature kernel.
SWATHING VS PRE-HARVEST GLYPHOSATE EFFECT ON YIELD OF SPRING WHEAT
Adapted From Darwent et al. 1994.

The diagram illustrates the yield (bus/acre) of spring wheat under swathed and glyphosate treatments at different seed moisture content stages. Seed moisture content is classified into three categories: >60%, 41-60%, and <40%. The yield is highest for swathed treatment in the soft dough stage, particularly when seed moisture content is between 41-60%.
Watery ripe  Late milk  Soft dough  Hard dough  Ripe
SWATHING VS PRE-HARVEST GLYPHOSATE EFFECT ON THOUSAND KERNEL WEIGHT OF SPRING WHEAT

Adapted From Darwent et al. 1994.

![Bar graph showing the effect of swathing versus pre-harvest glyphosate on thousand kernel weight based on seed moisture content.](image-url)
TIMING OF PRE-HARVEST GLYPHOSATE EFFECT ON GLYPHOSATE RESIDUES IN SPRING WHEAT SEED

Adapted From Cessna et al. 1994.
Proper Application Rates for Pre-Harvest Glyphosate

<table>
<thead>
<tr>
<th>Formulation (g/l)</th>
<th>Rate (L/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>356-360</td>
<td>1.0</td>
</tr>
<tr>
<td>400</td>
<td>0.81</td>
</tr>
<tr>
<td>480</td>
<td>0.76</td>
</tr>
<tr>
<td>500</td>
<td>0.73</td>
</tr>
<tr>
<td>540</td>
<td>0.67</td>
</tr>
</tbody>
</table>
Effect of timing and glyphosate rate on glyphosate residue level in field pea seed (adapted from Cessna et al. 2002).

Canadian MRL
Bottom peas hard and yellow; middle peas firm and yellow; top peas firm and easily indented

<table>
<thead>
<tr>
<th>Timing</th>
<th>0.5 (.33)</th>
<th>1 (0.67)</th>
<th>1.9 (1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 3</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Bottom peas well formed but green and easily indented; middle peas soft; top peas small and watery
Bottom peas firm and yellow; middle peas well formed and easily indented; top peas formed, very soft
Bottom peas firm and yellow; middle peas well formed and easily indented; top peas formed, very soft
Proper timing for Field peas

- 75 to 80% of pods are brown
Pre-harvest glyphosate in canola

- A maximum of 1.0 L/acre (356-360 g/l) or 0.67 L/acre (540 g/l) is allowed per season in Roundup Ready canola.
The Lentil Situation
Quantity of Canadian Lentil Exports to the EU 27

Year | Quantity (tonnes)
-----|------------------
2005 | 112,786
2006 | 131,711
2007 | 115,121
2008 | 108,197
2009 | 100,060
2010 | 116,807
2011-October | 85,249
Timelines

- February 2011: EU detects Glyphosate on Organic lentils; public notification made
- March: Increased testing of EU lentil imports – more positives found – EU customers increasingly concerned
- April: CICILS and Canadian and US industries respond
- April: Canadian and US industry meet with customers in 4 EU countries.
- May: CICILS/Pulse Canada meeting with EU Regulators
Timelines

- May: Monsanto delivers data package for MRL application in EU. Starts review process.
- November: Expected European Food Safety Agency (EFSA) Report
- March 22-23: Earliest possible date for approval by EU standing committee
Codex – International Standards

- No Codex MRL for glyphosate, but requested in April
- Recommendation of 5 ppm March/July 2012 decisions
- No Codex MRL for several new product registrations
- Codex; backlogged and out of step with global joint reviews
Challenge in Measuring Residue

- Variability in test result higher when a small sample is drawn
- Using a reference sample, test results varied from 24-38%
- Zero glyphosate sample tested from <0.01-0.348 ppm

Challenge: regulations state a maximum while tests will give a range
Bottom line

• Glyphosate MRLs for lentil in EU – marketing problem over the last year.
• If approved, EU MRL will be set at level that removes market risk for Canadian lentils – in time for 2012 crop?
• Harmonization of new product registrations and establishment of MRLs at CODEX – slow, but will help reduce future MRL problems.
HEAT: Harvest Aid/ Desiccant
Relative Days to Harvest

- REGLONE
- HEAT (+/- GLYPHOSATE)
- GLYPHOSATE
- UNTREATED

Pre-harvest Treatment Applied

Relative Days to Harvest

HEAT provides Fast, Complete Crop Dry-down
HEAT: Harvest Aid/ Desiccant
Pre-Harvest Application

- Field Peas
- Lentils
- Dry Beans
- Soybeans

Oilseed

Sunflower*

*Glyphosate is not registered for pre-harvest use
HEAT: Harvest Aid/ Desiccant
Lentils – 12 Days

HEAT provides Fast, Complete Crop Dry-down
HEAT: Harvest Aid/ Desiccant
Seed Germination – Lentils/ Peas

Effect of Pre-harvest Treatment on Seed Germination

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Lentils</th>
<th>Peas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>HEAT + MERGE</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Reglone</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2009/10 BASF Internal Trials
Lentils N=5
Peas N=8

HEAT + MERGE Can be Applied to Seed Crops
HEAT: Harvest Aid/ Desiccant Application Rates

• **HEAT + Glyphosate**
  - 1 Jug of HEAT Treats 40 acres
    - Add 1 L/ac of glyphosate (360 g/L equivalent)
    - Add 200 ml/ac of MERGE
      - (1 jug of Merge per 1 jug HEAT)
    - Apply in 10 - 20 IMP gallons of water

• **HEAT**
  - 1 Jug of HEAT Treats 30 acres
    - Add 400 ml/ac of MERGE
      - (2 jugs of Merge per 1 Jug HEAT)
    - Apply in 10 – 20 IMP gallons of water
Pesticide MRLs

• Growers need to pay attention to PHI’s. Food safety is becoming an increasing issue worldwide.
• Follow label guidelines for timing and rates.
• Check with dealer to see if MRL issue with glyphosate and lentil has been resolved. Also, Heat MRL’s need to be established and accepted.
Risk of selection for resistance by herbicide group

Number of applications:
- High ≤ 10
- Moderate 11 - 20
- Low > 20

- High
  - 1
  - 2

- Moderate-high
  - 5

- Moderate
  - 3
  - 8

- Low-moderate
  - 7
  - 22

- Low
  - 4
  - 6
  - 9
  - 10

Other

- 9

Group break down:
- Low
- Moderate
- Moderate-high
- High
- Other
Kansas: confirmed glyphosate resistance in kochia in 2007

In corn, cotton, soybean, cropland: up to 500 sites, covering up to 10,000 acres

Source: Westra, Colorado State Univ.; Stahlman, Kansas State
GR kochia in southern Alberta: 3 chem-fallow fields in close proximity to each other

<table>
<thead>
<tr>
<th>Situation</th>
<th>Number of sites</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grain Production</strong></td>
<td></td>
</tr>
<tr>
<td>Chemical fallow</td>
<td><strong>28</strong></td>
</tr>
<tr>
<td>Winter grain Production</td>
<td><strong>19</strong></td>
</tr>
<tr>
<td><strong>Horticulture</strong></td>
<td></td>
</tr>
<tr>
<td>Tree crops</td>
<td><strong>4</strong></td>
</tr>
<tr>
<td>Vine crops</td>
<td><strong>15</strong></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
</tr>
<tr>
<td>Driveway</td>
<td><strong>1</strong></td>
</tr>
<tr>
<td>Fence line &amp; crop margin</td>
<td><strong>25</strong></td>
</tr>
<tr>
<td>Irrigation channel</td>
<td><strong>8</strong></td>
</tr>
<tr>
<td>Airstrip</td>
<td><strong>1</strong></td>
</tr>
<tr>
<td>Railway right-of-way</td>
<td><strong>1</strong></td>
</tr>
<tr>
<td>Roadside</td>
<td><strong>1</strong></td>
</tr>
</tbody>
</table>
Predicting weeds at risk for glyphosate resistance

- Currently 21 GR weed species worldwide, but only two in E. Canada – giant ragweed and Canada fleabane in RR soybean in Ontario (www.weedscience.org)

- Glyphosate selection pressure is greatest at in-crop herbicide application for top 10 annual weed species except kochia

- In the Grassland region, the top three weeds predicted at greatest potential risk of glyphosate resistance are kochia, wild oat, then green foxtail

- In the Parkland region, wild oat, green foxtail, and cleavers are the top three species
Delaying glyphosate resistance in pulses

• Tank-mix glyphosate in pre-seed burnoff
  – Heat
  – CleanStart

• Use glyphosate tank-mixes in chem-fallow
  – Heat, CleanStart, dicamba
  – New formulation of dicamba called Distinct (not yet registered) will provide better control of kochia in chem-fallow than dicamba.
Pre-seed recommendations for sustainable glyphosate

• Canola
  – Cleanstart – if volunteer canola present, target the 1-leaf stage

• Wheat / Barley
  – Glyphosate / 2,4-D – outside the kochia area / won’t reduce risk of GR cleavers
  – Glyphosate / Dicamba – risk of GR cleavers
  – Glyphosate / Bromoxynil / Bromoxynil-MCPA – risk of GR cleavers & kochia
  – CleanStart – reduces risk of GR cleavers and kochia
  – Glyhosate + Heat – reduces risk of GR cleavers and kochia
Pre-seed recommendations for sustainable glyphosate

• Pulse Crops
  – CleanStart
  – Heat
Objectives:
(1) tool for producers to assess their risk of glyphosate resistance on a field-by-field basis;
(2) raise awareness for proactive resistance management in western Canada
Producer answers 10 questions related to crop production system, tillage system, and glyphosate usage (each question with four possible answers)
Tool indicates relative risk of glyphosate resistance based on the 10 responses
Glyphosate Resistance Summary

- First cases of a glyphosate-resistant weed in western Canada confirmed in 2012
- Kochia was predicted in 2010 to be the top weed at risk
- Field-to-field spread of GR kochia may be rapid
- Urgent call to action: collaboration among all stakeholders to manage the problem
- *Future proposed research:*
  - expanded field survey in S. Alberta
  - field trials: dose-response, alternative herbicides
  - mechanism of resistance
Thank you!