Tools for Managing Resistance and Weed Control – Pulse Crop Herbicide Options

Eric Johnson¹, Hugh Beckie², Jessica Weber³, Jessica Pratchler⁴ and Chris Willenborg¹
¹ University of Saskatchewan ²AAFC, ³ Western Applied Research Corporation ⁴NorthEast Agricultural Research Foundation
Disclaimer

• The information presented in this talk is from publicly funded research. It involves information on herbicides not currently registered in some pulse crops. Please consult herbicide labels before applying any herbicides listed in this presentation.
Weed Science Program, University of Saskatchewan
FEWER NEW SOLUTIONS BEING DEVELOPED

The declining rate of patent applications for new herbicides since 1990

Over a twenty year period there was a significant reduction in output of herbicide patents which stabilised in 2008, but at a very low level.

Source: Bayer CropScience
DuPont Crop Protection and Syngenta Announce Publication of a New Joint Patent for Herbicide Development

12.19.16

New chemistry class for weed management expected to be launched in 2023

WILMINGTON, Del., and BASEL, Switzerland, Dec. 19, 2016 – DuPont Crop Protection (DuPont) and Syngenta announced today the publication of a joint patent, focused on the development of a new herbicide chemistry class. Collaboration on the project started in 2015 and has resulted in the joint patent entitled “Substituted cyclic amides and their use as herbicides.” The new herbicide has entered into the pre-development stage and is expected to be launched in 2023.

Substituted cyclic amides as herbicides
WO 2016164201 A1

ABSTRACT

Disclosed are compounds of Formula I, including all stereoisomers, N-oxides, and thereof (I) wherein R³, R⁴, R⁵, R⁶, Q¹, Q², Y¹, and Y² are as defined in the disclosure; and T is ¹⁻A⁻ and also as defined in the disclosure. Also disclosed are compositions containing the compounds of Formula I and methods for controlling undesired vegetation comprising contacting the undesired vegetation or its environment with an effective amount of a compound or a composition of the invention.
History of Pulse Broadleaf Weed Control

• Prior to Imi Chemistry (1970 – 1990)
  • Trifluralin, Ethafluralin (Group 3), Metribuzin (Group 5), MCPA amine / sodium salt (Group 4), Tropotox Plus (Group 4), Basagran (Group 6), Pea Pack (Sencor / MCPA) (Group 5 + 4).

• Imi Chemistry (Group 2’s) 1990-
  • Pursuit, Odyssey, Solo, Ares
  • 2007 – Clearfield lentil Introduced
Pulse Herbicides 2000 -

• 2002 – Pesticide Minor Use Program introduced
  • Assisted in the introduction / registration of:
    Carfentrazone (AIM), Sulfentrazone (Authority),
    Flumioxazin (Valtera) – Group 14’s; Pyroxasulfone
    (Focus, Zidua) – Group 15; and Clomazone
    (Command) – Group 13;
  • BASF introduced saflufenacil (Heat) – Group 14; Viper
    (imazamox + bentazon – Group 2 + 6).
  • NuFarm – pyraflufen + MCPA (Goldwing) – Group 14 + 4)
Group 2 (ALS) resistance

- Kochia
- Cleavers
- Wild Mustard
- Stinkweed
Characteristics of Recent Herbicides

• Quite a few are soil active
  • Soil active herbicides tend to be less consistent due to environmental interactions
  • Generally, not as broad spectrum of weed control
  • Not perfect tolerance, particularly in lentil
• One-shot weed control in pulses unlikely concept in future.
Chickpea Developments

- Imi-tolerant: CDC Alma (kabuli) and CDC Cory (desi).
- Prairie Pesticide Minor Use Consortium prepared Minor Use submission for Solo to PMRA. Registration hoped for this year.
- All new varieties will be imi-tolerant.
- Tolerant to pyroxasulfone.
Potential Herbicide in Chickpea

• Pyridate
  • Trade Name: Tough or Lentagran
  • Group 6 (same mode of action as bromoxynil, Basagran)
  • Post-emergence, contact, no residual
  • Old chemistry – Used to be Sygenta product, now belongs to Engage Agro of the Belchim group; working on new formulation
• Pyridate

• Chickpea tolerance very good, works on a number of broadleaf weeds – strong on kochia, pigweeds, lambs-quarters, shepherd’s purse, not as strong on wild mustard.

• Contact – coverage important, works best on small weeds

• Very smelly

• Company working on submission for registration
Lentil

- Pyroxasulfone (Focus, Zidua)
- Flumioxazin (Valtera)
- Pyroxasulfone + Heat
- Amicarbazone
Pyroxasulfone injury in lentil
Effect of pyroxasulfone rate on lentil yield.
Scott. 2010.

\[ y = -0.4273x^2 + 3.0797x + 23.257 \]

\[ R^2 = 0.6185 \]
Maxim Lentil
Injuries from Fluthiacet-Methyl And Sulfentrazone
Photo taken June 28, 2016
Heat and Pyroxasulfone May be Additive – Results in **Fababean**, Saskatoon, 2017
Effect of Heat and Pyroxasulfone on Yield of Lentil – Weeds Present – Saskatoon 2017

Highest injury rating
~ 10%
Wild mustard control
- 50 to 60%
Kochia control
- 70-80%
Valtera and Focus are not Edge substitutes for lentil

- **Valtera** fall-applied: provides good control of winter-annual weeds (including narrow-leaved hawksbeard), and the first, major flush of kochia. Not residual enough to provide season-long control of kochia flushes.

- **Focus** can be very effective on cleavers if soil organic matter is <6%. Very good on downy and Japanese brome. Other weed efficacy – environment dependent.
Caution for lentil growers!

• Be careful not to overuse Group 14’s!!
  • Valtera in fall followed by Heat in spring probably not a good idea! (haven’t researched it)
  • Don’t want to lose this group due to resistance development!
Lentil

• Amicarbazone – Group 5 herbicide (triazine)
  • Arysta product
  • Registered in corn and turfgrass in USA
  • Also registered in sugarcane in Australia
  • Mostly root uptake, very soluble herbicide.

• Preliminary results: Lentil / wild mustard selectivity ratio was 15:1 in growth chamber.
ED$_{50}$
Lentil – 897 g ai ha$^{-1}$
Wild mustard - 61 g ai ha$^{-1}$
Amicarbazone

• Field tested at Saskatoon (clay-loam) and Scott (loam) in 2017.
• PRE- and POST- application at rates of 50 to 400 g ai/ha.
• Also, tested PRE- for volunteer RR control in corn
• Lentil exhibited better tolerance at Saskatoon than Scott.
Amicarbazone – Preliminary Results

• Scott

  • None of the PRE- or POST- treatments provided season-long control of kochia.
  • Pre-applications provided >70% suppression / control of wild mustard until early July, but final ratings in August were <70%.
  • Post applications > 150 g ai/ha provided season-long suppression / control of wild mustard >75%. Rates >200 g ai/ha: 86 to 97% control
  • Rates >300 g ai/ha applied either PRE- or POST- unacceptable injury in lentil
Amicarbazone in lentil – Scott 2017

![Graph showing weed biomass and yield for different treatments.](image-url)
Amicarbazone – Preliminary Results

- **Saskatoon**
  - Rates >300 g ai/ha applied either PRE- or = 400 g ai/ha POST- unacceptable injury in lentil
  - Similar results on wild mustard as at Scott
  - Rates > 150 g ai/ha PRE- or POST- provided > 70% control of stinkweed
Volunteer RR canola control in corn – RRE applications

- Heat 25
- Heat 50
- Heat 100
- Ami 100
- Ami 200
- Ami 400

% Control vs. Days After Application
Future of Amicarbazone

• Arysta interested in pursuing in pulses
• Lots of research required before it will be available to growers
  • Tolerance of other pulses?
  • Split-timing – pre and post?
  • Is it any better than Sencor?
Field Pea

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

• 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
Herbicide Layering

• Should be viewed as another tool, not a solution.
• "At some point, we must stop looking to herbicides as the solution to a problem created by herbicides."

Dr. Andrew Kniss
University of Wyoming
Layering Options for Group 2 R cleavers
- Necessary in high organic matter soils

• PRE
  • Field pea – Edge (fall applied, helps to incorporate with heavy harrow), Authority, Heat, Command*, Focus*

• POST
  • Field pea – Viper, Basagran

*Not yet registered
Group 2 Resistant cleavers control
Average of 3 Years (2013-2015). SOM > 6%
Melfort (2013), Rosthern (2014-15)
Group 2 Resistant cleavers control
Average of 2 Years (2014-2015). SOM > 6%. Rosthern, SK.
Fababean – Data generated for potential Minor Uses

- Heat – pre-seed
- Authority – pre-seed
- Viper – post-emergence
- Heat and Heat / glyphosate, glufosinate – desiccation
- Valtera – pre-emergence
- Focus – pre-emergence
- Investigating injury from residual herbicides.
## Soybean - Current Herbicide Options

<table>
<thead>
<tr>
<th>Pre-Seed / Pre-Emergent</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim® / CleanStart® (carfentrazone)</td>
<td>14</td>
</tr>
<tr>
<td>Authority® / Authority Charge®</td>
<td>14</td>
</tr>
<tr>
<td>(sulfentrazone / +carfentrazone)</td>
<td></td>
</tr>
<tr>
<td>Blackhawk™ (carfentrazone + 2,4-D)</td>
<td>14+4</td>
</tr>
<tr>
<td>Edge™ Granular (ethafluralin)</td>
<td>3</td>
</tr>
<tr>
<td>Express® SG (tribenuron)</td>
<td>2</td>
</tr>
<tr>
<td>Fierce® (flumioxazin + pyroxsulfone)</td>
<td>14+15</td>
</tr>
<tr>
<td>Focus® (carfentrazone + pyroxsulfone)</td>
<td>14+15</td>
</tr>
<tr>
<td>Heat® (saflufenacil)</td>
<td>14</td>
</tr>
<tr>
<td>Reflex® / Flexstar® (fomesafen)</td>
<td>14**</td>
</tr>
<tr>
<td>Valtera™ (flumioxazin)</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In-Crop</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basagran® / Basagran Forte® (Bentazon)</td>
<td>6</td>
</tr>
<tr>
<td>Blazer® (acifluorfen)</td>
<td>14</td>
</tr>
<tr>
<td>Odyssey® / Odyssey Ultra®</td>
<td>2 / 2+1</td>
</tr>
<tr>
<td>(imazamox + imazethapyr / +sethoxydim)</td>
<td></td>
</tr>
<tr>
<td>Pinnacle® SG (thifensulfuron methyl)</td>
<td>2</td>
</tr>
<tr>
<td>Solo® ADV (imazamox)</td>
<td>2</td>
</tr>
<tr>
<td>Viper® ADV (imazamox + bentazon)</td>
<td>2+6</td>
</tr>
<tr>
<td>Reflex® / Flexstar® (fomesafen)</td>
<td>14**</td>
</tr>
<tr>
<td>Quizalofop, sethoxydim, clethodim</td>
<td>1</td>
</tr>
</tbody>
</table>

**Fomesafen is for use in Manitoba Red River Valley Only**
Xtend soybean

- Resistant to Dicamba
- Lower-volatile formulation (still volatile)
- Applied PRE- and/or POST-
- Rates of dicamba
  - 300 to 600 g ai/ha (4.3 to 8.6 ounces active per acre)
- Not great on volunteer Roundup Ready Canola!!
Volunteer Canola Control in Xtend Soybean – Saskatoon 2017

To achieve 70% reduction in Canola Biomass POST, Dicamba had to be applied at a rate of 1942.3 g ai/ha.
Suggestion for Xtend Soybean

• Think of it as 2-pass system!!
  • PRE- and POST-
• Apply PRE- glyphosate + dicamba at 300 to 600 g ai/ha.
• Apply POST- glyphosate + either Solo, Odyssey, Basagran, or Viper
• Glyphosate + Dicamba PRE- followed by Glyphosate + Viper POST- (4 different modes of action, 2, 4, 6, 9)
Dicamba applied at 600 g ai/ha
May 15, 2015
SPG Demo – Ag In Motion
Glyphosate only pre

Viper + Glyphosate in crop
Engenia (Dicamba) + Glyphosate in-crop

Credit: Sherrilyn Phelps
Enginia (dicamba) + Glyphosate Pre

Credit: Sherrilyn Phelps
Enginia + Glyphosate Pre

Viper + Glyphosate in crop
Enginia + Glyphosate in crop
Glyphosate in crop

Credit: Sherrilyn Phelps
Interrow spraying of low to non-selective herbicide in lentil
Untreated

Inter-row sprayed with glyphosate + glufosinate
To Conclude:

- Herbicide Options for Pulses in the Future
  - For most pulses, herbicide options will continue to be few and far between;
  - Will likely not be totally safe to use on crop;
  - Will likely require other herbicides / integrated practices to provide broad-spectrum control
  - Soybean – potential for more options in future due to large acreage world-wide.
    - HPPD (Group 27) resistance under development (Syngenta and Bayer). Syngenta MGI tolerant to mesotrione, glufosinate, and isoxaflutole.
Acknowledgements