HR crop management: a Canadian perspective

Hugh J. Beckie

Science & Technology Branch
Transgenic/GM crops: global area in 2014: 182 million ha

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>M ha</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States</td>
<td>73.1</td>
<td>40.3</td>
</tr>
<tr>
<td>2</td>
<td>Brazil</td>
<td>42.2</td>
<td>23.2</td>
</tr>
<tr>
<td>3</td>
<td>Argentina</td>
<td>24.3</td>
<td>13.4</td>
</tr>
<tr>
<td>4</td>
<td>India</td>
<td>11.6</td>
<td>6.4</td>
</tr>
<tr>
<td>5</td>
<td>Canada</td>
<td>11.6</td>
<td>6.4</td>
</tr>
</tbody>
</table>

First generation traits:
HR : 58%
Bt : 14%
HR + Bt : 28% (stacked)
Herbicide Resistance Stewardship/Management Plan (required since 2004)

Applicant needs to address:

- Control of volunteers; identify any potential changes in agronomic practices related to the HR trait which could impact sustainability, e.g., soil conservation
- **Selection of herbicide resistance in weeds resulting from the potential continued application of the same herbicide in subsequent rotations:** guidelines for rotation of crops and herbicides
- Introgression of HR trait into related species
- Management of the HR crop during the growing season, esp. where multiple resistance due to cross-pollination could arise in subsequent growing seasons
- Communication to growers; **efficient reporting mechanism**
- Monitoring effectiveness of the stewardship plan
Resistance management labeling in Canada since 1999
Resistance BMPs on labels

- Rotate the use of (name of product) or other Group (site of action group number) herbicides within a growing season (sequence) or among growing seasons with different herbicide groups that control the same weeds in a field.

- Use tank mixtures with herbicides from a different group; the less resistance-prone partner should control the target weed(s) as effectively as the more resistance-prone partner.

- Herbicide use should be based on an IWM program that includes scouting, historical information related to herbicide use and crop rotation, and considers tillage (or other mechanical control methods), cultural (e.g., higher crop seeding rates; precision fertilizer application method and timing to favour the crop and not the weeds), biological (weed-competitive crops or varieties), and other management practices.
Resistance BMPs on labels

- Monitor weed populations after herbicide application for signs of resistance development. If resistance is suspected, prevent weed seed production in the affected area if possible by an alternative herbicide from a different group. Prevent movement of resistant weed seeds to other fields by cleaning harvesting and tillage equipment when moving between fields, and planting clean seed.

- Have suspected resistant weed seeds tested by a qualified laboratory to confirm resistance and identify alternative herbicide options.

- Contact your local extension specialist or certified crop advisors for additional pesticide resistance management recommendations for specific crops and weed biotypes.

- For further information or to report suspected resistance, contact (company) at (toll free number) or at (internet site).
A Framework for Postrelease Environmental Monitoring of Second-generation Crops with Novel Traits

Hugh J. Beckie,* Linda M. Hall, Marie-Josée Simard, Julia Y. Leeson, and Christian J. Willenborg

ABSTRACT

As first-generation genetically modified/transgenic crops with novel agronomic traits have been grown commercially in a number of countries since the mid-1990s, second-generation crops with novel traits (CNTs) are now being tested in confined field trials around the world. Postrelease monitoring (PRM) of abiotic stress-tolerant and other second-generation CNTs will strengthen prerelease environmental risk assessments, for which protocols are being developed. We outline a comprehensive framework and protocol for case-specific PRM of such CNTs in Canada, using drought-tolerant canola (Brassica napus L.) as a model CNT. The primary potential environmental risk associated with cultivation of drought-tolerant canola is increased invasiveness of volunteers or feral plants (self-perpetuating populations) and weedy relative-crop hybrids or backcrossed progeny in nodal (noncropped disturbed) and natural areas adjacent to CNT cultivation, resulting in loss of abundance or biodiversity of native plant species. Accurately predicting CNT invasiveness a priori is problematic, especially for traits that may enhance plant fitness and invasiveness. Thus, PRM can effectively address the greater uncertainties in the environmental risk assessment of these second-generation vs. first-generation CNTs and thereby enhance environmental protection and security of the food supply.

Published in Crop Sci. 50 (2010)
Published online 10 June 2010.
© Crop Science Society of America | 5585 Guilford Rd., Madison, WI 53711 USA
All rights reserved. No part of this periodical may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Permission for printing and for reproducing the material contained herein has been obtained by the publisher.
Monitoring / Surveillance

- Regular, periodic random field surveys of HR weeds led by a public institution (each usually conducted within provincial or state boundaries)
- Grower management questionnaires may accompany the field survey data collection; correlation analysis can identify reduced-risk practices
- Supplemented by testing samples of suspected HR weeds submitted by growers to a qualified lab, and mapping occurrence
- Combined activities will allow close tracking of HR weed occurrence in time and space, and facilitate early grower awareness and timely management
GR kochia across the Canadian prairies

SHORT COMMUNICATION

Glyphosate-resistant kochia (Kochia scoparia L. Schrad.) in Saskatchewan and Manitoba

Hugh J. Beckie¹, Robert H. Gulden², Nasir Shaikh³, Eric N. Johnson⁴, Christian J. Wiltshire⁵, Glen A. Brown⁶, Scott W. Chisholm⁴, Chris Lenkeit⁴, and Greg Ford⁴
GR kochia in GR canola

Environmental Impact of Glyphosate-Resistant Weeds in Canada
Hugh J. Beckie, Peter H. Sikkema, Nader Soltani, Robert E. Blackshaw, and Eric N. Johnson*
GR Canada fleabane/horseweed: 155 sites in 8 counties
GR giant ragweed: 71 sites in 5 counties

GR common ragweed: 5 sites in Essex County
Stacked-HR trait soybean

- Management of GR weeds, such as giant and common ragweed, horseweed, and/or kochia
- Roundup Ready 2 Xtend™: glyphosate + dicamba
- Approved in 2012 in Canada (available in 2016)
- Dicamba at 600 g ai/ha (or 300 fb 300); E.I. = 15.8 (moderate)
- Enlist™: glyphosate + 2,4-D
- Approved in 2013 in Canada (available in 2016)
- 2,4-D at 834 g ai/ha x 2 sequential applications max; E.I. = 25.6 (high)
Stacked-HR trait (glyphosate + dicamba) canola (Roundup Ready 2 Xtend™)

- Dicamba-HR canola expected to be approved and released in the next decade (after corn)
- Cultivars with three-way stack (incl. glufosinate)
- Dicamba-HR canola susceptible to another auxinic herbicide, 2,4-D, commonly used to control volunteers
- What will be the management implications?
- dicamba currently applied to 10 - 15% of wheat and barley fields @ 140 g ai/ha (2 crops cover 50% of annually-cropped area)
- increasing acreage of soybean and corn (incl. cultivars with this stacked trait) across the Canadian prairies will increase the dicamba selection pressure for HR weeds (300 - 600 g ai/ha)
- growers will need to tank-mix another herbicide with dicamba or an alternative to dicamba to control canola volunteers in a cereal crop grown the following year
32 Gp 4 HR weed biotypes (27 BL; 5 grass species-quinclorac):
- Aster and Mustard families account for 40%
- Inheritance: often single dominant gene
- Unpredictable cross-resistance pattern across herbicide classes (phenoxy, benzoic acid, carboxylic acid, quinoline carboxylic acid)
Technology Stewardship Agreement & Use Guide (TUG): improving stewardship

- Growers do not usually read the TUG; mandatory training sessions for growers to enhance adoption of BMPs
- Industry main objective: regulate planted and harvested seed
- Industry does not really monitor effectiveness of the stewardship plan
- Recommendations needed on herbicide-use intensity (e.g., multiple applications of glyphosate, dicamba, etc. in a field every year) and HR crop rotation frequency thresholds (e.g., back-to-back canola cultivation)
- Enhanced industry and federal & provincial/state government incentives (e.g., crop insurance) to increase adoption of BMPs
- Useful model to emulate?: GMHR canola (no glyphosate the following year) and cotton (post-herbicide surveys) in Australia
Proactive HR weed management is rare; growers greatly discount potential future vs. present rewards

Cultivars with stacked HR traits will provide a short-term respite from HR weeds, but will perpetuate the herbicide treadmill and accelerate the selection of multiple-HR weed populations in the longer term – industry stewardship plans need teeth

Recommendations needed for maximum herbicide-use intensity (within and across growing seasons) and HR crop rotation frequency

Concomitantly, industry and government incentives must expand to improve grower adoption of BMPs for HR crops and HR weeds

The only long-term / sustainable solution is for government or end users of commodities to set herbicide-use reduction targets in our major field crops, and include financial incentives or penalties in agricultural programs to support this policy