BIOTECH TOPIC
Resistance management: control of volunteer and ratoon cotton
Table 1. Herbicides registered for volunteer cotton control.

<table>
<thead>
<tr>
<th>Actives</th>
<th>MOA</th>
<th>Conc &amp; formulation</th>
<th>Appl rate</th>
<th>Stage</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amitrole + Ammonium Thiocyanate</td>
<td>Q</td>
<td>250g/L + 220g/L SL</td>
<td>4.3–5.6L/ha</td>
<td>Cotyledon – 8 leaf</td>
<td>See label for rain fastness. Apply in 50–100L/ha water. Addition of 0.25% Li700 may improve results. Tank mix with glyphosate. Sowing can occur immediately after application. Bleaching of isolated crop leaves may be seen after emergence.</td>
</tr>
<tr>
<td>Amitrole + Paraquat</td>
<td>Q + L</td>
<td>250g/L + 125g/L SC</td>
<td>2–4L/ha</td>
<td>Up to 8 leaf</td>
<td>Can be applied after an initial spray of a glyphosate herbicide (Double Knockdown). Refer to label for spot spray rates.</td>
</tr>
<tr>
<td>Bromoxynil</td>
<td>C</td>
<td>200g/L EC</td>
<td>1.5L/ha or 1–1.5L/ha with glyphosate</td>
<td>Cotyledon – 6 leaf</td>
<td>Apply in minimum of 80L/ha water for Roundup Ready cotton. See label for rain fastness. Refer to label for restrictions on spray quality &amp; condition.</td>
</tr>
<tr>
<td>Carfentrazone – Ethyl</td>
<td>G</td>
<td>400g/L EC</td>
<td>Roundup Ready: 0.045–0.060 L/ha, plus adjuvant Conventional 0.030–0.045 L/ha</td>
<td>2–6 leaf</td>
<td>Apply minimum spray volume of 80L/ha. Tank mix with glyphosate, or products containing paraquat. Refer to label for adjuvant recommendation.</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>240g/L EC</td>
<td>Roundup Ready: 0.075–0.1 L/ha, plus adjuvant Conventional 0.050–0.075 L/ha</td>
<td>2–6 leaf</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>135g/L +115g/L SL</td>
<td>1.6–2.4L/ha SL 2.4–3.2L/ha</td>
<td>1–4 leaf 5–9 leaf</td>
<td>Apply in 50–100L water/ha. For best results, spray during humid conditions in the late evening.</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>800g/kg WG</td>
<td>50g/ha</td>
<td>Pre-emergent</td>
<td>Do not apply post emergent treatments if rain is likely within 4 hours. Do not irrigate (any method) treated crop of pasture for 48 hours after application. May be banded (&gt;40%) over the row or broadcast. Minimum spray volume 150L/ha for optimum results.</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>500g/kg WG</td>
<td>45g/ha plus adjuvant</td>
<td>Up to 4 leaf</td>
<td>Do not apply post sowing pre-emergent. Apply up to 24 hours prior to sowing. Can be tank mixed with glyphosate. Refer to label for adjuvant details.</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>200g/L SL</td>
<td>3.75L/ha in 100L water</td>
<td>2–6 leaf</td>
<td>Only apply to Liberty Link cotton varieties. Max 2.25kg a.i./ha/season (3 applications). As a contact herbicide, coverage is critical to effectiveness. Will not control Liberty Link cotton volunteers.</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>750g/kg WG</td>
<td>470g/ha</td>
<td>Pre-emergent</td>
<td>Registered for control of volunteer cotton in pigeon pea. Refer to label for critical comments.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>480g/L SC</td>
<td>0.750L/ha</td>
<td>Pre-emergent</td>
<td>Registered for control of volunteer cotton in pigeon pea. Refer to label for critical comments.</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>333g/L</td>
<td>0.45 L/ha 0.6 L/ha</td>
<td>2–6 leaf 5–7 leaf</td>
<td>Summer fallow.</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>700g/kg</td>
<td>9–26g/ha plus Bonza 1%</td>
<td>2–6 leaf</td>
<td>May be tank mixed with Roundup Attack herbicide. Apply in 80–250L water per ha. Mandatory down wind no spray zone 100–250m.</td>
</tr>
</tbody>
</table>

The importance of resistance management, diseases prevention and insect population control.

A key part of any Resistance Management Plan for growers of Bollgard II® cotton is the control of volunteer and ratoon cotton. This can, however, be difficult to achieve, as shown in a recent survey carried out by staff from the Queensland and New South Wales Departments of Primary Industries. Volunteer cotton plants from the previous season were present on 71% of cotton farms in QLD and 81% of cotton farms in NSW. On more than 50% of farms, volunteers were found in the current year’s cotton crop, however most volunteers were found on roadsides, in channels and along fence lines.

Before looking at methods to improve control of volunteer and ratoon cotton, it’s good to understand why it is so important. In short, it helps achieve resistance management, disease prevention and insect population control objectives.

1. Resistance management

The presence of volunteer and ratoon cotton is a risk factor for the development of resistance in moth (*Helicoverpa* spp.) populations to the insecticidal proteins (Cry1Ac and Cry 2Ab) in Bollgard II cotton. This is because ratoons and volunteers provide additional opportunities for *Helicoverpa* spp., that may carry the resistance genes to these proteins, to survive and propagate.

Similarly, fields containing Bollgard II ratoons and volunteers are unsuitable for planting a refuge because the population of *Helicoverpa* spp. moths, provided by the refuge, may have been exposed to the Cry1Ac or Cry2Ab toxins and therefore may not be susceptible to the proteins.

2. Disease prevention and risk mitigation

The ratoon and volunteer plants can act as crop hosts and/or stimulate the growth of soil bacteria, increasing the risk of Verticillium wilt, Fusarium wilt, Black root rot and Alternaria leaf spot.

Viruses such as Tobacco Streak virus and Cotton Bunchy Top (CBT) virus are unable to survive without a live plant host. In particular, the risk of Cotton Bunchy Top virus is increased when ratoon and volunteer cotton plants are present anywhere on a farm.

Cotton volunteers and ratoons provide both a host for CBT and also a green bridge for the vector of the disease – the cotton aphid – to survive over winter. Cotton aphids may then spread the virus to nearby cotton crops, often resulting in severe yield losses.

Removing volunteers and ratoons is the simplest way of preventing aphid survival, even though CBT can survive in several other broadleaf weeds. Unfortunately, chemical control of aphids is often not effective due to resistance issues.
3. Control of insect populations

The presence of cotton volunteers and ratoons gives many insects an opportunity to survive over winter, increasing the risk of early season infestations and crop damage the following year. These insects include Cotton aphids, Mealybugs, Silverleaf Whitefly and Pale cotton strainers. Infestation of the crop early in the season can result in yield losses through square damage or a reduction in leaf area. It may also require costly insecticide sprays for control – for example, Silverleaf whitefly sprays can cost dryland growers between $55 and $105/ha, an expense that could be avoided had insect populations been controlled through good volunteer and ratoon control.

Insect populations can be quite mobile, even over winter, as they seek suitable host plants or are spread via wind, surface water run-off, rain splash, birds, and the movement of people and farm equipment. This makes farm-wide or even valley-wide volunteer and ratoon control a key objective.

4. Agronomic considerations

Cotton volunteers compete with the plants in your refuge crop in the same way that weeds do. As well as competing for water, nutrients and light, volunteers may cause other agronomic problems. These include poor water flow through furrows and a reduction in the effectiveness of sprays of other weeds through shielding.

If your refuge is in a fallow area and volunteers are left to grow, they can cause a significant drying down of the soil profile, and reduce the available water in the soil for following crops. In fact, ratoon cotton can dry the profile down to over 1 metre.
Strategies for the management of volunteer cotton in refuge crops

Implement appropriate cultural methods

The best way to avoid the presence of Bollgard II volunteers in refuge crops is not to plant refuges into fields that were planted to Bollgard II the previous season. If this is unavoidable, proactive control methods must be in place before planting. These include:

► Reducing the amount of viable seed left in fields and surrounding areas by using herbicide options and cultural practices will reduce the number of volunteers that germinate.
► Cultivation of broadacre fields in fallow areas will act as a control method for volunteers of differing sizes, from seedlings to plants.
► Manual removal of plants (chipping) can also be effective in low-density situations. Cultivation is also useful to manage other weeds present in the field.

Develop appropriate herbicide strategies

If refuge crops are planted into a Bollgard II field from the previous season, ensure appropriate control mechanisms are available and can be implemented in a timely fashion. Pre-watering is a method used to establish volunteers prior to planting a refuge into moisture. This allows a window for appropriate herbicide control of seedling volunteers prior to the emergence of the refuge crop.

The Herbicides Table shows herbicide options registered for control of cotton volunteers. Most herbicide options work well on seedling volunteers, but once plants are established, control becomes increasingly difficult.
Additional information

To find out more about volunteer and ratoon control, please contact your Technology Service Provider or your Monsanto Regional Business Manager.

Rohan Sippel
Regional Business Manager
Central Queensland
0400 299 985
rohan.sippel@monsanto.com

Mick Fing
Regional Business Manager
Darling Downs & South West Queensland
0417 305 717
michael.bernard.luff@monsanto.com

Tom Luff
Regional Business Manager
Gwydir & Border Rivers
0400 491 902
thomas.bernard.luff@monsanto.com

Paul Brady
Regional Business Manager
Namoi & Walgett
0409 935 513
paul.1.brady@monsanto.com

Luke Sampson
Regional Business Manager
Macquarie, Lachlan, Bourke
0427 701 986
luke.sampson@monsanto.com

Carlos Rahme
Regional Business Manager
Southern New South Wales
0428 540 181
carlos.rahme@monsanto.com

Mark Dawson
Cotton Sales Lead
0428 106 090
mark.m.dawson@monsanto.com

Keryn McLean
Marketing and Stewardship Lead
0409 536 446
keryn.mclean@monsanto.com

Kate Lang
Compliance Manager
0418 327 101
katherine.sarah.lang@monsanto.com

Meredith Errington
Cotton Agronomic Specialist
0408 402 556
meredith.anne.errington@monsanto.com

Monsanto Australia
Head Office: 12/600 St Kilda Road, Melbourne, VIC 3004
Post: PO Box 6051, St Kilda Road Central, VIC 8008
Phone: 1800 069 569 Fax: 03 9522 7185
www.monsanto.com.au
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