



ROUNDUP READY FLEX[®] COTTON

WEED RESISTANCE MANAGEMENT PLAN



1. OBJECTIVE

The ROUNDUP READY FLEX® cotton Weed Resistance Management Plan (WRMP) details strategies that can be implemented to minimise the risk of glyphosate resistance developing in weeds on-farm. It complements the ROUNDUP READY FLEX® accreditation course and technical manual. ROUNDUP READY FLEX® cotton offers superior and effective weed control to growers, with a wide glyphosate application window, outstanding crop safety, broad spectrum weed control and the ability to control weeds where they appear. The flexibility of an Integrated Weed Management (IWM) strategy, including ROUNDUP READY FLEX® cotton, offers management efficiencies as well as a variety of in-crop weed control options. Prudent management of ROUNDUP READY FLEX® technology and mitigation of resistance risks will ensure these options for weed control are available to Australian cotton growers well into the future.

2. GROWING ROUNDUP READY FLEX COTTON

There are several requirements that growers need to be aware of when planting ROUNDUP READY FLEX® cotton, as outlined by the Technology User Agreement (TUA) and the product labels for Roundup Ready® Herbicide with PLANTSHIELD® and Roundup Ready® PL Herbicide with PLANTSHIELD® Technology.

These requirements are designed to promote the longevity of the effectiveness of the trait and herbicides and include:

- Completion of a ROUNDUP READY FLEX® accreditation course prior to planting the trait for the first time
- Reporting any suspected glyphosate resistant weed species to a Bayer representative
- Implementing an IWM strategy

Growers should make sure they familiarise themselves with both the TUA terms and conditions and the relevant glyphosate product labels.

3. PROTECTING AN IMPORTANT TOOL – GLYPHOSATE

Herbicide resistant weeds have been a reality for decades in Australia – no herbicide is immune, including glyphosate. While the problem is significant, it is also manageable and effective mitigation strategies can reduce the risk and delay its development. In Australia, glyphosate resistant populations of several weed species have been found, including some throughout the cotton growing regions. Glyphosate is a critically important part of any IWM program on cotton farms, and growers want to make sure that the benefits it delivers are preserved and maintained. Where glyphosate resistance has occurred, it can be effectively managed through good agronomic practices. There are actions that every grower can take to prevent or manage glyphosate resistance on their property. By acting now, we can ensure the long-term sustainable use of glyphosate herbicides in cotton crops, by minimising the risk of glyphosate resistance developing.

Naturally occurring populations of some weeds may possess biotypes with resistance to glyphosate. Growers should be aware of this prior to using glyphosate and should aim to decrease the development and spread of resistant populations. If you suspect resistant biotypes are present, they should be sampled and tested. Contact the local Bayer Regional Business Manager for assistance with this process.

The WRMP aims to reduce the likelihood of glyphosate resistance developing, it does not, guarantee that resistance will not occur.

4. UNDERSTANDING YOUR GLYPHOSATE RESISTANCE RISK

Each field planted to ROUNDUP READY FLEX® cotton has its own unique risk of glyphosate resistance developing, based on its usage history, the weeds present and their population density, and other historical rotations and agronomic management strategies employed.

As a part of any sound IWM plan, growers are encouraged to assess their resistance risk prior to planting ROUNDUP READY FLEX® cotton, and when making decisions about weed management strategies. The Queensland Department of Primary Industries (DPI) have developed a “Risk Assessment Tool” which can be accessed at <https://www.cottoninfo.com.au/resistance-toolkit>. This tool can be used to help make decisions about what strategies could be used to reduce the specific risk areas on each farm, and in each field.

5. ON FARM FACTORS THAT CHANGE RESISTANCE RISKS

Factors that decrease resistance risk

- Monitoring and preventing weed control escapes from setting seed
- Planning and implementing an IWM strategy to reduce the weed seed-bank
- Strategic use of alternative knockdown herbicides and tillage in fallows prior to sowing
- Use of alternate herbicide modes of action including residual herbicides in crops and fallows
- Use of a double-knock glyphosate followed by tillage or paraquat (Group L) based products at effective rates
- Applying stewardship plans when growing glyphosate tolerant crops
- Farm hygiene to prevent importing and moving resistant seeds

Factors that increase resistance risk

- Frequent glyphosate-based chemical fallows
- Continuous reliance on glyphosate as a knockdown prior to sowing
- Inter-row use of glyphosate in grain crops (unregistered)
- Lack of tillage
- Lack of use of alternative herbicide modes of action in fallows and crops
- Allowing survivors of glyphosate applications to set seed
- High weed numbers
- Lack of crop competition on weeds
- Over-reliance on glyphosate tolerant crops as a weed control mechanism

6. RESISTANCE MANAGEMENT PRINCIPLES FOR ROUNDUP READY FLEX® COTTON

As outlined in the Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology labels, there are some guidelines for designing a successful IWM strategy. The implementation of these principals should result in the reduction in the weed population entering the ROUNDUP READY FLEX® cotton cropping phase and maximise the control of weeds that may be resistant to glyphosate. These are;

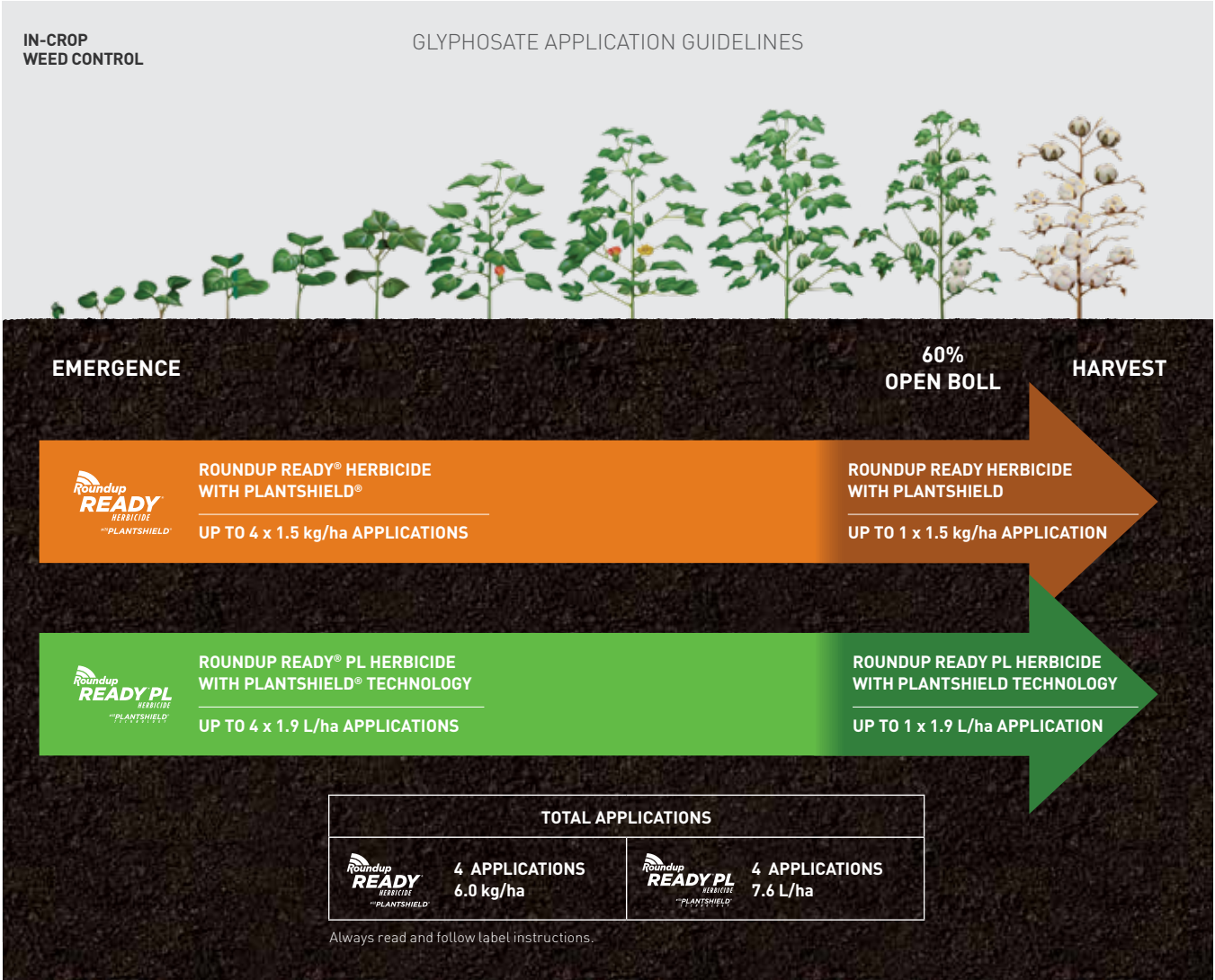
- a. Aim to enter the ROUNDUP READY FLEX® cropping phase of your rotation with a low weed burden
- b. Integrate as many different weed control options as possible through all phases of the crop rotation
- c. Make every herbicide application count – use registered rates at the correct application growth stage and always assess its effectiveness
- d. Rotate herbicides with different modes of action throughout the crop rotation
- e. Regularly monitor the effectiveness of resistance management practices
- f. Test weed populations for herbicide resistance status as a part of ongoing IWM
- g. If planting into a paddock with suspected glyphosate resistance growers must have a plan to manage such weeds

The simplest and most effective way to minimise the risk of resistance developing in a ROUNDUP READY FLEX® cotton crop is to rotate away from glyphosate immediately following the ROUNDUP READY FLEX® cotton crop. Preventing seed set from any weeds surviving glyphosate application is critical to preventing resistance development and spread – never use the same technique twice on the same weed, or weeds growing from seed produced by a surviving weed.



The following table outlines some key principles for weed control at different stages through the cotton season. For more information about any of these recommendations, see the ROUNDUP READY FLEX® cotton technical manual.

PRE-PLANT KNOCKDOWN	<ul style="list-style-type: none">• Always start clean by planting into a weed-free field using either tillage or a herbicide application• Know your field history in order to identify whether any volunteer cotton present is ROUNDUP READY FLEX®• Consider using approved tank mixes with Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology or other registered products as part of an IWM strategy
RESIDUAL HERBICIDES	<ul style="list-style-type: none">• Residual herbicides should be used where appropriate in a ROUNDUP READY FLEX® system• Consider using residual herbicides where weeds not controlled by Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology are present• The residual herbicide can be applied as a pre-emergence application (either a pre-plant incorporated application, or at planting application)• Use the recommended labelled rate and timing of the residual herbicide



IN-CROP WEED CONTROL	<ul style="list-style-type: none"> • Target the first application of Roundup Ready Herbicide with PLANTSHIELD or Roundup Ready PL Herbicide with PLANTSHIELD Technology on young cotton with weeds less than 6 cm in size • Sequential applications may be required to control new and subsequent germinations of weeds • Select the timing of sprays based on the most difficult to control weed species in each field • Post-directed sprays should be used to achieve more thorough coverage on weeds • Refer to the 'Weeds Controlled' table in the Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology labels for rate recommendations on specific weeds • Be aware of any potential contamination of spray application equipment (including mixing stations) • Ensure all equipment is thoroughly cleaned and free of residues • Only tank-mix registered products • Ensure all applications are made according to label guidelines on water volume, droplet size and environmental conditions • Be aware of off-target drift to susceptible crops and fields with both aerial and ground applications • Growers should use registered non-glyphosate in-crop herbicides where required to increase diversity of weed control tactics
LAY-BY APPLICATIONS	<ul style="list-style-type: none"> • If you currently use lay-by herbicides, then consider maintaining this program • A robust lay-by program can provide residual control of weeds not controlled by Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology • Use the recommended label rate and timing of the residual herbicide
PRE-HARVEST APPLICATION	<ul style="list-style-type: none"> • Over-the-top application of Roundup Ready Herbicide is available if required before harvest and after cotton reaches 60% open bolls, as one of the 4 applications. Rate: 1.5 kg/ha for Roundup Ready Herbicide with PLANTSHIELD or 1.9 L/ha for Roundup Ready PL Herbicide with PLANTSHIELD Technology • This application can be used to control late season weeds and improve harvest efficiency • Compatible with commonly used defoliants (see Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL with PLANTSHIELD Technology labels) • Do not use on crops intended for seed production

Bayer strongly recommends that growers consult an agronomist when designing an IWM strategy for their property. For further resources and information see www.glyphosateresistance.org.au and www.weedsmart.org.au.

7. MONITORING HERBICIDE EFFICACY

All growers or agronomists should inspect fields between 14 and 28 days after spraying with glyphosate to monitor the effectiveness of the herbicide application. During an inspection, any surviving weeds that are normally susceptible to glyphosate should be identified. The outcomes of any inspection and any remedial application used should be recorded. Any case of suspected resistance should be reported immediately to Bayer for further investigation.

8. WHAT TO DO IF YOU SUSPECT RESISTANCE

If any spray failure of Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology occurs, it is essential to determine the reason. Possible reasons for spray failures may be:

- Resistant weeds
- Poor spray application

Any weeds which are suspected to be resistant to glyphosate should be tested to confirm this. Bayer will provide support for any ROUNDUP READY FLEX® cotton growers with testing of suspected resistant weeds in a ROUNDUP READY FLEX® cotton field. Contact your Technology Service Provider (TSP) or Bayer Regional Business Manager for more information.

9. MANAGEMENT OF RESISTANT OR HARD TO CONTROL WEEDS

To maximise the effectiveness of in-crop applications of Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology, growers should base the timing of these applications on the growth stage of the most difficult to control weed species present in each field. The “Weeds Controlled” table on the Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology labels lists the weeds which glyphosate will control and rate recommendations on specific weeds. Some “hard to control” weeds will not be controlled by glyphosate and are not listed on the Roundup Ready Herbicide with PLANTSHIELD and Roundup Ready PL Herbicide with PLANTSHIELD Technology labels. Examples of these are

Fleabane (*Conyza bonariensis*) and Feathertop Rhodes Grass (*Chloris virgata* Sw.). These weeds, where present should be controlled by other means. For information and guidance on their control see the cotton pest management guide (<http://crdc.com.au/publications/cotton-pest-management-guide>), consult your agronomist or guidelines produced by QDAFF or NSW DPI.

Currently in the Australian cotton growing regions there are several weeds confirmed as glyphosate resistant, and others at high risk of developing resistance. In addition to the “hard to control” weeds, an IWM strategy should take these weeds into account and special care should be taken to control these weeds and prevent them setting seed.

a. Glyphosate-resistant grass species

There are currently ten grass weed species where glyphosate resistant populations have been identified.

- Annual ryegrass (*Lolium rigidum*)
- Awnless barnyard grass (*Echinochloa colona*)
- Liverseed grass (*Urochloa panicoides*)
- Windmill grass (*Chloris truncata*)
- Great brome grass (*Bromus diandrus*)
- Red brome grass (*Bromus rubens*)
- Sweet summer grass (*Brachiaria eruciformis*. (Sm.) Griseb.)
- Feathertop Rhodes grass (*Chloris virgata*)
- Winter grass (*Poa annua*)
- Northern barley grass (*Hordeum glaucum*)

b. Glyphosate-resistant broadleaf species

There are currently seven broadleaf weed species where glyphosate resistant populations have been identified.

- Flaxleaf fleabane (*Conyza bonariensis*)
- Tall fleabane (*Conyza sumatrensis*)
- Sowthistle (*Sonchus oleraceus*)
- Prickly lettuce (*Lactuca serriola*)
- Wild radish (*Raphanus raphanistrum*)
- Tridax daisy (*Tridax procumbens*)
- Willow-leaved lettuce (*Lactuca saligna*)

10. TOOLS

The CropLife Australia website houses information on resistant weed populations in Australia. please consult www.croplife.org.au

Mix It Up™ is an initiative, developed by Bayer, dedicated to helping growers and advisers manage herbicide resistance. Mix It Up™ offers a free resistance tracker tool, where users can discover herbicide resistance levels in their area. The tool searches herbicide resistance data that's been collected in cropping regions since 1993. Further information can be found at www.mix-it-up.com.au.

WeedSmart is an initiative that promotes the long-term sustainability of glyphosate and other herbicide use in Australian agriculture. The program provides farmers and agronomists with the latest tools and resources to manage herbicide resistance. Further information can be found at www.weedsmart.org.au.



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