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EXECUTIVE SUMMARY

Monsanto has conducted research into glyphosate usage in the cotton industry. Data was collected from over 200 growers, consultants and agronomists across the cotton growing region.

The main objectives of the research were to understand current;

- on-farm practices
- prevalence of herbicide resistance
- resistance management techniques implemented
- attitudes towards resistance

Survey results highlighted most cotton growers are managing glyphosate resistant weeds on farm. 74% of growers indicated they have resistant weeds across 22% (on average) of their fields. Growers also indicated that over half of the identified weeds are suspected resistant due to herbicide failure. Only a small number of growers were found to be using herbicide resistance testing services. However, 40% of all surveyed growers felt access to a free resistance testing program would assist on-farm resistance management.

Survey results reinforced the industry’s reliance on glyphosate for weed control, in preference to pre-emergent and post-emergent herbicides.

- Less than 50% of growers applied a pre-emergent herbicide yet, 85% of advisors recommended a pre-emergent application.
- Only 25% of growers applied a post-emergent herbicide.
- In comparison 80% of advisors recommended post-emergent herbicide use.
- 90% of growers reported excellent or very good control of in-crop weeds using glyphosate.

Survey results also indicated growers have a need for assistance to target difficult to control weeds. Furthermore, there is a knowledge gap in understanding the weeds controlled by Roundup Ready® Herbicide with PLANTSHEL® by Monsanto. In instances where weeds survived Roundup Ready Herbicide with PLANTSHEL® by Monsanto application, growers could not identify the reason. Particularly with difficult to control weeds, Fleabane, Bellvine and Peachvine. Many advisors believed that Fleabane, Feathertop Rhodes Grass and Windmill grass are on label. Finally, growers are increasingly using non-chemical practises such as inter-row cultivation and chipping as weed control strategies.

Glyphosate resistance is a significant industry issue. However, survey results have highlighted growers and advisors view the problem as manageable.

This research was driven through Monsanto’s desire to influence positive on-farm change with glyphosate product use and effective integrated weed management (IWM) practices.
METHODOLOGY

Monsanto collaborated with market research specialists, Kynetec to conduct the 2016 research program. The program was divided into two sections;

- qualitative survey
- quantitative survey

The qualitative survey involved five focus groups across major cotton growing regions. A small group of growers and advisors provided detailed attitude and behaviour information towards glyphosate resistance and IWM.

The quantitative survey consisted of 179 telephone interviews with growers and advisors across cotton growing regions. The average length of these interviews was 40 minutes. Interviews captured detailed information about on-farm management practices used to prevent and manage glyphosate resistance.

179 TELEPHONE INTERVIEWS
KEY FINDINGS

Weeds on Farm

Top 5 weeds

Growers and advisors identified five main weeds targeted for control in cotton (subject to regional variation);

- Fleabane
- Barnyard Grass
- Milk/Sow Thistle
- Feathertop Rhodes Grass
- Peachvine

These weeds are targeted in both pre-planting and fallow periods.

The weed spectrum targeted for control is seasonally dependent. However, the top five weeds identified by growers has proven consistent with Monsanto’s previously conducted Post Spray Surveys.

Figure 1. Percentage (%) of respondents identified main weeds for control prior to planting and within the cotton cropping phase.
Fleabane – A difficult weed

- Fleabane was identified as the most difficult weed to control
- 65% of respondents identified Fleabane in their top five most difficult weeds to control

Whilst the top five weeds identified are difficult for growers to control on farm, this is not due to glyphosate resistance. Three of the top five weeds identified; Fleabane, Feathertop Rhodes Grass and Peachvine are not registered for control with Roundup Ready Herbicide with PLANTSHEILD by Monsanto.

**Figure 2. Percentage of respondents that have identified weed as difficult to control.**

65% IDENTIFIED FLEABANE MOST DIFFICULT WEED
GLYPHOSATE RESISTANCE

Three quarters of cotton growers interviewed identified that suspected glyphosate resistant weeds were present on their farm. Only 22% (on average) of fields contained weeds that were confirmed to be resistant. (figure 3).

Figure 4 details the on-farm location of glyphosate resistant weed species, represented as a percentage of surveyed growers. Resistant weeds are most likely to be located:

- in crop (61%)
- irrigation channels and ditches (59%).
- fencelines (42%)
- fallow areas (40%)

The varied weed locations identified in figure 4 emphasises that resistance can become an issue anywhere on farm, with some areas more difficult to manage than others.

For further information on weed management in challenging locations, such as fencelines refer to:

Weedsmart (www.weedsmart.org.au)


Figure 3. Glyphosate Resistance by percentage of growers and area (22% on average).

Figure 4. Location of glyphosate resistant weeds (n=105)
Three of the five weeds identified as most difficult to control (Fleabane, Feathertop Rhodes Grass and Peachvine) are not registered for control with Roundup Ready Herbicide with PLANTSHIELD by Monsanto.

Of the 74% of growers who indicated they had glyphosate resistance, further information was sought on weed species.

Fleabane and Feathertop Rhodes Grass were the two major weeds identified as glyphosate resistant (figure 5), also the two most difficult to control weeds (figure 2). It is critical to note that neither of these weeds are listed on the Roundup Ready Herbicide with PLANTSHIELD by Monsanto label. Therefore, will not be controlled by the product.

Figure 5 shows many growers are identifying glyphosate resistant populations of Annual Ryegrass and Barnyard Grass on-farm. However, these results are very region specific. Southern NSW, Central NSW and the Namoi valley report a higher prevalence of glyphosate resistant Annual Ryegrass. In contrast, Border Rivers reports higher rates of glyphosate resistant Barnyard Grass.

Figure 6 indicates high numbers of both growers and advisors believe Roundup Ready Herbicide with PLANTSHIELD by Monsanto *should* control weed species; Fleabane, Feathertop Rhodes Grass and Windmill Grass. It is critical growers and advisors understand product label registrations to ensure effective control of target weed species. Further information on the weeds controlled by Roundup Ready Herbicide with PLANTSHIELD by Monsanto can be found at www.monsanto.com.au
Despite 74% of growers believing they have glyphosate resistant weeds present on farm, only a third of cases have been independently verified. Over half of all cases of herbicide resistance were assumed due to surviving weeds (Figure 7).

Growers and advisors highlighted access to resistance testing would be a valuable tool in managing resistant weeds. 40% of growers indicated they would utilise a free resistance testing program.

In response to this finding, Monsanto have developed a free herbicide resistance testing program. This allows growers to test five key weeds for resistance to three important herbicides. Further details on the program can be obtained by contacting your Monsanto Regional Business Manager.

Figure 6. Belief that three key non-label weeds are actually present on the Roundup Ready Herbicide with PLANTSHIELD by Monsanto label.

Figure 7. Method used by growers to determine whether a surviving weed is herbicide resistant.
Survey results have shown resistance to non-glyphosate herbicides is present in low levels. Figure 8 shows that only a small proportion of fields have weeds identified as resistant to other herbicides. Eighty percent (80%) of fields did not have any other herbicide resistant weeds present.

Despite the low level of fields with resistance to non-glyphosate products, there was concern about development of resistance to other herbicide groups. Over 50% of growers and 95% of advisors surveyed expressed concern about resistance development to Group A herbicides. There was also an awareness of resistance development in other herbicide groups (figure 9).
Survey results indicated most growers were active in on-farm weed management decisions, rather than delegating to an advisor or other third-party. Results also indicated 86% of growers rely on paddock inspections to determine their tailored management plan. This is in preference to a set weed management program.

Cotton growers average 5.3 applications of glyphosate per entire cotton growing season. This equates to average applications of:

- 2.1 during fallow
- 0.5 at sowing and
- 2.7 post emergent.

However, application frequency is regionally variable.

As shown in figure 10, growers continue to be happy with the performance of glyphosate. 90% rated the level of control achieved as Excellent or Good. The continued performance of glyphosate is pivotal to the success of the Roundup Ready® Flex cotton system.

Survey responses indicate growers are relying heavily on glyphosate. The majority are not using any other herbicide in pre-emergent or post-emergent application windows. Despite 85% of advisors recommending a pre-emergent application and 80% recommending a post-emergent application. Results show only 42% of growers applied a pre-emergent herbicide and 26% a post emergent herbicide.

Following identification of glyphosate resistant Annual Ryegrass and Barnyard Grass (figure 5), incorporation of a post-emergent grass herbicide may be a valuable strategy.
Figure 11. Use of non-glyphosate herbicides (pre-emergent and post-emergent) recommended by advisors and implemented by growers. Where implemented, the herbicide groups used.
Eighty percent (80%) of growers undertook non-herbicide control of surviving weeds on farm. Of these control strategies implemented, inter-row cultivation and chipping were most common. On average, surveyed growers and advisors considered;

- inter-row cultivation effective in removing surviving weeds (90%*)
- Chipping (86%*)

Research continues to demonstrate that successful IWM strategies use of a range of chemical and non-chemical techniques. The survey highlights grower understanding of IWM, and the importance, with most successfully integrating IWM within their farming systems (figure 12).

* % of total survey respondents

**Figure 12: Management practices used to prevent and manage development of herbicide resistance.**
CONCLUSION

Results obtained from the 2016 weed resistance management survey have provided an overview of:

- the prevalence of resistant weeds,
- grower management strategies and
- actions taken to prevent/manage weeds into the future.

The data suggests that there is an emerging issue with glyphosate resistance. 74% of growers indicated resistant weed presence across 22% (on average) of their fields. The survey has shown growers are active in making weed management decisions. Most growers are implementing an IWM strategy, comprising of several varied and targeted practices to eliminate weeds and manage weed seed banks.

Glyphosate continues to perform well, with 90% of growers rating its efficacy as good or excellent. This is vital in supporting Roundup Ready Flex technology and cotton farming systems. There are some knowledge gaps within industry regarding weeds controlled by Roundup Ready Herbicide with PLANTSHIELD by Monsanto, highlighting the requirement for further product education and importance of alternate management strategies for weeds not controlled by glyphosate.

In summary, cotton growers and advisors have robust systems in place for preventing and managing herbicide resistance, however, should continue to remain vigilant to protect vital herbicide groups into the future.

90% GROWERS RATE EFFICACY OF GLYPHOSATE AS GOOD OR EXCELLENT
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Front cover photograph: Robert Reardon and Tristram Hertslet, 2015 Monsanto cotton growers of the year, Worral Creek, Talwood, Queensland and Tom Luff, Monsanto Regional Business Manager.