Herbicide resistance in Australian cotton farming systems – a journey through time

By Eric Koetz, Research Agronomist, NSW DPI

TRADITIONAL agriculture relied heavily on horsepower and steel during the 1950s–1980s. The minimum till and no till revolution that has followed has allowed growers to grow more with less by maintaining ground cover and capturing more water allowing crops to be grown even in low rainfall years. How has this change manifested itself in the Australian cotton industry? The move away from cultivation was a slow process until the adoption of Roundup Ready cotton in the early 2000s.

In the 1990s, Australian cotton farmers relied on a range of chemical and mechanical tools to control weeds in their fields. Weed control relied on large inputs of herbicide followed by the inevitable hand chipping to control escapes or survivors.

Graham Charles reported in 1991 that the cost of weed control from a survey of growers in 1989 averaged $187 per hectare with herbicides accounting for $76 and chipping $67. In 2018 the Australian Cotton Comparative Analysis reported herbicide cost was $134 per hectare and chipping was $4 per hectare. The relative reduction in costs can be attributed to the introduction of Roundup Ready cotton in the early 2000s.

This system evolved quickly to a relatively simple weed management plan of applying four glyphosate applications in crop. Early results were impressive with many problem weeds disappearing from the cotton farming landscape and chipping crews no longer required in the majority of fields.

A journey through time shows that weed spectrums have indeed changed with the introduction of new technologies and stewardship programs.

The Australian cotton industry has been supporting weed surveys for almost 30 years. Surveys conducted in 1990 and again in 2001 prior to the introduction of Roundup Ready cotton by Graham Charles show that fields were infested with predominantly broadleaf weeds (Table 1).

By 2010 broadleaf weeds still dominated cotton fields, but there was a change in species. Much like broadacre no-till systems, cotton started to rely on knockdown herbicides for the majority of weed control, especially in fallows. A species shift was noticed in cotton with common broadacre weeds such as fleabane and sowthistle becoming increasingly common in cotton fields (Table 1).

TABLE 1: Weed surveys in Australian cotton through time

Ranking	1991	2001	2010
1	Noogoora burr	Peachvine	Flaxleaf fleabane
2	Cyperus species	Bladder ketmia	Sowthistle
3	Bathurst burr	Nutgrass	Peachvine
4	Nightshade species	Awnless barnyard grass	Bindweeds
5	Bladder ketmia	Rhyncosia	Dwarf amaranth
6	Cowvine	Annual verbine	Bladder ketmia
7	Thornapple	Volunteer cotton	Caustic weed
8	Caltrop	Nightshade species	Awnless barnyard grass

The situation today

Surveys conducted across cotton farming regions in the 2015–16 and 2017–18 seasons have given us another picture in time of the species shift in the past 10 years. While broadleaf weeds dominated cotton fields in the 1990s and early 2000s, glyphosate proved to be a very effective management tool. But there was a significant change in the species recorded in cotton fields. Some 15 years after Roundup Ready cotton was introduced (Table 2), grasses are now the dominant weed in the majority of cotton fields.

This scenario reflects similar patterns to broadacre cropping systems where summer grasses have emerged as problematic weeds. The first reports of glyphosate resistance occurred on the

Inter row spraying, able to apply in-crop residual and knockdown herbicides to add diversity to the system.

Liverpool Plains when grasses started to survive applications of glyphosate in summer fallows.

As we approach 20 years of Roundup Ready cotton in Australia we are starting to detect increases in glyphosate resistance amongst grass and broadleaf weeds. Herbicide resistance screening of the samples collected in 2015–16 and 2017–18 have recorded significant levels of resistance to glyphosate. Among the six most problematic weed species in cotton fields, glyphosate resistance has reached alarming levels (Table 3).

These weeds are proving difficult to control in a glyphosate dominant management system. Consequently there has been a switch to include a more integrated approach to weed management with the inclusion of pre-emergent and residual herbicides into weed management plans.

The cotton industry has been very proactive in developing a stewardship program around integrated weed management. The addition of in-crop tillage has also proven to be a useful tool for controlling late emerging weeds in crop and controlling survivors of herbicide application.

This approach is the cornerstone of the Herbicide Resistance Management Strategy developed by the cotton industry. As a result of the diverse approach to weed control adopted by Australian cotton growers we still have good efficacy with glyphosate as our main herbicide and various pre-emergent, OTT and layby herbicides with different modes of action available. When you add targeted tillage, the system is very robust and will remain that way as long as we remain focussed on controlling survivors from glyphosate applications.

TABLE 2: Weed ranking in cotton valleys

	2015–16			2017–18		
	1	2	3	1	2	3
Darling Downs	FTRG	Flb	ABYG	FTRG	WMG	B Ket
Border Rivers	Flb	FTRG	ABYG	ABYG	FTRG	B Ket
Gwydir	ABYG	FTRG	Flb	FTRG	ABYG	Peachvine
Namoi	WMG	Flb	ARG/ ABYG	FTRG	ABYG	Peachvine
Macquarie	WMG	ARG	Flb	WMG	ABYG	ST
Southern Valleys	ABYG	ARG	Flb	ARG	ST	Flb

FTRG = feathertop Rhodes grass.
WMG = windmill grass.
Flb = fleabane,
ABYG = awnless barnyard grass.
ARG = annual ryegrass.
ST = sowthistle
B Ket = bladder ketmia.

TABLE 3: Glyphosate resistance (%) in six common weeds in Australian cotton fields

Weeds	2015–16	2016–17	2017–18
Fleabane	97	75	NT
Sowthistle	22	10	28
Barnyard grass	72	65	57
Windmill grass	90	45	44
Feathertop Rhodes grass	20	35	40
Annual ryegrass	NT	NT	83

NT not tested.