GRDC FOCUS DELIVERS GAINS IN HERBICIDE RESISTANCE MANAGEMENT

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Herbicide resistance poses one of the greatest challenges to the future viability of Australian cropping systems, costing growers more than $200 million annually.

The challenge

Australian grain growers have become increasingly reliant on herbicides to control weeds over the past 30 years with the transition to minimum and zero tillage farming systems.

Weeds which have evolved resistance to herbicides have placed significant pressure on existing herbicides - more than 35 cropping weed species in Australia now have populations that are resistant to at least one herbicide mode of action (MOA) group and many are being found to be cross-resistant to multiple herbicide MOAs.

The discovery of new effective chemistry has slowed over recent decades, with this trend expected to continue.

Herbicide resistance can develop through the selection of naturally occurring resistant weeds; the movement of resistant genes through pollen; or the importation of already-resistant weed seeds through flood, animals, or practices such as the purchase of contaminated grain or feed and use of contaminated machinery. Species shift to naturally tolerant species also occurs.

More diverse strategies embracing non-herbicide control tools must be developed and adopted to help preserve herbicide efficacy in Australian cropping systems.

At the same time, it's important that research targets the biochemical and molecular resistance mechanisms responsible for endowing herbicide resistance, the biology and ecology of major crop weed species and monitoring the extent of herbicide resistant weed populations.

Investing in these research areas will ultimately guide future best-practice integrated weed management recommendations and help mitigate herbicide resistance development across Australian cropping regions.

The response

GRDC's national investment in herbicide resistance research, development and extension has been channelled through several research partners including the Perth-based Australian Herbicide Resistance Initiative (AHRI), the University of Adelaide and the University of Sydney.

AHRI attracts an annual investment contribution of over $1.5 million from GRDC and its work encompasses three key areas as well as a communications program.

- **Resistance evolution** - involves regular large-scale random field surveys to collect weed seeds of key cropping weeds which is part of a national herbicide resistance survey investment.

This area of research is essential for monitoring on-going herbicide sustainability and helps establish changes in the extent of herbicide resistance.

- **Resistance mechanisms** - investigation into the biochemical and molecular genetic basis of novel herbicide resistance in Australian major crop weeds. This work is furthering researchers' understanding of how Australian crop weeds develop resistance to herbicides. The information is widely disseminated and, when relevant, incorporated into management strategy recommendations.
- **Resistance management** - a program focussed on maximising crop production/sustainability while minimising crop-weed and herbicide resistance problems in Australian grain crops.

The University of Adelaide is also undertaking a range of leading weed science research programs addressing integrated weed management, herbicide resistance, weed ecology and crop-weed interactions in agricultural systems. Some of these investments include:

- Mechanisms, evolution and inheritance of resistance.
- Weed management in Australia's southern region mixed farming systems: strategies to combat herbicide resistance in southern Australian mixed farming systems.
- Emerging weeds (seed ecology).
- Cultural management for weed control and maintenance of crop yield.

The University of Sydney is coordinating a multi-faceted weeds research program in conjunction with Charles Sturt University, the New South Wales Department of Primary Industries, the University of Queensland and the Queensland Department of Agriculture and Fisheries. The weeds research project operates under five key themes:

- **Herbicide innovation** - resistance screening and new uses of existing chemistries, as well as evaluating chemistries prior to their commercial release.
- **Crop competition** - evaluation of the role tightened row spacing and increased plant density can have on reducing the impact of weeds.
- **Strategic weed biology** - examining weed biology to find each species' Achilles heel, which could be a short-lived seedbank or susceptibility to competition from taller crops.
- **Cover crops and mulches** - using a mixture of species to limit or remove the need for spraying fallow and build up organic matter. Includes evaluation of cover-crop termination times to preserve soil moisture prior to cash cropping.
- **Engineering innovation** - evaluating and developing mechanical and digital ways of mapping, identifying and killing weeds and their seeds. This includes harvest weed-seed control, mapping and site-specific mechanisation, as well as the ability of non-chemical methods such as lasers to control weeds.

Recognising the importance of disseminating the outcomes and practical implications of research undertaken by its research partners, GRDC, along with other partners, contributes to WeedSmart – an industry-led initiative to enhance on-farm practices and promote the long-term sustainability of herbicide use.

WeedSmart primarily uses digital media such as the internet, Facebook, Twitter and an app to offer information and advice to growers in the form of fact sheets, case studies, podcasts, webinars, videos and `ask an expert' question and answer opportunities.

WeedSmart's messaging is based on the `Big Six' - a series of practical easy-to-follow management tactics and supporting research information to help growers produce more crop and less weeds to combat the evolution of resistance to herbicides.

The plan incorporates the rotation of crops and pastures, using the double knock at critical times, mixing and rotating herbicides, stopping weed seed set, utilising crop competition and harvest weed seed control.

With glyphosate being one of the most important and widely-used knockdown herbicides in Australian cropping systems, GRDC also supports the Australian Glyphosate Sustainability Working Group (AGSWG). The AGSWG is a collaborative initiative involving key research and development-based crop protection companies aimed at promoting the sustainable use of glyphosate in Australian agriculture. The work of the AGSWG is vitally important with 17 weed species now confirmed to have glyphosate-resistant populations in Australian cropping systems.

In addition to progressing herbicide resistance RD&E on a national front, GRDC signed a five-year $45 million Herbicide Innovation Partnership agreement with Bayer CropScience in 2015 to address the global slow-down in chemical weed-control research over the past 20 years and the consequent absence of new herbicides.

With the cost of discovering and delivering a new herbicide to market far beyond GRDC's resources, typically exceeding US$250 million, it's imperative that GRDC enters into these types of commercial partnerships to ensure Australian weeds are incorporated in international screening and testing research. Additionally, under the agreement, any new compounds used in other countries such as the United States, Canada, or in Europe, will earn GRDC a royalty that will be reinvested into Australian grains research.

The impact

ABARES AGSURF data shows that the cost of chemical use has increased from $78.72 per hectare in the 5-year period 2011-2015 relative to $88.03 per hectare in the period 2016 to 2020 which is a 11.8% increase.

In the same two periods grain income only increased by 5.6% from $629/ha to $666/ha. It is expected that in wet years chemical costs will rise, however, crop yields should also increase. GRDC's objective is to hold costs constant relative to income.

Analysis has shown that GRDC investment into herbicide resistance over the past 25 years has returned a benefit-to-cost ratio of $3.50 for every dollar invested.

This is exemplified in the research and extension activities which have delivered significant practical benefits to the Australian grains industry. Among those achievements are:

- Extensive research and communication on the efficacy of harvest weed seed control leading to the widespread adoption of these tools. This includes involvement in the development of the now-commercialised integrated Harrington Seed Destructor.
- Pivotal early AHRI research established the promise of Sakura (pyroxasulfone) for use in Australian grain cropping systems, resulting in the early introduction of Sakura to Australia.
- Development, communication and implementation of the Ryegrass Integrated Management (RIM) model, simulating profitable cropping and management and control of ryegrass in Australian grain farming systems.

On a communications and extension front, activities conducted by GRDC's major research partners are proving successful in generating herbicide resistance awareness and management change among growers.

The 2021 Grower Practice Survey showed that growers were moving into alternative methods to control weed seedbanks including crop toping, chaff carts, chaff lines, seed impact mills, and spraying under wind rows.

Validation

Western Australian grain grower Gary Lang has taken a proactive approach to weed control on the family's 5000 hectare farming operation near Wickepin, south east of Perth, in a bid to avoid the management challenges of herbicide resistance.

His strategy is multi-faceted and includes the use of crop competition, strategic crop selection, chaff decking and herbicide applications.

While this has helped drive down the weed seedbank and dramatically reduce weed numbers, Gary is continually looking to instigate further improvement and accessing up-to-date research information is a critical part of ensuring his strategy is as targeted and effective as possible.

“Herbicide resistance represents a significant threat to profitability if you are forced to take country out of production, so we have tried to get on the front foot with our weed management. We want to continue making crop choices that are not dictated by herbicide resistance in weeds,” he said.

“A key part of achieving that is access to research information and industry expertise whether through WeedSmart or a third party like an agronomist; this information underpins every management decision we make.

“The biggest testament to our weed strategies came in 2018 when around 80 per cent of our winter crop was planted before there was any weed germination. So we used very little glyphosate as a knockdown herbicide and suffered minimal yield loss due to weeds which is a fantastic achievement.

“This was mirrored across Western Australia – out of 16 million tonnes of grain harvested state-wide in 2018, probably 12 million tonnes were grown without a knockdown herbicide treatment. That’s what herbicide resistance management is all about.”

The outlook

Herbicide resistance will continue to be a leading investment priority for GRDC as part of its drive to deliver enduring profitability to Australian grain growers.

GRDC remains focused on RD&E investments that improve yield and yield stability and optimising input costs.

The development and implementation of effective integrated weed management options will play a key role in meeting these targets and help industry address challenges such as pressures on herbicides due to resistance, limits to new molecule discovery and management of community expectations.

References and resources

Australian Herbicide Resistance Initiative
https://ahri.uwa.edu.au/

ABARES 2021 AGSRF database
https://apps.agriculture.gov.au/agsurf/

WeedSmart
https://weedsmart.org.au/

Weeds team aims to keep northern growers ahead of resistance
https://grdc.com.au/resources-and-publications/groundcover/groundcover-july-august-2018/weeds-team-aims-to-keep-northern-growers-ahead-of-resistance

Impact of Weeds on Australian Grain Production
www.grdc.com.au/ImpactOfWeeds

GRDC Integrated Weed Management Manual
https://grdc.com.au/resources-and-publications/all-publications/publications/2019/iwmm

GRDC Organisational Performance Research – 2017 Grower Survey Report

GRDC Farm Practices Survey Report 2016

GRDC Farm Practices Survey Report 2021 Table 68, p 96.

Ground Cover Herbicide Resistance supplement May-June 2013, Making Herbicides Last