When is a weed resistant?

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Herbicide resistance has been simply described as an induced inherent ability of some plant species to survive and reproduce after receiving a lethal dose of herbicide. Globally, herbicide resistance has been confirmed in 187 weed species across more than 300,000 paddocks in a range of modes of action (Figure 1). In Australia herbicides are classed according to groups based on their mode of action. Herbicide resistance has been confirmed in 11 of the 19 mode of action groups.

Resistance is a costly problem. If resistance develops, growers have to use alternate control measures or herbicides, and these can be more expensive and/or less effective. In some cases, growers will not be able to grow certain crops, or may have to change their farming system to include more tillage.

Understanding if weeds are resistant to a particular herbicide is not clear cut. Some weeds are tolerant to the application of a specific herbicide, but this does not necessarily mean that they are resistant weeds. To declare a weed to be resistant the international survey of resistant weeds has stated that it must fulfil five criteria:

- Fulfilment of the Weed Science Society of America definition of resistance and the survey's definition of a herbicide-resistant weed;
- Data confirmation using acceptable scientific protocols;
- The resistance must be heritable;
- Demonstration of practical field impact; and,
- Be a weed identified to species level and not be the result of deliberate/artificial selection.

The use of these worldwide criteria provides a uniform definition to provide continuity – meaning any development of resistance can be tracked.

For the first criteria the Weed Science Society of America defines herbicide resistance as being: "The inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. In a plant, resistance may be naturally occurring or induced by such techniques as genetic engineering or selection of variants produced by tissue culture or mutagenesis."

This criteria sets the basis for resistance but does not relate it to any in-field practical significance. The additional criteria incorporate both scientific and practical considerations which are important. For example, the failure of a herbicide to act against a weed that is not labelled or is not agriculturally important, although it may be scientifically interesting.

Herbicide resistance present at a low level can also be established using these criteria. This is important as when a weed population starts to develop resistance, it responds favourably to a change in control tactics for only a small period of time after detection.

Early recognition that a weed population has developed resistance means appropriate management strategies can be tailored to minimise the potential spread of the resistant weed and the impact of the resistance on the cropping system.

GLYPHOSATE RESISTANCE

Glyphosate, the active ingredient in Roundup herbicides is a Group M herbicide. Since its commercial introduction over 30 years ago, glyphosate has become the most used herbicide worldwide. This is due to its highly effective broad-spectrum efficacy and its high level of environmental safety. In recent years glyphosate resistance has been confirmed in biotypes of 13 weed species globally.

In Australia weed resistance to glyphosate is rare but does exist in a number of annual ryegrass, barnyard grass and liverseed grass populations. In fact, Australia was the first country to confirm resistance to glyphosate with resistant annual ryegrass discovered in 1996.

The national glyphosate sustainability working group (www.weedscrc.org.au/glyphosate) lists a number of factors that are implicated with glyphosate resistance:

- Continuous reliance on glyphosate pre-seeding;
- Lack of tillage;

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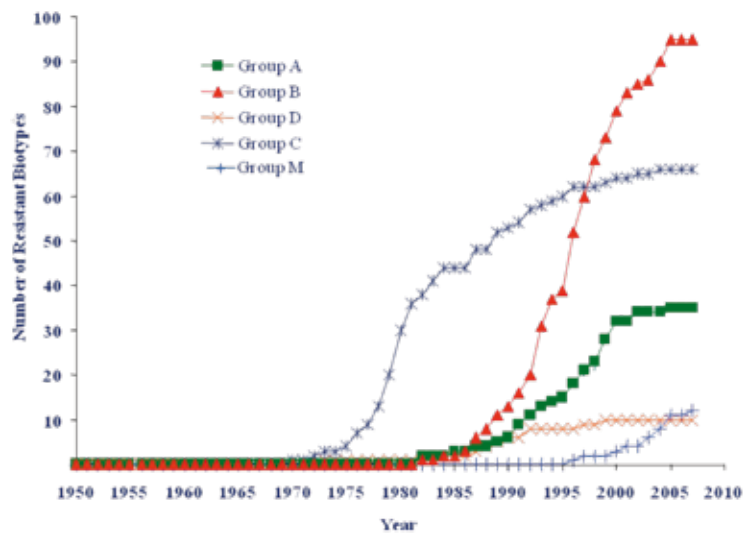
FIGURE 1: Development of herbicide resistance worldwide in different herbicide groups



(Adapted from Ian Heap; www.weedscience.com).
*Group D cases do not include chlorthal.**Group C cases only includes triazines, does not include ureas, nitriles, etc. ***Glyphosate is a Group M Herbicide.

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- Lack of effective in-crop weed control;
- Frequent glyphosate-based chemical fallow;
- Inter-row glyphosate use (unregistered);
- Frequent crop topping with glyphosate; and,
- High weed numbers.

These common factors show that with a proper integrated weed management approach the risks of glyphosate resistance can be managed. Using other mode of action groups in the crop rotation, ensuring good spray application with a high level of weed control and using robust rates will all reduce the chance of resistance developing.

All weed populations contain individual plants that are resistant to herbicides. Repeated use of any herbicide will expose weed populations to selection pressure, allowing resistant plants to survive and increase (Figure 2). It is the use pattern imposed on glyphosate, and not glyphosate itself, that is the issue.

It is fundamentally an over reliance on one weed control tool.

GLYPHOSATE RESISTANT CROPS

With the introduction of glyphosate resistant crops in to the Australian cropping system (cotton in 2000 and canola in 2008) there has been an increased focus on the sustainability of glyphosate in the cropping system.

Monsanto has developed resistance management plans for cotton and canola to steward both the technology and the herbicide to ensure they remain effective tools in the cropping system.

These management plans have been studied by external scientists to ensure the rigour of the science.

This work supports the resistance management strategies already put in place to prevent seed set from survivors of glyphosate applications by using alternative weed control options. An important aspect of the crop management plan is the accreditation course, through which growers are educated on the principles of resistance management and the importance of implementing an integrated weed management strategy.

In canola, Monsanto has worked with leading weed researchers in Australia since 1998 to develop the Resistance Management Plan. The RMP for Roundup Ready canola utilises the Paddock Risk Assessment and Management Option Guide (PRAMOG) as a step-by-step risk assessment process on a paddock by paddock basis. The three steps are:

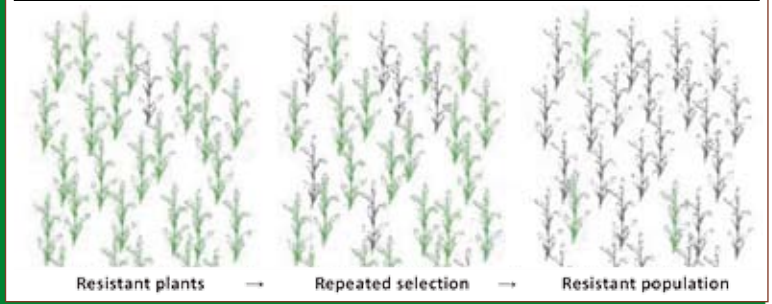
- An evaluation of glyphosate use history in the paddock;
- A determination of glyphosate resistance 'risk status' for annual ryegrass; and,
- A choice of management actions based on risk.

The application of Roundup herbicide in Roundup Ready canola, provides more flexibility in timing of application and the range and size of weeds that can be controlled in one application.

Roundup herbicide can control weeds with established resistance to other groups of herbicides, for example Group A or Group B resistant weeds. Controlling these weeds in the canola rotation stops weeds from setting seed, which reduces recruitment to the weed seed bank, and controls weed proliferation in following crops in the rotation.

The availability of Roundup Ready canola therefore also supports the sustainable use of triazine tolerant (TT) and (IMI) herbicide systems in pulse crops such as lupins. ■

FIGURE 2: Change in resistant plant frequency in the farming system



Application of Roundup Ready herbicide over the top of Roundup Ready canola at the six-leaf stage. (Photo: Nufarm)

OUT OF AFRICA

Pictured is a clever and simple device made by Laurie Sessions, a wheat farmer from Kenya. Laurie found some pieces of scrap pipe of the right diameter (3") and cut grooves in the end with an angle grinder.

Attaching a 'T' handle on the end is optional. These low cost aids make opening chemical drums quick and easy.

Photos taken and supplied by Robert Ward, Austarm Machinery Pty Ltd, Email: austarm@austarm.com