Group A Herbicide Resistance

in Tasmanian ryegrass populations

National Vegetable Extension Network
TASMANIA

Recent surveys of Tasmanian ryegrass (Lolium spp.) populations have shown a significant increase in Group A herbicide resistance. John Broster (Charles Sturt University) found an increase in resistance from 18% in 2010 to 46% in 2015 to diclofop-methyl 'Fop' and sethoxydim 'Dim' herbicides

Group A herbicides consist of three families, 'Fops', 'Dims' and 'Dens' (Table 1). Group A and B herbicides have a higher risk for resistance than other groups. As few as six applications of a Group A herbicide to a population can result in resistant individuals.

This risk of herbicide resistance is well known to mainland cropping systems in southern Australia. There have been significant increases in resistance over these regions, with Group A resistance surveyed in 2010 with almost 100% of populations resistant.

Table 1: List of Group A herbicides (Sourced from: CropLife Australia)

CHEMICAL FAMILY	ACTIVE CONSTITUENTS
Aryloxyphenoxypropionates (Fops)	clodinafop (Topik®), cyhalofop (Barnstorm®), diclofop (Cheetah®Gold, Hoegrass®, Decision®), fenoxaprop (Cheetah® Gold, Wildcat®), fluazifop (Fusilade®, Fusion®), haloxyfop (Verdict®), propaquizafop (Shogun®), quizalofop (Targa®)
Cyclohexanediones (Dims)	butroxydim (Falcon®, Fusion®), clethodim (Select®), profoxydim (Aura®), sethoxydim (Cheetah® Gold, Decision®), tralkoxydim (Acheive®)
Phenylpyrazoles (Dens)	pinoxaden (Axial®)

Key messages

- **The selection of resistant weeds can occur in just 3-4 years if herbicide groups (Modes of Action) are not rotated.**
- **If you are experiencing poor results from your herbicides in spite of timely, correct application, then you may have herbicide resistant weeds.**
- **Minimise the risk of resistance or slow down the rate of further resistance by using a range of management options.**

Although the frequency of herbicide resistance in Tasmania is still quite low in comparison with these regions, it poses a significant risk to the industry if it continues to follow the same trends. To reduce this risk, it is important that producers and their advisors continue to follow Integrated Weed Management (IWM) practices.

What is herbicide resistance?

Herbicide resistance is defined as the inherited ability of an individual plant to survive and reproduce following a herbicide application that would kill a 'wild-type' individual of the same species.

As of November 2016, 47 weed species in Australia were resistant to at least one herbicide Mode of Action.

Resistant individuals are present in weed populations prior to their exposure to herbicides. The incidence of these individuals varies greatly between species.

If the same herbicide Mode of Action is applied repeatedly, and survivors are not killed before seedset with an alternative Mode of Action or method, the proportion of resistant individuals will increase (see Figure 1).

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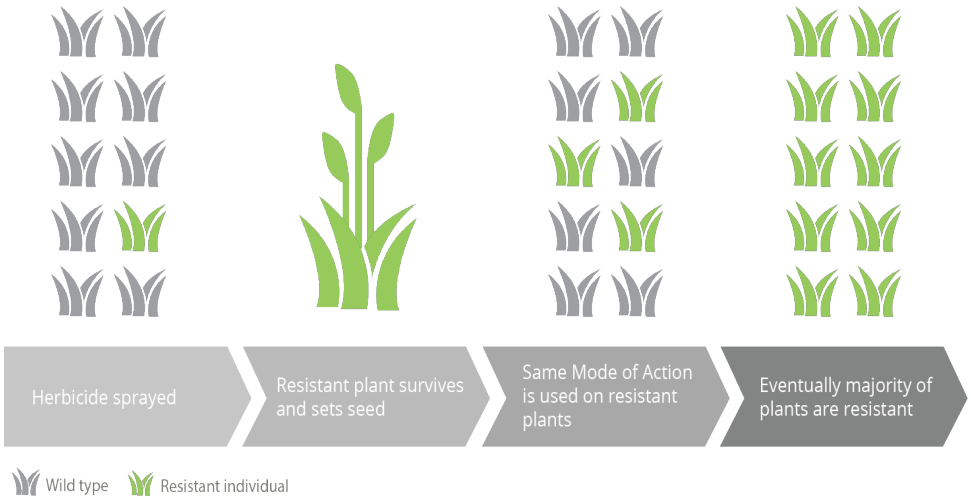

Figure 1: Development of resistance in the plant population

Resistance Managment

An integrated approach, using a combination of chemical, cultural, mechanical and biological risk-decreasing actions is recommended. It is important to not rely on herbicides alone.

A useful way of reducing your risk of herbicide resistance is by using a combination of tactic groups. Each tactic group provides a key opportunity to control weeds, depending on management objectives for the crop and the target weed's growth stage. The table below (Table 2), provides an overview of the groups and their associated tactics. Integrating tactic groups reduces weed numbers and seedbank stores, whilst minimising the risk of resistant weed development.

The following table has been adapted for vegetable crops from the resource Integrated Weed Management in Australian Cropping Systems developed by the Grains Research and Development Corporation (GRDC), and can be found at at www.grdc.com.au/IWMM

Table 2: Tactic groups used to aid in weed management planning (Adapted from: GRDC)

TACTIC GROUP	OPPORTUNITY	WEED IMPACT	TACTIC
TG 1 Minimise weed seeds in the target area soil seedbank	Fallow, Stubble, Pre-sowing, Pasture phase	Encourage germination of weed seeds (subsequently killing them)	• Autumn tickle • Delayed sowing (seeding) • Stale/false seed bed
		Reduce viability of weed seed in the seedbank	• Burning residues • Inversion ploughing • Grazing crop residues
		Reduce germination of weed seeds	• Permanent beds • Reduced tillage
		Removal of weed seeds from the seedbank	• Grazing crop residues • Grazing - actively managing weeds in pastures • Encouraging insect predation of seed

TACTIC GROUP	OPPORTUNITY	WEED IMPACT	TACTIC
TG 2 Kill weed(s) (seedlings) in the target area	Fallow Pre-sowing Early post-emergent Pasture phase	Kill weeds, particulary seedling weeds	• Fallow and pre-sowing cultivation • Burning residues • Knockdown (non-selective) herbicides for fallow and pre-sowing control • Double knockdown or 'double-knock' • Pre-emergent herbicides • Selective post-emergent herbicides • Inter-row shielded spraying and crop row band spraying • Inter-row cultivation • Spot spraying, chipping, hand rouging and wiper technologies • Mulching (plastic or biodegradable) • Hand weeding
TG 3 Stop weed seed-set	Pasture phase Late fallow Late stubble In-crop	Controlling weed seed-set while maintaining yield	• Spray-topping with selective herbicides • Crop-topping with non-selective herbicides • Wiper technologies • Crop dessication and windrowing • Pasture spray-topping • Grazing - actively managing weeds in pastures • Spot spraying, chipping, hand rouging and wiper technologies • Silage and hay - crops and pastures
		Controlling weed seed-set while sacrificing yield	• Renovation crops and pastures - green manuring, brown manuring, mulching and hay freezing

TACTIC GROUP	OPPORTUNITY	WEED IMPACT	TACTIC
TG 4 Prevent viable weed seeds within the target area being added to the weed seedbank	Pasture phase Late crop salvage Harvest	Physical removal of viable seed from paddock	• Managing weeds in non-crop areas (e.g. headlands, irrigation lines) • Silage and hay - crops and pastures • Weed seed collection at harvest • Crop dessication and windrowing • Burning residues • Grazing crop residues • Hand roughing
TG 5 Prevent introduction of viable weed seed from external sources	Sowing Fallow Stubble In-crop Pasture phase Farm operations Livestock feeding	Whole-farm hygiene	• Sow weed-free seed • Clean farm machinery and vehicles • Manage livestock feeding and movement • Mown or concrete tracks between sites

Principles to reduce the risk of herbicide resistance

1. Rotate and mix

Following the label; rotate, mix or use sequential treatments of herbicides with different Modes of Action. The mode of action can be found on the label (Figure 2).

Figure 2: The Mode of Action of herbicides is clearly stated on the herbicide label

2. Follow the label and recommendations

Follow the recommended rates, timing and equipment; and spray in ideal weather conditions with the correct nozzles, speed, water volume, water quality and adjuvant, if needed. Many modern formulations contain an adjuvant. Check the label to see if it is required. Aim to stop weed escapes as they are more likely to select for resistance.

3. Stop weed seed set

Stop weeds going to seed; resistance spreads via seeds. This can be achieved by crop or spray topping paddocks or capturing weed seeds at harvest for burning.

4. Manually remove volunteers and escapes

Figure 3: Annual ryegrass escapes of a herbicide application (Sourced from: DPIRD)

5. Increase competition

Grow crops that establish quickly and can smother weeds. Rotation, soil management, variety, row orientation, sowing time, seeding rates, crop nutrition and irrigation are factors that influence how well a crop can compete with weeds.

6. **Rotate crops and pastures**
   Mix it up, keep a diverse rotation of crops to confuse predictability loving weeds, and allow for more weed control options. This could include the addition of break crops, or crops tolerant to specific herbicides that can target resistant weeds.

Testing

If you are getting poor results in spite of timely, correct application, then you may have herbicide resistant weeds. Commercial seed testing is available to confirm population resistance. Two types of commercial seed testing available are:

1. **Seed Test** – This method of testing uses seeds of plants suspected to have resistance. Approximately 3,000 weed seeds are required to test for multiple resistance.
2. **Quick-Test™** – This test uses whole plants with roots collected from the paddock, rather than just the seeds. For each herbicide tested, 50 plants are required. When they reach the lab, plant samples are transplanted and grown before a spray treatment at 5-7 days. Results are generally available by 4 to 6 weeks. Quick-Tests can be done by Peter Boutsalis of Plant Science Consulting.

Figure 4: Annual ryegrass tested for herbicide resistance (Sourced from: WeedSmart)

Contact the testing service before sampling and testing to ask about sampling, handling and transport requirements.

In-Situ Testing

To obtain quick feedback, you can spray test strips of alternative herbicides to see what still works on areas experiencing spray failure. Adjust application rates to the growth stage of the weed and stay within label recommendations.

When using in-situ testing, be mindful of stress factors that may decrease efficacy, including frost and moisture stress. For an accurate assessment of the level of control, conduct weed plant counts before and after applying the herbicide.

References and resources

- A decade of monitoring herbicide resistance in *Lolium rigidum* in Australia, John Broster, James Pratley at: https://researchoutput.csu.edu.au/en/publications/a-decade-of-monitoring-herbicide-resistance-in-lolium-rigidum-in-
- Australian Herbicide Resistance Initiative at https://ahri.uwa.edu.au
- CropLife Australia at https://www.croplife.org.au
- DPIRD (WA) - Herbicide resistance and susceptibility testing - https://www.agric.wa.gov.au/grains-research-development/herbicide-resistance-and-susceptibility-testing
- Farm Biosecurity at http://www.farmbiosecurity.com.au
- GRDC Integrated Weed Management Manual at https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm
- Plant Science Counsulting by Peter Boutsalis at http://www. plantscienceconsulting.com.au
- WeedSmart at http://www.weedsmart.org.au

Project Snapshot - IWM Approaches

The University of New England is currently researching Integrated Weed Management approaches as part of a Hort Innovation-funded research project. The project aims to better understand weed ecology and behaviour, and improve the weed management effectiveness of sustainable techniques This will help decrease reliance on herbicides and allow them to be used more strategically, reducing the risk of herbicide resistance developing in the industry. Find out more about the project at www.une.edu.au/iwmvegetables

Further Information

If you need further information or help with testing, contact VegNET Industry Development Officer Theresa Chapman on theresac@rmcg.com.au or your local agronomist.