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HERBICIDE RESISTANCE
Managing the risks

What is herbicide resistance?

How herbicide resistance develops

The repeated use of the same chemical group or chemical class of herbicides to control a weed or disease can cause changes to a plant's genetic makeup. The surviving plants that develop resistance then set seed, passing the genes of resistance to the next generation.

This means that subsequent uses of the herbicide or herbicide class increase the proportion of less-susceptible or resistant weed or disease populations. In the end, the entire population is resistant to the herbicide or herbicide class.

KEY MESSAGES

- Test weeds for resistance after a field spray to quantify resistance.
- Adopt pre-emergent strategies such as planting winter wheat and apply residual herbicides.
- Don't always use the same approach as there are multiple tools in the toolbox.
- Use several 'tools' referring to the Big 6 simultaneously for greater effectiveness.
- Practice good farm hygiene and biosecurity to avoid spreading herbicide resistance.

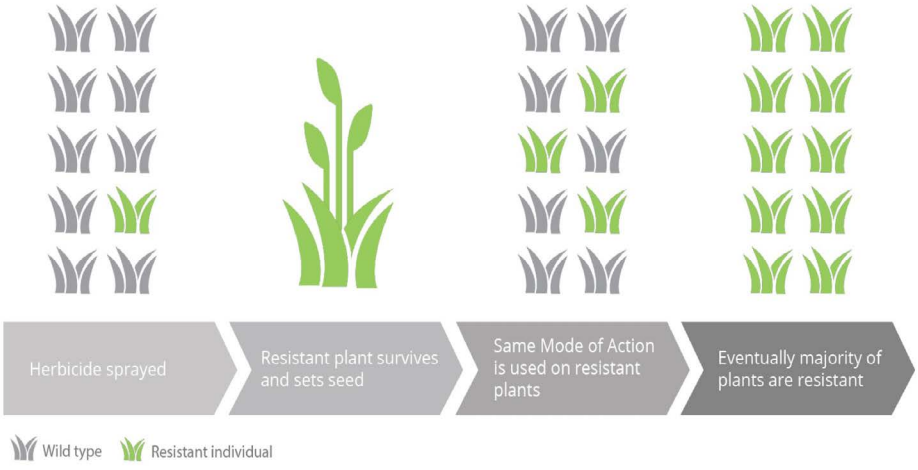

Figure 1: Development of resistance in a plant population

Hort Innovation

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RMCG

ahr applied horticultural research

Managing herbicide resistance

The GRDC WeedSmart program has developed a guide which provides a range of strategies to combat herbicide resistance in weeds. Although the WeedSmart "Big 6" guidelines were developed for broadacre cropping systems, they provide important strategies that can be applied to horticulture. These guidelines support the fundamental strategy of reducing and keeping the weed seedbank low, bearing in mind that not one strategy in isolation is the complete solution for managing herbicide resistance in weeds. WeedSmart recommends combining multiple strategies for tackling weed resistance effectively.

The following key messages apply Big 6 strategies to horticulture and include additional recommendations.

1. Test weeds for resistance with different active ingredients and modes of action
2. Use diverse crop rotations, or cover crops/ biofumigation crops
3. Increase crop or crop cover competition
4. Mix and rotate herbicides
5. Optimise spray efficiency
6. Stop weed seed set
7. Practice farm hygiene and good biosecurity
8. Implement monitoring, data collection and record keeping.

Diverse rotations

Rotating a variety of crops, including cover crops, allows different groups or classes of herbicides or biofumigation to be used to target problem weeds.

- Prioritise paddocks for longer-term management and categorise all paddocks on the farm using a rating for herbicide resistance.
- In paddocks with existing resistance, reassigning rotations around available chemistry is essential. Choose rotations that allow a variety of herbicide groups or classes to be used.
- Use diverse rotations if possible, such as spring crops (peas, beans, leafy vegetables) or quick-to-establish cover crops like buckwheat, and summer or autumn crops such as corn, potatoes, onions or carrots.
- Take advantage of fast-growing, multispecies cover crops to provide competition.
- If rotating with livestock, use strategic grazing practices to manage the weed burden in paddocks. For example, spray out broadleaf weeds in grass-based pasture.
- When using cover or biofumigation crops, rotate active ingredients and modes of action for termination.
- If growing grain crops or other small seeded crops that are 'dry harvested', ensure that weeds cannot go to seed before harvest.

Increase crop competition

- Use high sowing rates for broadacre crops or cover crops.
- Use narrow row spacing if possible and ensure yield and airflow in the crop are not compromised.
- Adjust seeding rates to suit the crops and production systems using precision seed placement.
- Sow break crops earlier, and at higher rates as earlier sowing dates can help winter crops be more competitive in cooler climates. Maintaining and improving crop vigour and competition can reduce seed set by weed survivors.
- Use remote imaging tools to identify poor growth areas for remediation to reduce weed pressure; weeds grow well in areas where crops do not.
- Irrigate before planting, unless it has rained, to enable a knockdown prior to sowing, if possible.
- Provide soil amelioration and amendments as required to improve soil health. Healthy soils grow more competitive crops. Where crops don't grow, weeds do.

Mix and rotate active ingredients and modes of action

- Weeds find it easy to evolve resistance to simple, predictable weed control. Avoid using the same herbicide groups or classes continuously by mixing two herbicides at full rates and then rotate to another herbicide mix.
- Follow the label and recommendations to ensure tank mixes are compatible and use recommended adjuvants, if required.
- Incorporate multiple modes of action in a double knock (e.g. glyphostate/Group 1/ Group 2 knockdown followed by paraquat and Group 14).
- Be aware of maximum residue limits (MRLs) in horticultural crops.
- Keep good records of herbicide application by (active ingredient, group/class) and discuss options with your agronomist, if required, to avoid reliance on single active ingredients or herbicide groups/classes.

Optimise spray efficiency

- Use herbicides at the optimum time to achieve a complete kill and target weeds when they are small.
- Ensure good coverage, calibrate spray gear and ensure all nozzles are suitable for herbicides and are working well, and that pressure and ground speed are correct.
- Adhere to recommended product and water rates as per label.

Stop seed set

- Stopping seed set reduces the size of the weed seed bank and cleans up the survivors to selective herbicides, preventing the development of herbicide resistance.
- Use cultural practices such as slashing prior to seed set to reduce the seed potential, if possible.
- Aim to reduce the weed seed bank by not allowing weeds to seed (e.g. not allowing 'survivors' in paddock margins), especially for seeds that can be distributed by wind or with people and animals.

Implement harvest weed seed control

Some tactics to control weed seeds at grain or seed crop harvest are:

- Burning stubble after grain or seed crop harvest where large volumes of seed have set

- Avoiding cultivating deeply where large volumes of seed have set, as seed viability is more compromised when exposed to UV and insects, without moisture
- Baling at harvest
- Chaff management (including chaff lining, chaff carts, and chaff tramlining).

Any strategy that destroys seed at harvest is a good strategy to use.

Farm hygiene and weed biosecurity

- **Good farm hygiene** reduces the risk of transferring herbicide-resistant plant material between and within farms:
  1. Provide foot baths and brushes and/or disinfectant sprays to be used between different risk areas.
  2. Control and limit access to production areas by anybody who does not have to be there and make sure that those who access paddocks are clean (vehicles, machinery, equipment, clothing – especially boots).
  3. Have a dedicated farm vehicle that doesn't leave the property and may be used by visitors to access production areas.
  4. Ensure washdown water is collected and disposed of where it cannot run onto paddocks.
- Have a **farm biosecurity plan**!

At a minimum, have a visitor register, ask where they have visited recently, provide signage to inform visitors of biosecurity expectations and have a designated parking area (check out the FarmBiosecurity BIOPLUS or Onside app to make visitor registration and tracing easier).

Testing

- Testing can not only prevent the costly situation of sacrificing an expensive crop, but it gives certainty when spraying weeds.
- Testing allows for the development of a chemical strategy for a paddock and helps you decide whether it's possible to achieve adequate control in your rotation.
- Autumn and summer are the best times to take weed samples, and seed samples can be taken in summer.

TESTING SERVICES

- Peter Boutsalis, Plant Science Consulting, Adelaide 0400 664 460 info@plantscienceconsulting.com.au
- John Broster, Charles Sturt University, Wagga Wagga 0457 272 075 jbroster@csu.edu.au
- Roberto Busi, University of Western Australia, Perth (08) 6488 7870 roberto.busi@uwa.edu.au

Monitoring, data collection and overall good record keeping

- Keep records, collect data on yields, Normalized Differentiated Vegetation Index (NDVI), seeding rates, row spacings, crop health observations and data on crop health, weed species, and pressure and cropping inputs.

INTEGRATED RESISTANT MANAGEMENT STRATEGIES (IRM) INVOLVE:

- Rotating chemical groups or classes to avoid cross-resistance.
- Adopting Integrated Crop Protection (ICP) strategies using the three approaches of: biological, cultural and chemical control.

Planning for optimum management

- Know the risks for your farm (e.g. not being able to use most of the above approaches to reduce the risk of herbicide resistance or manage existing resistance will mean risks are relatively high).
- Have a weed management plan in place (e.g. as part of the biosecurity plan) and follow it.
- Talk to your neighbours and contractors about risks and area wide management.

Cross-resistance

Cross-resistance means resistance to a particular herbicide's active ingredients that results in resistance to other herbicides. To avoid cross-resistance, different chemical groups must be rotated in spray applications to reduce the number of times active ingredients in each group are used.

Cross-resistance is usually present among herbicides sharing similar binding target sites or similar detoxifying pathways in the target weed.

Where ryegrass is 100% resistant to fluazifop, it will be 100% resistant to haloxyfop. Resistance testing results from Tasmania in 2023 showed that out of 14 paddocks tested with suspected resistance, 13 had resistance to fluazifop, with an average of 80% of plants surviving a herbicide application.

WHAT DOES THE LABEL TELL ME?

Information on resistance management is present on herbicide labels. The text box below provides an example *Source: APVMA PubCris*

RESISTANT WEEDS WARNING
GROUP 15 HERBICIDE

Sakura 850 WG Herbicide is a member of the isoxazoline group of herbicides and has the inhibitor of very long chain fatty acids (VLCFA inhibitors) mode of action. For weed resistance management Sakura is a Group 15 herbicide. Some naturally-occurring weed biotypes resistant to Sakura, and other Group 15 herbicides, may exist through normal genetic variability in any weed population. These resistant individuals can eventually dominate the weed population if these herbicides are used repeatedly. These resistant weeds will not be controlled by Sakura or other Group 15 herbicides.

Do not rely exclusively on Sakura for weed control. Use as part of an integrated weed management program involving herbicides with other modes of action and non-chemical methods of control. CropLife Australia resistance management strategies are available from your local agricultural chemical supplier or at the CropLife Australia website (www.croplife.org.au). Refer to these strategies for details of how to manage the build-up of resistant weeds on your farm.

Case study: 'Pub to Paddock' Field Day in Tasmania

Tasmanian vegetable growers attended a resistant ryegrass workshop run by RMCG. The growers soon learnt that to keep the triffid (ryegrass) at bay, it was a matter of adopting old tricks for new problems.

Pre-emergent herbicides are well known and well-adopted in broadacre cropping systems. In Tasmanian rotations, however, they do not often make an appearance. This is due to plant backs in other staple crops, cost, and knowledge in using them.

The farm where the workshop was held was in Tasmania's north-west coast, near Boat Harbour. The farm grows a mixture of vegetables, poppies, pyrethrum and grain crops, as well as tulip bulbs. The paddock had been sown to onions grown on a lease. The grower tackled the resistance in this paddock in three ways.

First, he sacrificed the onion crop near the headland where the population of grass was the greatest. He then hand sprayed the surviving plants in other parts of the crop with glyphosate. His ongoing strategy for this paddock was to design his rotation to provide different herbicide group options, as well as incorporate pre-emergent herbicides into his grain breaks which can achieve excellent control when applied correctly. The next crop in this paddock was tulip bulbs, which provide a mode-of-action break for the paddock.

Other ideas he incorporated on his farm were:

- The use of grains as a double-break to significantly reduce the weed seed bank.
- Sowing earlier to achieve better control with pre-emergent herbicides.
- Manage break crops well, every year, to achieve good grass control across the farm.
- Silage crops or burn stubbles where plants have set seed or seeds have dropped.

Photo: How herbicide resistance happens **Credit**: growiwm.org/herbicide-resistance

USEFUL RESOURCES

- Pesticide resistance – Michigan State University
  canr.msu.edu/grapes/integrated_pest_management/how-pesticide-resistance-develops
- WeedSmart provides information on weed resistance management strategies – The Big 6
  weedsmart.org.au/big-6
- Farm Biosecurity
  farmbiosecurity.com.au/biosecurity-at-your-fingertips
- Australian Herbicide Resistance Initiative
  ahri.uwa.edu.au/crop-protection-forum-comes-to-adelaide
- A strategic approach to weed management for the Australian vegetable industry
  une.edu.au/about-une/faculty-of-science-agriculture-business-and-law/school-of-environmental-and-rural-science/research/plant-soil-and-environment-systems/weed-science/a-strategic-approach-to-weed-management-for-the-australian-vegetable-industry 2?SQ_VARIATION_530443=0
- FRAC Code List of fungicides (2024)
  frac.info/media/kufnaceb/frac-code-list-2024.pdf
- Australian Pesticides and Veterinary Medicines Authority (APVMA) Gazette which is published fortnightly and contains details on registration of new agrichemicals
  apvma.gov.au
- Soil Wealth ICP fact sheet on Big 6 + 3 managing herbicide resistance
  soilwealth.com.au/2022/09/big-6-3-for-managing-herbicide-resistance
- VegNET Tasmania fact sheet – Group A herbicide resistance in Tasmanian ryegrass populations
  soilwealth.com.au/2019/09/group-a-herbicide-resistance-in-tasmanian-ryegrass-populations