HERBICIDES ARE GROUPED BY MODE OF ACTION AND RANKED BY RESISTANCE RISK

Growers and agronomists are now better aided to understand the huge array of herbicide products in the marketplace in terms of mode of action grouping and resistance risk by reference to the mode of action chart. All herbicide labels now carry the mode of action group clearly displayed such as:

GROUP	A	HERBICIDE

Know your herbicide groups to make use of this!

Not all mode of action groups carry the same risk for resistance development, therefore specific guidelines for Groups E, O, P and R have not been developed to date because there are no recorded cases of weeds resistant to members of these groups in Australia.

Products represented in Group A and Group B are **HIGH RESISTANCE RISK** herbicides and specific guidelines are written for use of these products.

Specific guidelines are also included for the **MODERATE RESISTANCE RISK** herbicides, Groups C, D, F, G, H I, J, K, L, M, N Q and Z herbicides.

INTEGRATED WEED MANAGEMENT STRATEGIES

Strategies are designed to minimise the development of resistance by adopting Integrated Weed Management (IWM) strategies. Do not rely on a single strategy to keep resistance at bay but integrate them into the crop production program. Some of the key strategies are:

- Rotation of herbicide mode of action groups within and across years. (Refer to specific guidelines for each herbicide mode of action group.)
- Apply two or more different herbicide modes of action on a particular weed. For example:
    - tank mix two or more compatible herbicides with different modes of action which are all effective on the target weed and recommended on the product labels. Apply each herbicide at full label rates
    - use herbicides which already contain two or more actives with different modes of action which are all effective on the target weed
    - “double-knock” where two herbicides with different modes of action are applied to the target weed in sequential applications
- Keeping accurate records of your herbicide applications on a paddock basis.
- Reading the herbicide product label and literature carefully and follow the instructions.
- Always using robust label rates to ensure maximum weed control.

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INTEGRATED WEED MANAGEMENT STRATEGIES (cont.)

- Rotatation of crop and variety.
- Identification and monitoring your surviving weed populations. (Keep good records of weed populations).
- If a weed control failure is suspected do not use the same product or product from the same mode of action group.
- Testing – confirm resistance status.
- Additional cultural weed control techniques to reduce seed banks, eg. burning, cultivation, varied sowing, competitive crops and varieties, green manuring, grazing and collection and/or destruction of weed seed at harvest.
- Control weed escapes before the weeds set and shed viable seed.
- Do not introduce or spread weeds by contaminated seed, grain, livestock, machinery or hay.
- Crop and pasture topping.
- Attend training courses, eg. GRDC IWM course, *ChemCert* and field days.
- Additional information can be obtained from:
  - CropLife Australia (www.croplife.org.au),
  - Australian Glyphosate Sustainability Working Group (www.glyphosateresistance.org.au),
  - Grains Research & Development Corporation (www.grdc.com.au),
  - WeedSmart (www.weedsmart.org.au),
  - International Information on Herbicide Resistent Weeds (weedscience.org) and
  - State Government Departmental publications.
- Detailed programs for herbicide resistance management for weed control in canola, cotton and rice are included (refer CropLife Australia website www.croplife.org.au).
  - Cotton - Liberty Link® Cotton, Roundup Ready Flex® Cotton, are available from Bayer, Monsanto and Nufarm.
  - Canola - Roundup Ready Canola® and Clearfield® Production Systems are available from Monsanto, BASF, Nufarm and Crop Care.
- Seek advice from local advisers (agronomists).
- Consider using alternative methods of weed control to reduce weed numbers before applying herbicides. If applying herbicides to high density weed populations and/or to crops that are poor competitors with limited weed control options, always follow-up with tactics that prevent seed from returning to the seed bank.

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INTEGRATED WEED MANAGEMENT STRATEGIES (cont.)

Weed control options for IWM

	Herbicidal	*Non-herbicidal*
Crop phase	- Crop topping - Knockdown herbicides eg. double knock strategy before sowing - Selective herbicides before and/or after sowing – but ensure escapes don't set seed - Utilising moderate resistance risk herbicides - Use mixtures and/or sequences of different modes of actions	- Rotate crops - Rotate varieties - Grow a dense and competitive crop - Cultivation - Green/brown manure crops - Varied sowing times - Cut crops for hay/silage - Burn stubbles/windrows - Collect and/or destroy weed seeds at harvest - Grazing
Pasture phase	- Spray topping - Winter cleaning - Selective herbicides – but ensure escapes don't set seed - Use mixtures and/or sequences of different modes of actions	- Good pasture competition - Hay making or silage - Cultivation - Grazing
Fallow phase	- Chemical fallow - Optical spot spray technology - Use mixtures and/or sequences of different modes of actions - Selective herbicides – but ensure escapes don't set seed - Knockdown herbicides eg. double knock strategy	- Cultivation - Grazing - Burning

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Risk of herbicide resistance development

Management Option	Low	Medium	High
Herbicide mix or rotation in cropping system	> 2 modes of action	2 modes of action	1 mode of action
Weed control in cropping System	Herbicide and many non herbicidal methods	Herbicide and some non herbicidal methods	Herbicide only
Use of same mode of action per season	Once	Twice	Many times
Cropping system crop Rotation	Diverse range of crops grown in rotation	Some crop rotation	Limted or no crop rotation
Weed density	Low	Moderate	High
Number of applications / Field	0-5	5-10	10+
Weeds which set seed and enter seedbank	None / Minimal	Some	Most

Adapted from HRAC resistance risk table 2018

Diversity is the key to managing resistance. Incorporate as many diverse weed control and cropping system practices as possible to minimize the risk of herbicide resistance development.

Keep yourself informed and be pro-active in the fight-back against resistance.

For further information on resistance management strategies, consult your reseller agronomist, farm consultant or Departmental Agronomist, or refer to the GRDC Integrated Weed Management Manual.

You can do something to reduce the impact!

Follow the latest resistance management strategies described in this document.

Note:
In the specific guidelines for each mode of action group in the following pages, the boxes contain the chemical families, followed by a list of active constituents, with the trade name of the first registered product or successor in parentheses.

For a complete list of registered products containing each active constituent, refer to the website of the Australian Pesticides and Veterinary Medicines Authority (APVMA) at www.apvma.gov.au for the PUBCRIS database.

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5. SPECIFIC GUIDELINES FOR GROUP A HERBICIDES

GROUP	A	HERBICIDE

High resistance risk

Globally herbicide resistance to Group A herbicides has been confirmed and documented in more than 40 grass weed species across more than 40 countries. Group A resistance is extensive and prolific with tens of millions of hectares affected, in fact it is the second most likely herbicide mode of action to develop resistance with only the Group B mode of action more likely.

Group A resistance commonly exists across wide areas of Australia in the grass weed species including more than 20,000 populations ofannual ryegrass, annual veld grass, more than 5,000 populations ofwild oats, phalaris, more than 200 populations of brome grass, crabgrass, crowsfoot grass and more than 200 populations of barley grass. Resistance has developed in broadacre and vegetable situations.

Research has shown that as few as 6 applications to the same population of annual ryegrass can result in the selection of resistant individuals. A population can go from a small area of resistant individuals to a whole paddock failure in one season.

1. Fops, dims and dens are Group A herbicides and carry the same high resistance risk.
2. Where a Group A herbicide has been used on a particular paddock for control of any grass weed, avoid using a Group A herbicide to control the same grass weed in the following season, irrespective of the performance it gave.
3. Frequent application of Group A herbicides to dense weed populations is the worst case scenario for rapidly selecting for resistance.
4. Where resistance to a member of Group A is suspected or known to exist, there is a strong possibility of cross resistance to other Group A and Z herbicides. Therefore use other control methods and herbicides of other mode of action groups in a future integrated approach.

All the above recommendations should be read in conjunction with the Integrated Weed Management (IWM) strategies

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Advice given in this strategy is Valid as at 22 June 2018. All previous versions of this strategy are now invalid.
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CHEMICAL FAMILY	ACTIVE CONSTITUENT (FIRST REGISTERED TRADE NAME)
GROUP A	**Inhibitors of acetyl co-enzyme A carboxylase (Inhibitors of fat synthesis/ACC'ase inhibitors)**
Aryloxyphenoxypropionates: (Fops):	clodinafop (Topik®), cyhalofop (Barnstorm®), diclofop (Cheetah® Gold*, Decision®*, Hoegrass®), 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 (Achieve®)
Phenylpyrazoles: (Dens):	pinoxaden (Axial®)

* ***This product contains more than one active constituent***

List of chemical families, approved active constituents and, in parenthesis, the trade name of the first registered product or successor. Refer to the APVMA website (www.apvma.gov.au) to obtain a complete list of registered products from the PUBCRIS database.

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