

Fungicide Resistance Management Strategies

*Developed by the CropLife Australia Fungicide Resistance Management Review Group
and industry researchers*

Valid as at 23 November 2010

Banana (Tropics) Strategy updated with effect 23 March 2011

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CropLife Australia Limited
Locked Bag 916, Canberra ACT 2601
Phone: 02 6230 6399 Email: info@croplifeaustralia.org.au Fax: 02 6230 6355

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INTRODUCTION

1. WHAT IS FUNGICIDE RESISTANCE?

Resistance by fungal pathogens to fungicides usually evolves following the intensive use of fungicides for disease control. In any fungal population there are likely to be individuals that have some degree of natural resistance and which are less susceptible to fungicides, even before the chemicals are used. Resistance arises through the incorrect use of fungicides by selection of the resistant forms of fungi. Continued use of a fungicide or fungicide chemical group can result in a significant build up of resistant individuals in the fungal population – to the point where that particular product, or other products from the same chemical group, is no longer effective. In some cases, removal of the selection pressure can result in the fungal population regaining its sensitivity to the fungicide group, but this is not always the case. The risk of fungicide resistance developing varies between different chemical groups and different fungal pathogens, such that specific strategies are recommended for those situations considered to carry the highest risk.

2. WHAT CAN BE DONE TO PREVENT OR DELAY RESISTANCE?

- 2.1 The most common approach to managing fungicide resistance is through responsible use of fungicides, of which the resistance management strategies presented in this document are good examples. In their most basic form, these strategies advocate rotation of fungicide products with a different chemical activity group to prevent over-use of any one product or activity group. More complex strategies safeguard against the development of cross-resistance or resistance to multiple chemical groups. In Australia, all fungicide products are labelled to identify which activity group they belong to. The activity group is indicated by a number (or letter/number combination) code on the product label.
- 2.2 Selecting the most effective or appropriate way to apply fungicides will make them work better and assist in delaying the development of resistance. A good understanding of the pathogen's life cycle and epidemiology will also help in the selection of the most appropriate application method. As a general rule, targeted applications to control a certain development stage or population level are most effective, whereas shotgun approaches like application of fungicides through irrigation systems could accelerate the development of resistance by exposing a large portion of the fungal population to sub-lethal rates. Particular attention should be given to label recommendations, rates and coverage. Adherence to suggested disease threshold levels is also good resistance management practice.
- 2.3 The use of cultural practices or growing varieties of crops with a high degree of natural resistance to diseases – requiring fewer or less frequent fungicide applications.
- 2.4 Working with industry bodies such as the CropLife Australia Fungicide Resistance Management Review Group to establish resistance management strategies for minor crops and/or those crops for which no strategies exist. Of particular concern are permitted uses of fungicides, often in minor crops, where repeated use of a limited number of fungicide alternatives occurs. Although not explicitly stated on agricultural use permits, such permitted uses should also incorporate measures to prevent resistance.
- 2.5 In the event of tank mixing products and/or co-formulations, always follow the recommendation from the most recent Fungicide Resistance Management Strategies and apply the most stringent strategy applicable to the pathogen most at risk of developing resistance.

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- 2.6 Certain environments are conducive to continuous infection and consistently high disease pressure. Examples of such environments are nurseries, tunnels, glasshouses and other structures of protected cultivation. Because protected cultivation usually requires multiple applications of fungicides at short intervals to control high disease incidence, these are often the origin of resistance to fungicides. Users of fungicides should be particularly mindful of the resistance risk under these conditions. Do not use a fungicide product to which resistance has been confirmed and stop using a product if resistance is suspected. When the fungicide in question no longer gives adequate control, stop using it temporarily and consult the supplier on its current resistance status.
- 2.7 In the absence of an established resistance management strategy for a particular crop/disease situation, it is recommended that the use of fungicides from any given activity group (excluding Group M) be limited to a maximum of one-third of the total number of fungicide applications. The use of consecutive applications of fungicides from the same activity group should also be limited by alternating between products from different activity groups. The use of Group M fungicides is not limited, as these fungicides carry an inherently low risk of fungicide resistance developing.

ACTIVITY GROUP LABELLING IN AUSTRALIA

In order to help fungicide users to manage fungicide resistance, all fungicide products sold in Australia are classified according to the chemical activity group of their active constituent. The activity group must be indicated by a letter code on the product label. Australia was the first country to introduce compulsory activity group labelling on products. Since the introduction of activity group labelling in Australia, other countries have adopted activity group classification systems, however caution should be shown if cross-referencing activity groups between Australia and other countries, as there are some differences in classification.

CHANGES TO ACTIVITY GROUPS

In 2008, CropLife Australia completely revised Australia's fungicide activity grouping system to bring it into line with the international Fungicide Resistance Action Committee (FRAC) activity group classification system. This was the first major revision of the Australian classification system since its introduction several years ago. Activity group codes have now been changed from letters to numbers (or letter/number combinations). For a complete list of all fungicide active constituents registered in Australia and their old and new activity groups, see the Fungicide Activity Group Table on the CropLife Australia website at www.croplifeaustralia.org.au.

The activity group codes for all fungicide products have been changed and **the new activity group code should be used when referring to the fungicide resistance management strategies**. Fungicide product registrants have three years (from October 2008) to update labels to reflect the new activity groups, but in the interim, some product labels may display the old activity group code. **Where there is a temporary difference in activity group code on fungicide product labels, the new activity group code should be used when choosing the appropriate resistance management strategy.**

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RESISTANCE RISK

Table 1: Plant pathogens accepted as showing a high risk of development of resistance to fungicides (adapted from EPPO, 2002)

FRAC Pathogen	Crop	Disease
<i>Botryotinia fuckeliana</i> (<i>Botrytis cinerea</i>)	Various, especially grapevine	Grey mould
<i>Erysiphe graminis</i>	Wheat / barley	Powdery mildew
<i>Mycosphaerella fijiensis</i>	Banana	Black sigatoka
<i>Phytophthora infestans</i>	Potato	Late blight
<i>Plasmopara viticola</i>	Grapevine	Downy mildew
<i>Pseudoperonospora cubensis</i> and related	Cucurbits	Downy mildew
<i>Pyricularia oryzae</i>	Rice	Rice blast
<i>Sphaerotheca fuliginea</i> and related	Cucurbits	Powdery mildew
<i>Venturia</i> spp.	Apple, pear	Scab

Table 2: Plant pathogens accepted as showing a medium risk of development of resistance to fungicides

FRAC Pathogen	Crop	Disease
<i>Bremia lactucae</i>	Lettuce	Downy mildew
<i>Gibberella fujikuroi</i> *	Rice	Bakanae
<i>Leptosphaera nodorum</i> (<i>Stagonospora nodorum</i>)	Wheat	Leaf spot
<i>Monilinia</i> spp.	Stone and pome fruit	<i>Monilinia</i> rots
<i>Mycosphaerella graminicola</i> (<i>Septoria tritici</i>)	Wheat	Leaf spot
<i>Mycosphaerella musicola</i>	Banana	Yellow sigatoka
<i>Peronospora</i> spp.	Various	Downy mildew
<i>Podosphaera leucotricha</i>	Apple	Powdery mildew
<i>Puccinia</i> spp.	Wheat/barley	Rusts
<i>Pyrenophora teres</i>	Barley	Net Blotch
<i>Pyrenophora tritici-repentis</i>	Wheat	Tan spot (yellow spot)
<i>Tapesia</i> spp.	Wheat/barley	Eyespot
<i>Uncinula necator</i> *	Grapevine	Powdery mildew

* The EPPO Guideline lists these pathogens as high risk and baselines are normally requested

Pathogens with high resistance risk:

In some cases, fungicides from additional fungicide activity groups may be available under permit for use in the above crop/pest situations. Details of such permits can be obtained from the Australian regulator's (APVMA) website: (www.apvma.gov.au). In the absence of a resistance management strategy for activity groups of products available under permit, **or in the absence of restrictions contained within the permit**, it is strongly advised that those products (excluding Group M fungicides) be used in alternation with registered products from other fungicide activity groups, which should be used in accordance with the following resistance management strategies.

Pathogens with medium or unlisted resistance risk

In some cases, fungicides from additional fungicide activity groups may be available under permit for use in the above crop/pest situation. Details of such permits can be obtained from the Australian regulator's (APVMA) website: (www.apvma.gov.au). In the absence of a resistance management strategy for activity groups of products available under permit, it is advised that spray programs incorporating those products (excluding Group M fungicides) also incorporate registered products from other fungicide activity groups, which should be used in accordance with the following resistance management strategies.

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Crop(s): Apples, Pears

Pest(s): Apple and Pear Scab

Resistance Management Strategy for:

Group 3	(DMI);
Group 9	(Anilinopyrimidine);
Group 11	(Quinone outside Inhibitor) fungicides; and
Combinations of Group 9	(Anilinopyrimidine) and Group 3 (DMI) fungicides; and Dodine.

1. To prevent or delay the onset of resistance to Group 3 fungicides, **DO NOT** apply more than four **Group 3** sprays alone per season.
If more sprays, are required apply a tank mix of a **Group 3** with a **Group 9** or suitable product from **Groups M** or **M1** to **M9**, or apply a registered product containing a combination of a **Group 3** and a **Group 9** fungicide.
2. **DO NOT** apply more than four sprays per season of **Group 9** fungicides (solo products).
DO NOT apply more than five sprays per season of products containing a combination of a **Group 9** and a **Group 3** fungicide.
DO NOT apply more than three sprays per season of **Group 11** fungicides. If two or three consecutive applications of **Group 11** fungicides are used, then they must be followed by at least the same number of applications of fungicide(s) from a different group(s) before a **Group 11** fungicide is used again, either in the current or following season.
Where spray programs include both solo **Group 9** products and combination products, the maximum cumulative number of applications is five per season.
3. To prevent or delay the onset of resistance to Dodine, **DO NOT** apply more than three consecutive sprays of Dodine, and no more than a total of six Dodine sprays per season.
If more sprays are required, tank mix Dodine with a protectant product at the registered rate.

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Crop(s): Banana

Pest(s): Leaf diseases

Resistance Management Strategy for:

Group 3 (DMI);
Group 11 (Quinine outside Inhibitor) fungicides; and
Group 9 (Anilinopyrimidine) fungicides;

TROPICS (e.g. Nth QLD, NT and Northern WA)

1. Apply a regular schedule of protectant sprays.
2. When disease potential is high, apply a maximum of two consecutive **Group 3** sprays before changing to a fungicide of a different activity group.
3. **DO NOT** apply more than six **Group 3** sprays in any 12 month period.
4. **DO NOT** apply any **Group 3** sprays in the months of June, July, August and September **DO NOT** apply more than four **Group 11** sprays in any 12 month period.
5. **DO NOT** apply consecutive sprays of **Group 11** fungicides.
6. Apply a minimum of two sprays from a different activity group between sprays of a **Group 11** fungicide.
7. **DO NOT** apply **Group 11** sprays in the months of May, June, July, August and September.

NOTE: Due to the disrupted growing season in 2011 CropLife has modified the banana Resistance Management Strategy (tropics) to allow banana growers to use these fungicides during the month of May 2011, provided they continue to implement the other elements of the resistance management strategy.

8. **DO NOT** apply more than six **Group 9** sprays in any 12 month period.
9. **DO NOT** apply more than two consecutive sprays of **Group 9** fungicide before changing to a fungicide of a different activity group. When using consecutive applications of **Group 9** fungicides, follow with at least as many different activity group fungicides before resuming with a **Group 9** fungicide.
10. De-leafing must be conducted in accordance with industry guidelines.

Chemical Group	Max. number of applications/year	Max. number of consecutive sprays	Restricted (no-spray) periods
Group 3	6 (& no more than 2 of 3 sprays)	2	June to September inclusive
Group 11	4 (& no more than 1 of 3 sprays)	Not allowed	May to September inclusive
Group 9	6 (& no more than 2 of 4 sprays)	2	No restriction

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Crop(s): Banana (cont.)

Pest(s): Leaf diseases (cont.)

SUB-TROPICS (e.g. Sth. QLD and Nth. NSW)

1. When using **Group 3** fungicides, apply a maximum of two consecutive **Group 3** sprays before changing to a fungicide of a different activity group.
2. **DO NOT** apply more than five **Group 3** sprays in any 12 month period.
3. **DO NOT** apply more than four **Group 11** sprays in any 12 month period.
4. **DO NOT** apply consecutive sprays of **Group 11** fungicides.
5. Apply a minimum of two sprays from a different activity group between sprays of a **Group 11** fungicide.
6. **DO NOT** apply more than five **Group 9** sprays in any 12 month period.
7. **DO NOT** apply more than two consecutive sprays of **Group 9** fungicides before changing to a fungicide of a different activity group. When using consecutive applications of **Group 9** fungicides, follow with at least as many different activity group fungicides before resuming with a **Group 9** fungicide.

Chemical Group	Max. number of applications/year	Max. number of consecutive sprays
Group 3	5 (& no more than 2 of 3 sprays)	2
Group 11	4 (& no more than 1 of 3 sprays)	Not allowed
Group 9	5 (& no more than 2 of 4 sprays)	2

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Crop(s): Cucurbits

Pest(s): Downy Mildew

Resistance Management Strategy for:

Group 4 (Phenylamide);
Group 11 (Quinone outside Inhibitor); and
Group 40 (Dimethomorph) fungicides

1. Start disease control early and maintain a regular program using a fungicide from groups other than **Group 4, 11** or **40**.
2. When conditions favour disease development, **DO NOT** wait for disease to appear, but apply two consecutive sprays of a **Group 4** or **11** product, at the interval recommended on the label, or a single spray of a **Group 11** fungicide. Then resume the program of sprays using products from a different group to the **Group 4, 11** or **40** products just applied.
3. **DO NOT** apply more than four sprays of a **Group 4** or of a **Group 40** product per season.
DO NOT apply more than two sprays of **Group 11** fungicides per crop.
4. Continue alternation of fungicides between successive crops.

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Crop(s): Cucurbits

Pest(s): Powdery Mildew

Resistance Management Strategy for:

Group 3 (DMI, pyrimidine);
Group 1 (Methyl Benzimidazole Carbamate); and
Group 11 (Quinone outside Inhibitor) and other “systemic” fungicides

1. Start disease control early. **DO NOT** wait for powdery mildew to appear before spraying, but start as soon as practicable after crop emergence.
2. Use protectant sprays in early crop growth. Apply protectant sprays up to the fruit set stage of the crop if the disease normally occurs during this period. If this schedule is interrupted (eg. by rain) use a tank mix of protectant plus systemic before recommencing the protectant program.
3. After fruit set, use systemic fungicides in one or more of the following ways:
 - a. Tank mix systemic fungicides with a protectant fungicide **AND** use fungicides from at least two different systemic activity groups per crop.
 - b. Alternate systemic fungicides with a protectant fungicide **AND** use fungicides from at least two different systemic activity groups per crop.
 - c. Alternate systemic fungicides from at least three different activity groups per crop.
 - d. **Apply Group 11 fungicides preventatively.**
4. **Use a maximum of 1 Group 11 containing spray out of every 3 fungicide applications.**
5. **Do not use consecutive applications of Group 11 fungicides.**
6. **Do not apply more than two Group 11 products per crop.**

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Crop(s): Fruit (post-harvest treatment)

Pest(s): Post-harvest diseases

Resistance Management Strategy for:

Group 1 (Methyl Benzimidazole Carbamates);
Group 3 (DMI);
Group 2 (Dicarboximide); and other “systemic” fungicides

1. For the last pre-harvest spray, use a fungicide with a different activity group to the fungicide planned for use as a post-harvest treatment.
2. Where alternatives are available, rotate to use as many different activity groups as possible.
3. **DO NOT** dispose of unused dip solutions as a spray to crops or orchards.
4. **DO NOT** dispose of unused dip solutions within or near the crop or orchard area.

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Crop(s): Grape

Pest(s): Downy Mildew

Resistance Management Strategy for:

Group 4 (Phenylamide);
Group 11 (Quinone outside Inhibitor); and
Group 40 (Dimethomorph) fungicides

1. Start disease control sprays when the vine shoots are approximately 20cm long and continue spraying at intervals of 7-21 days using a protectant or non-phenylamide fungicide.
2. When conditions favour disease development, apply two consecutive sprays of a **Group 4** product. **DO NOT** apply more than two consecutive sprays of a **Group 4** product. **DO NOT** apply more than four sprays of a **Group 4** product per season.
3. **DO NOT** apply more than three consecutive sprays of a **Group 40** fungicide, and no more than a total of six sprays per season.
4. **DO NOT** apply more than two sprays per season of **Group 11** fungicides. If two consecutive applications of **Group 11** fungicides are used, then they must be followed by at least the same number of applications of fungicide(s) from a different group(s) before a **Group 11** fungicide is used again, either in the current or following season.
5. Apply Group 11 fungicides preventatively.
6. Apply a maximum of two consecutive applications in alternation with fungicides from a different MOA group with satisfactory efficacy against the target pathogen/s.

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Crop(s): Grape

Pest(s): Powdery Mildew

Resistance Management Strategy for:

Group 3 (DMI);
Group 5 (Amine);
Group 11 (Quinone outside Inhibitor); and
Group 13 (Quinoline) fungicides

1. **DO NOT** apply more than two consecutive sprays of a **Group 3** fungicide.
DO NOT apply more than three **Group 3** sprays per season.
DO NOT use **Group 3** fungicides curatively.
2. **DO NOT** apply more than two consecutive sprays of a **Group 5** fungicide.
DO NOT apply more than three **Group 5** sprays per season.
3. **DO NOT** apply more than two sprays per season of **Group 11** fungicides. If two consecutive applications of **Group 11** fungicides are used, then they must be alternated with a fungicide from a different activity group.
4. Apply Group 11 fungicides preventatively.
5. Apply a maximum of two consecutive applications in alternation with fungicides from a different MOA group with satisfactory efficacy against the target pathogen/s.
6. **DO NOT** apply more than two consecutive sprays of a **Group 13** fungicide.
DO NOT apply more than three **Group 13** sprays per **season**.

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Crop(s): Grape
Pest(s): Grey Mould (Bunch Rot)

Resistance Management Strategy for:

Group 2 (Dicarboximide);
Group 1 (Methyl Benzimidazole Carbamate);
Group 9 (Anilinopyrimidine) and combinations of **Group 9** (Anilinopyrimidine) and **Group 12** (Phenylpyrroles);
Group 17 (Hydroxyanilide); and
Group 7 (Carboxamide) fungicides

1. If three or fewer bunch rot sprays are applied in a season, use no more than one spray from the same fungicide group during the season, for any **Group 1, 2 or 9** (including combinations with **Group 12**), **Group 17** or **7** fungicides.
2. If four or more bunch rot sprays are applied in a season, use no more than two sprays from the same fungicide group during the season, for any **Group 1, 2 or 9** (including combinations with **Group 12**), **Group 17** or **7** fungicides.
3. **DO NOT** apply more than two consecutive sprays from the same fungicide group, for any **Group 1, 2 or 9** (including combinations with **Group 12**) or **Group 17** fungicide, including from the end of one season to the start of the following season.
4. **DO NOT** apply consecutive sprays of **Group 7** fungicides, including from the end of one season to the start of the following season.
5. Late season fungicide treatments should be applied before Botrytis infection reaches unacceptably high levels in the vineyard.

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Crop(s): Lettuce

Pest(s): Botrytis

Resistance Management Strategy for:

Group 2 (dicarboximide)

1. Apply **Group 2** fungicide as a seedling drench soon after emergence.
2. Apply a protectant fungicide as a high volume foliar spray before planting out, then a **Group 2** fungicide immediately after planting.
3. Maintain a cover with protectant fungicide sprays at 7-10 day intervals.
4. If weather conditions favour Botrytis infection, tank mix the protectant with a **Group 2** fungicide.
5. **DO NOT** apply **Group 2** fungicides more than four times per season, irrespective of the target disease.

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Crop(s): Lettuce

Pest(s): Downy Mildew

Resistance Management Strategy for:

Group 4 (Phenylamide); and
Group 40 (Dimethomorph) fungicides

1. Start disease control early and maintain a regular program using a fungicide from groups other than **Group 4** or **40**.
2. When conditions favour disease development, **DO NOT** wait for disease to appear, but apply two consecutive sprays of a **Group 4** or **40** product at the interval recommended on the label. Then resume the program of sprays using products from a different group to the **Group 4** or **40** products just applied.
3. **DO NOT** apply more than four sprays of a **Group 4** or **40** product per season.

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Crop(s): **Onion**

Pest(s): **Downy Mildew**

Resistance Management Strategy for:

Group 4 (Phenylamide); and
Group 40 (Dimethomorph) fungicides

1. Start disease control early and maintain a regular program using a fungicide from groups other than **Group 4** or **40**.
2. When conditions favour disease development, **DO NOT** wait for disease to appear, but apply two consecutive sprays of a **Group 4** or **40** product at the interval recommended on the label. Then resume the program of sprays using products from a different group to the **Group 4** or **40** products just applied.
3. **DO NOT** apply more than four sprays of a **Group 4** or **40** product per season.

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Crop(s): **Ornamentals**

Pest(s): **Grey Mould**

Resistance Management Strategy for:

Group 9 (Anilinopyrimidine); and
Group 2 (Dicarboximide) fungicides

1. If three or fewer Botrytis fungicide sprays are applied per crop, use only one spray containing a **Group 9** fungicide. If four to six sprays are applied per crop, use a maximum of two sprays containing **Group 9** fungicides. If seven or more sprays are applied per crop use a maximum of three sprays containing **Group 9** fungicides.

Avoid applying more than two successive sprays of a **Group 9** fungicide, including from the end of one season to the next.

2. **DO NOT** apply more than two consecutive sprays of a **Group 2** fungicide.

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Crop(s): Passionfruit

Pest(s): *Alternaria* sp.

Resistance Management Strategy for:

Group 2 (Dicarboximide); and
Group 11 (Quinone outside Inhibitors) fungicides

1. Maintain a protective cover with a protectant fungicide such as mancozeb.
2. Limit the use of **Group 2** to strategic periods, i.e. before, during and after extended wet periods.
Always tank mix the **Group 2** fungicide with a protectant such as mancozeb.
DO NOT apply more than four **Group 2** sprays in a season.
3. The total number of **Group 11** sprays should be no more than one-third of the total number of fungicide sprays per season.

DO NOT apply more than two consecutive applications of a **Group 11** spray.
If two consecutive applications of a **Group 11** spray are applied, they must be followed by at least the same number of sprays from an alternative chemical group.

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Crop(s): Peanut

Pest(s): Leaf Spots, Rust, Net Blotch

Resistance Management Strategy for:

Group 3 (DMI); and
Group 11 (Quinone outside Inhibitor) fungicides

1. **DO NOT** apply more than three consecutive **Group 3** sprays alone, before changing to a fungicide of a different activity group.

Apply a maximum of five **Group 3** sprays per season.

2. **DO NOT** apply **Group 11** products as more than 50% of the total number of sprays in any one season, up to a maximum of three sprays of **Group 11**.

DO NOT apply more than two consecutive applications of a **Group 11** spray.

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Crop(s): Poppies

Pest(s): Downy Mildew

Resistance Management Strategy for:

Group 4 (Phenylamide);
Group 11 (Quinone outside Inhibitor); and
Group 40 (Carboxylic acid amide) fungicides

1. Start disease control early and maintain a regular program with a fungicide from groups other than **Group 4, 11 or 40**, using the spray interval recommended on the label.
2. When conditions favour disease development (high humidity, still weather, overcast skies), **DO NOT** wait for symptoms (white downy growth on the underside of lower leaves followed by brown angular lesions) to appear, but apply two consecutive sprays of a **Group 4, 11 or 40** product, at the interval recommended on the label. Then resume the program of sprays using products from a different group to the **Group 4, 11 or 40** products just applied.
3. **DO NOT** apply more than two sprays per season of a product containing a **Group 4** fungicide.
DO NOT apply more than two sprays per season of a product containing a **Group 11** fungicide.
DO NOT apply more than two sprays per season of a product containing a **Group 40** fungicide.

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Crop(s): Potato

Pest(s): Late Blight (Irish Blight)

Resistance Management Strategy for:

Group 4 (Phenylamide);
Group 11 (Quinone outside Inhibitor); and
Group 40 (Dimethomorph) fungicides

1. Start disease control early and maintain a regular program using a fungicide from groups other than **Group 4, 11 or 40**.
2. When conditions favour disease development, **DO NOT** wait for disease to appear, but apply two consecutive sprays of a **Group 4, 11 or 40** fungicide at the interval recommended on the label. Then resume the program of sprays using products from a different group to the **Group 4, 11 or 40** fungicides just applied.
3. **DO NOT** apply more than four sprays of a **Group 4 or 40** fungicide per season.
4. The total number of **Group 11** fungicide applications per season should not exceed one third of the total number of fungicide applications per crop. No more than two consecutive **Group 11** sprays should be applied. If consecutive applications of **Group 11** fungicides are used, then they must be followed by at least the same number of applications of fungicide(s) from a different group(s) before a **Group 11** fungicide is used again, either in the current or following season.

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Crop(s): Potato

Pest(s): Target Spot (Early Blight)

Resistance Management Strategy for:

Group 2 (Dicarboximide);
Group 3 (DMI);
Group 9 (Anilinopyrimidine); and
Group 11 (Quinone outside Inhibitor) fungicides.

1. Limit the use of **Group 2, 3, 9** or **11** fungicides to periods when conditions favour disease development.
2. **DO NOT** apply more than six **Group 2** sprays in one season. Apply no more than two consecutive sprays of a **Group 2** fungicide.
3. **DO NOT** apply more than six **Group 3** sprays in a season. Apply no more than two consecutive sprays of a **Group 3** fungicide alone.
4. If three or fewer fungicide sprays for target spot are applied per crop, use only one spray containing a **Group 9** fungicide. If four to six sprays are applied per crop, use a maximum of two sprays containing **Group 9** fungicides. If seven or more sprays are applied per crop use a maximum of three sprays containing **Group 9** fungicides.

Apply no more than two consecutive sprays containing a **Group 9** fungicide.

5. Do not apply more than three applications of a **Group 11** fungicide per crop, no more than two consecutive **Group 11** sprays per crop. If consecutive applications of **Group 11** fungicides are used, then they must be followed by at least the same number of applications of fungicide(s) from a different group(s) before a **Group 11** fungicide is used again, either in the current or following season.

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Crop(s): Pulse Crops

Disease (s): Grey Mould (Botrytis)

Resistance Management Strategy for

Group 1	(Methyl Benzimidazole Carbamates)
Group 2	(dicarboximide)
Group M3	(dithiocarbamate)

1. **DO NOT apply more than two consecutive Group 1 sprays, including a seed treatment containing a Group 1 fungicide. Apply no more than two consecutive sprays of a Group 1 fungicide alone.**
2. **DO NOT apply more than two Group 1 treatments (including seed treatment) in a season.**
3. **DO NOT apply more than two Group 2 sprays in one season. Apply no more than two consecutive sprays of a Group 2 fungicide.**
4. **DO NOT apply more than two Group M3 treatments (including seed treatment) in a season. Apply no more than two consecutive sprays of a Group M3 fungicide alone.**
5. **It is advisable to rotate groups between seasons.**

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Crop(s): Stone Fruit

Pest(s): Blossom Blight and Brown Rot

Resistance Management Strategy for:

Group 3 (DMI);
Group 2 (Dicarboximide);
Group 1 (Methyl Benzimidazole Carbamate); and
Group 9 (Anilinopyrimidine) fungicides

1. If applying **Group 3, 2** or **1** fungicides, **DO NOT** apply more than two consecutive sprays of fungicides from the same group before changing to another group.
2. **DO NOT** apply more than three sprays of a **Group 9** fungicide per season. If two or three consecutive sprays are applied, they must be followed by at least the same number of sprays from an alternative chemical group, including from one season to the next.
3. A post-harvest treatment should also be counted as an application.
4. The last blossom blight spray and the first pre-harvest brown rot spray should be regarded as consecutive applications.
5. The spray program should be considered and the strategy applied on a whole-orchard basis.

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Crop(s): Strawberry

Pest(s): Grey Mould (Botrytis)

Resistance Management Strategy for

Group 1 (Methyl Benzimidazole Carbamate);
Group 2 (Dicarboximide);
Group 9 (Anilinopyrimidine); and
Group 17 (Hydroxyanilide) fungicides

1. Apply a program of protectant fungicides during flowering. If conditions favour disease development during this period, use a **Group 1, 2, 9** or **17** fungicide.
2. **DO NOT** apply more than two successive sprays of **Group 1, 2, 9** or **17** fungicides.
3. Always apply **Group 1** fungicides in a tank mix with a protectant.
4. If three or fewer Botrytis fungicide sprays are applied per crop, use only one spray containing a **Group 9** fungicide. If four to six sprays are applied per crop use a maximum of two sprays containing **Group 9** fungicides. If seven or more sprays are applied per crop use a maximum of three sprays containing **Group 9** fungicides.

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Crop(s): Strawberry

Pest(s): Powdery Mildew

Resistance Management Strategy for:

Group 3 (DMI); and
Group 11 (Quinone outside Inhibitor) fungicides

1. Apply a program of protectant fungicides from early crop establishment and maintain a regular spray program throughout the crop growing cycle. If weather conditions favour powdery mildew development, use a **Group 3** or **11** fungicide.
2. **DO NOT** apply more than four **Group 3** sprays per season.
DO NOT apply more than two consecutive sprays of **Group 3** fungicides, including from one season to the next.
3. **DO NOT** apply more than three **Group 11** sprays per season.
DO NOT apply consecutive sprays of **Group 11** fungicides, including from one season to the next.
4. If three or fewer powdery mildew fungicide sprays are applied per crop, use only one spray containing a **Group 11** fungicide. If four to six sprays are applied per crop, use no more than two sprays containing a **Group 11** fungicide. If seven or more sprays are applied per crop use a maximum of three sprays containing a **Group 11** fungicide.
5. **DO NOT** use **Group 3** fungicides curatively.

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Crop(s): Tomato

Pest(s): Grey Mould

Resistance Management Strategy for:

Group 1 (Methyl Benzimidazole Carbamate); and
Group 2 (Dicarboximide) fungicides

1. Alternate or tank mix **Group 1** or **Group 2** fungicides with a protectant such as chlorothalonil, or with each other. Avoid applying two **Group 1** or two **Group 2** fungicides in succession, unless tank mixed with a protectant.
2. **DO NOT** apply more than four **Group 1** or four **Group 2** sprays in a season.

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Crop(s): Tomato

Pest(s): Target Spot (Early Blight)

Resistance Management Strategy for:

Group 2 (Dicarboximide);
Group 3 (DMI);
Group 9 (Anilinopyrimidine); and
Group 11 (Quinone outside Inhibitor) fungicides

1. Limit the use of **Group 2, 3, 9** or **11** fungicides to periods when conditions favour disease development.
2. **DO NOT** apply more than four **Group 2** sprays in one season. Apply no more than two consecutive sprays of a **Group 2** fungicide.
3. **DO NOT** apply more than six **Group 3** sprays in a season. Apply no more than two consecutive sprays of a **Group 3** fungicide alone.
4. If three or fewer fungicide sprays for target spot are applied per crop, use only one spray containing a **Group 9** fungicide. If four to six sprays are applied per crop, use a maximum of two sprays containing **Group 9** fungicides. If seven or more sprays are applied per crop, use a maximum of three sprays containing **Group 9** fungicides.

Apply no more than two consecutive sprays containing a **Group 9** fungicide.

5. **DO NOT** apply more than six sprays, or one third of the total sprays (whichever is lower) from **Group 11** fungicides. **DO NOT** apply more than two consecutive sprays of **Group 11** fungicides. If consecutive applications of **Group 11** fungicides are used, then they must be followed by at least the same number of applications of fungicide(s) from a different group(s) before a **Group 11** fungicide is used again, either in the current or following season.

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Advice given in this strategy is valid as at 23 November 2010 - **Banana (Tropics) Strategy updated with effect 23 March 2011**. All previous versions of this strategy are now invalid.

Phone: 02 6230 6399 Email: info@croplifeaustralia.org.au Fax: 02 6230 6355 Website: www.croplifeaustralia.org.au

Crop(s): Turf

Pest(s): Various Diseases

Resistance Management Strategy for:

All fungicides

1. **DO NOT** apply more than two consecutive sprays of fungicides from the same activity group (other than **Group 14, 28, M2, M3, M4** or **M5**), unless mixed with a protectant fungicide from **Group 14, 28, M2, M3, M4** or **M5**.

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