Fungicide Resistance Management Strategies

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

Valid as at 28 September 2011
Index to crop and pest strategies

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This strategy is a guide only and does not endorse particular products, groups of products or cultural methods in terms of their performance. Always follow the product label for specific use instructions. While all effort has been taken with the information supplied in this document no responsibility, actual or implied, is taken for the day to day accuracy of product or active constituent specific information. Readers should check with the Australian regulator’s (APVMA) product database for contemporary information on products and actives. The database can be sourced through www.apvma.gov.au. The information given in this strategy is provided in good faith and without any liability for loss or damage suffered as a result of its application and use.

Advice given in this strategy is valid as at 28 September 2011. All previous versions of this strategy are now invalid.

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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 apply the most stringent strategy applicable to the pathogen most at risk of developing resistance.
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.
RESISTANCE RISK

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

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

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

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

* 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](http://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](http://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.
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.
Crop(s): Banana
Pest(s): Leaf diseases

Resistance Management Strategy for:

- **Group 3** (DMI);
- **Group 11** (Quinine outside Inhibitor); 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.
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.

<table>
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<th>Chemical Group</th>
<th>Max. number of applications/year</th>
<th>Max. number of consecutive sprays</th>
<th>Restricted (no-spray) periods</th>
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<tr>
<td><strong>Group 3</strong></td>
<td>6 (&amp; no more than 2 of 3 sprays)</td>
<td>2</td>
<td>June to September inclusive</td>
</tr>
<tr>
<td><strong>Group 11</strong></td>
<td>4 (&amp; no more than 1 of 3 sprays)</td>
<td>Not allowed</td>
<td>May to September inclusive</td>
</tr>
<tr>
<td><strong>Group 9</strong></td>
<td>6 (&amp; no more than 2 of 4 sprays)</td>
<td>2</td>
<td>No restriction</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Chemical Group</th>
<th>Max. number of applications/year</th>
<th>Max. number of consecutive sprays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 3</td>
<td>5 (&amp; no more than 2 of 3 sprays)</td>
<td>2</td>
</tr>
<tr>
<td>Group 11</td>
<td>4 (&amp; no more than 1 of 3 sprays)</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Group 9</td>
<td>5 (&amp; no more than 2 of 4 sprays)</td>
<td>2</td>
</tr>
</tbody>
</table>
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.

4. DO NOT apply more than two sprays of Group 11 fungicides per crop.

5. Apply Group 11 fungicides preventively

6. Continue alternation of fungicides between successive crops.
Crop(s): Cucurbits
Pest(s): Powdery Mildew

Resistance Management Strategy for:

- Group 3 (DMI, pyrimidine);
- Group 11 (Quinone outside Inhibitor) and other “systemic” fungicides; and
- Group U8 (Actin Inhibitor) 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.
Crop(s):    Fruit (post-harvest treatment)

Pest(s):    Post-harvest diseases

Resistance Management Strategy for:

Group 3 (DMI);
Group 2 (Dicarboximide); and other “systemic” fungicides; and
Group 12 (Phenylpyrroles) 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.
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.
Crop(s): Grape

Pest(s): Powdery Mildew

Resistance Management Strategy for:

- Group 3 (DMI);
- Group 5 (Amine);
- Group 7 (Carboxamides);
- Group 11 (Quinone outside Inhibitor);
- Group 13 (Quinoline); and
- Group U8 (Actin Inhibitor) 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 consecutive sprays of Group 7 fungicides, including from the end of one season to the start of the following season. DO NOT apply more than four Group 7 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 alternated with a fungicide from a different activity group.

5. Apply Group 11 and other systemic 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.

7. DO NOT apply more than two consecutive sprays of a Group 13 fungicide. DO NOT apply more than three Group 13 sprays per season.
Crop(s): Grape
Pest(s): Grey Mould (Bunch Rot)

Resistance Management Strategy for:

Group 2 (Dicarboximide);
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 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 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 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.
Crop(s): Lettuce  
Pest(s): Botrytis  

Resistance Management Strategy for:  
Group 2 (dicarboximide) fungicides  

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.
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.
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.
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.
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.

This strategy is a guide only and does not endorse particular products, groups of products or cultural methods in terms of their performance. Always follow the product label for specific use instructions. While all effort has been taken with the information supplied in this document no responsibility, actual or implied, is taken for the day to day accuracy of product or active constituent specific information. Readers should check with the Australian regulator’s (APVMA) product database for contemporary information on products and actives. The database can be sourced through www.apvma.gov.au. The information given in this strategy is provided in good faith and without any liability for loss or damage suffered as a result of its application and use.

Advice given in this strategy is valid as at 28 September 2011. All previous versions of this strategy are now invalid.

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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.
   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.
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.

4. Apply Group 11 fungicides preventively.
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. Apply **Group 11** fungicides preventively. 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.
Crop(s): Potato
Pest(s): Target Spot (Early Blight)

Resistance Management Strategy for:

Group 2  (Dicarboximide);
Group 3  (DMI);
Group 7  (Carboxamide);
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. DO NOT apply more than four Group 7 sprays per season. Always tank mix Group 7 fungicides with a protectant such as mancozeb or metiram.

5. 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.

6. Apply Group 11 fungicides preventively. Do not apply more than three foliar 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.

When using a Group 11 fungicide in-furrow at planting, use a fungicide from a different group as the first foliar spray.
Crop(s): Pulse Crops
Disease(s): Grey Mould (Botrytis)

Resistance Management Strategy for

Group 1 (Methyl Benzimidazole Carbamates); Group 2 (dicarboximide); and Group M3 (dithiocarbamate) fungicides

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.
Crop(s): Stone Fruit
Pest(s): Blossom Blight and Brown Rot

Resistance Management Strategy for:

- **Group 3** (DMI);
- **Group 2** (Dicarboximide); and
- **Group 9** (Anilinopyrimidine) fungicides

1. If applying **Group 2** or 3 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.
Crop(s): Strawberry
Pest(s): Grey Mould (Botrytis)

Resistance Management Strategy for

Group 2 (Dicarboximide);
Group 9 (Anilinopyrimidines);
Group 12 (Phenylpyrroles); 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 2, 9, 12 or 17 fungicide.

2. **DO NOT** apply more than two successive sprays of Group 2, 9, 12 or 17 fungicides.

3. 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.

4. If three or fewer Botrytis fungicide sprays are applied per crop, use only one spray containing a Group 12 fungicide. If four to six sprays are applied per crop use a maximum of two sprays containing Group 12 fungicides. If seven or more sprays are applied per crop use a maximum of three sprays containing Group 12 fungicides.
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. Apply Group 11 fungicides preventively. **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. **DO NOT** apply more than three Group 11 sprays per season.

5. **DO NOT** use Group 3 fungicides curatively.
Crop(s): Tomato  
Pest(s): Grey Mould

Resistance Management Strategy for: Group 2 (Dicarboximide) fungicides

1. Tank mix Group 2 fungicides with a protectant such as chlorothalonil. Avoid applying two Group 2 fungicides in succession, unless tank mixed with a protectant.

2. **DO NOT** apply more than four Group 2 sprays in a season.
Crop(s): Tomato
Pest(s): Target Spot (Early Blight)

Resistance Management Strategy for:

- Group 2 (Dicarboximide);
- Group 3 (DMI);
- Group 7 (Carboxamide);
- 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. DO NOT apply more than four Group 7 sprays per season. Always tank mix Group 7 fungicides with a protectant such as mancozeb or metiram.

5. 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.

6. Apply Group 11 fungicides preventively. 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.
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.