Guide to Turf Diseases In Australia
Australian owned & operated since 1940, Colin Campbell (Chemicals) Pty Ltd has provided farmers, turf managers/green keepers, golf course superintendents & the home gardener with high quality products to help them produce the premium surface/crop that is needed.

We began developing and registering specific turf products over 40 years ago. In that time our product range has expanded to cover a wide range of turf protection products from fungicides, herbicides, insecticides, fertilisers and wetting agents.

Over half our turf professional products are manufactured here in Australia. We refine the active ingredient before formulating the finished product to ensure the high quality. The rest of our products are sourced from some of the world’s most reputable and innovative companies in the pesticide market. Using high quality control standards our products are produced in Europe, USA and Israel. These companies provide us with the premier formulations that have become synonymous with our range.

We test all products stringently before bringing the product to the turf market. Chemicals obviously have to be registered with the APVMA and many trials have to take place. We have experienced staff to do this or use outside contractors who have specific expertise in turf trials and with whom we have established long term relationships. Even when using contractors to do the trials we still conduct some of the trials ourselves to know the products inside out and test them in various climatic conditions.

Other products in our range that do not have to be registered are still evaluated with numerous trials. We use overseas data and claims as a starting point for our trial work to test the product. We DO NOT introduce an overseas product without the necessary testing under Australian conditions.

We make sure the product we are evaluating:
- Works and the product does what it is meant to do
- We determine a rate or different rates to get the best possible result
- The product does not have any phytoxicity issues or non target issues
- Test the limitations of the product
- It lives up to the standard you expect from us.
Our specialisation in the turf industry together with our overseas partners over the last 70 years produced many notable achievements including:

- The introduction and development work for Terrazole® (etridiazole) & Terraclor® (quintozone) into Australia in the early 1970’s.
- The introduction and development work for chlorothalonil (Dacogreen® (formerly Daconil®)) into the turf industry in 1971.
- We introduced the then unique formulation of Microencapsulation into Australia in 1983 with Pennside® (microencapsulated diazinon)
- Released the first liquid thiram formulation in 1990
- Released Proplant® in 2002, giving turf managers curative and prevention control of pythium, for 4 weeks, longer than any other fungicide in the market.
- Introduced Blazon® Blue nationally in 2006 a non staining washable spray indicator. Followed by Blazon® Green in 2010.
- In 2009 we introduced Vorlon®, the next generation in Benzimidazole fungicides which has a broader spectrum and is more OHS friendly to the user than Carbendazim.
- In 2011 we introduced Monstar* a brand new resistance group (Group 7) and active ingredient for use on Fairy Ring.
- In 2012 we have introduced an innovative product called DewCure to reduce dew formation and frost damage
- In 2015 we bring a liquid version of our popular mancozeb Dek fungicides appropriately named Liquid Dek
- In 2017 we will have Monstar fully registered for use on Fairy Ring
- In 2017 we will bring Emerald a brand new contact fungicide

Along with providing a wide range of high quality products, we back them up with a strong customer service program of knowledge and after sales support.

Currently we are working on many research and development projects for the professional turf market and we look forward to releasing some new and exciting products within the next few years. Our team has long term experience in the turf and horticulture industries and are happy to answer any questions you may have.

*All product names mentioned are Registered Trademarks of their respective owners.
*For use on permit only.
CONTACT US

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View our website for Labels/SDS and other information (mobile & tablet friendly)
www.campbellchemicals.com.au

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QR (Quick Response Codes) are a type of two-dimensional barcode that can be read using smartphones and dedicated QR reading devices, that link directly to text, emails, websites, phone numbers and more.
Download a QR reader from your smartphone or tablet app store

Scan for website  Scan for turf blog  Scan for twitter
Dollar Spot
(Sclerotinia homeocarpa)

Dollar Spot is a very common disease that occurs on the majority of turf species. Symptoms of dollar spot are small circular sunken patches 2-3 cm in diameter. Leaves will first develop a tan coloured lesion and then appear bleached. Fungal mycelium will be seen on the leaf surface when dew is present. Dollar spot development is favoured by warm humid weather followed by cool nights with heavy dews. The cottony mycelium is generally evident on the leaf surface following dews. Dollar spot has become prevalent all year round in some areas.

Registered Fungicides for control:

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dacogreen®“WeatherShield”</td>
<td>130mL-200mL</td>
<td>M5</td>
</tr>
<tr>
<td>Ippon®</td>
<td>60mL-90mL</td>
<td>2</td>
</tr>
<tr>
<td>250 GT®</td>
<td>120mL-180mL</td>
<td>2</td>
</tr>
<tr>
<td>Vorlon®</td>
<td>56mL</td>
<td>1</td>
</tr>
<tr>
<td>Tridim®</td>
<td>60mL</td>
<td>3</td>
</tr>
<tr>
<td>Protak®</td>
<td>65mL</td>
<td>3</td>
</tr>
<tr>
<td>Emerald®</td>
<td>10mL-15mL</td>
<td>29</td>
</tr>
</tbody>
</table>
Rhizoctonia is the most widespread of all turfgrass diseases. It appears as circular patches ranging from a few centimetres to a metre in diameter. The patch is often yellow to brown in colour and in periods of high humidity a smoke ring of mycelium will appear around the outer edge. It can occur all year round depending on weather conditions.

**Registered Fungicides for control:**

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Dacogreen® “WeatherShield”</td>
<td>130mL-200mL</td>
<td>M5</td>
</tr>
<tr>
<td>Ippon®</td>
<td>60mL-90mL</td>
<td>2</td>
</tr>
<tr>
<td>250 GT®</td>
<td>120mL-180mL</td>
<td>2</td>
</tr>
<tr>
<td>Flowable TMTD®</td>
<td>160mL</td>
<td>M3</td>
</tr>
</tbody>
</table>
**Take All Patch**  
(*Gaeumannomyces graminis var. avenae*)

Take All Patch is a disease commonly associated with Bentgrass growing on poor draining soil. Damage to Bentgrass is severe and often is killed. Infections will occur in late spring with the turf appearing reddish brown in colour before fading to a dull brown. Patches will be circular or ring shaped. The centre of the ring is bare and allows for weed and competition grasses to inhabit. This disease is prone to soils with a high pH level.

**Registered Fungicides for control:**

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tridim®</td>
<td>60mL</td>
<td>3</td>
</tr>
</tbody>
</table>

**Damping Off**  
(*Pythium spp*)

Appears as circular spots during warm to hot humid weather. Spots appear as brown to bronze in colour. *Pythium* causes severe blighting to leaf and roots on existing turf and new seedlings. Outbreaks most severe in the warmer months but can occur in cooler weather. Symptoms can spread and grow very quickly if not treated when they first appear. All turfgrass species are susceptible to *Pythium*.

**Registered Fungicides for control:**

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proplant® (preventative &amp; curative)</td>
<td>45mL-65mL</td>
<td>28</td>
</tr>
</tbody>
</table>
Helminthosporium Complex
(Drechslera spp, Bipolaris spp, Exserohilum spp)

Is a leaf, crown and root disease that occurs in all turf species. Pathogen development is favoured by moisture on leaf surface and temperatures between 3°C and 30°C. Lesions tend to develop on the leaf and sheath tissue. It is often found in dead and decaying tissue. This disease will attack stressed plants. Bipolaris sp is a common disease of Kikuyu affecting the leaf tissue.

Registered Fungicides for control:

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tridim®</td>
<td>60mL</td>
<td>3</td>
</tr>
<tr>
<td>Ippon®</td>
<td>45mL</td>
<td>2</td>
</tr>
<tr>
<td>250 GT®</td>
<td>90mL</td>
<td>2</td>
</tr>
<tr>
<td>Flowable TMTD®</td>
<td>160mL</td>
<td>M3</td>
</tr>
<tr>
<td>Dek DF®</td>
<td>200g-250g</td>
<td>M3</td>
</tr>
<tr>
<td>Liquid Dek®</td>
<td>335mL-415mL</td>
<td>M3</td>
</tr>
<tr>
<td>Emerald® (awaiting registration)</td>
<td>10mL-15mL</td>
<td>29</td>
</tr>
</tbody>
</table>

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Spring Dead Spot
(*Leptosphaeria* spp) *(on Couch grass)*

Spring Dead Spot affects a wide range of couch species. Symptoms typical of the disease include large circular shaped bleached patches. Patches are generally visible in Autumn and Winter. Spring Dead Spot is most severe where couch growth is under prolonged periods of dormancy.

Registered Fungicides for control:

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ippon*</td>
<td>65mL</td>
<td>2</td>
</tr>
<tr>
<td>250 GT*</td>
<td>130mL</td>
<td>2</td>
</tr>
</tbody>
</table>

(Preventative only for both products)

Winter Fusarium
(*Microdochium nivale*)

Very common turf disease causes leaf blight and spots on leaf blade. Can appear as large or small patches in Autumn, Winter and Spring. Patches generally yellow to bronze in colour and sometimes with a pinkish tinge generally less than 200 mm in diameter. Turf with a heavy thatch is most susceptible to this disease. The disease favours cool moist weather.

Registered Fungicides for control:

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ippon*</td>
<td>90mL</td>
<td>2</td>
</tr>
<tr>
<td>250 GT*</td>
<td>180mL</td>
<td>2</td>
</tr>
<tr>
<td>Vorlon*</td>
<td>76mL</td>
<td>1</td>
</tr>
<tr>
<td>Tridim*</td>
<td>60mL</td>
<td>3</td>
</tr>
<tr>
<td>Flowable TMTD*</td>
<td>160mL</td>
<td>M3</td>
</tr>
<tr>
<td>Liquid Dek*</td>
<td>335mL-415mL</td>
<td>M3</td>
</tr>
</tbody>
</table>
Red Thread
(Laerisaria fuciformis)

Is a disease commonly associated by low levels of maintenance and a poor fertiliser regime. Red thread is active over a wide range of temperatures, when moisture is in abundance the pathogen forms masses of stroma that are lined by pink mycelium. The affected tissue eventually collapses and becomes brown in colour. Red thread is generally remedied with a fertiliser application.

Registered Fungicides for control:
There are no fungicides currently registered. Consult your Campbell representative for more information.

Anthracnose
(Colletotrichum spp, Microdochium bolleyi)

Causal agent is the fungus Colletotrichum sp. Affected areas first show up as patches that may range between 50 mm and 300 mm in size. The leaves of infected plant turn yellow and gradually change to bronze as conditions favour development. Turf species suffering from some form of stress, be it moisture or nutritional, are most susceptible. Poa annua is the most susceptible turf species to Anthracnose. Extreme temperature also aids development.

Registered Fungicides for control:

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerald®</td>
<td>10mL-15mL</td>
<td>29</td>
</tr>
</tbody>
</table>

Consult your Campbell representative for more control measures.


**Fairy Ring**  
*(_Basidiomycetes_ spp)*

- **Type 1**: Very common turf disease in all turf varieties. Usually first appears as small rings or arcs. Mushrooms may appear as well (type 3). As the rings grow outward it decomposes organic matter in thatch or soil and releases nitrogen (hence the dark green appearance -type 2). Turf can die due to fairy ring damage (type 1). With fairy ring soil becomes hydrophobic.

- **Type 2**:  

- **Type 3**:  

**Registered Fungicides for control:**

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per 100m²</th>
<th>Resistance Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monstar¯</td>
<td>150mL-200mL + wetting agent</td>
<td>7</td>
</tr>
</tbody>
</table>

If you would like a customised fungicide program or any other information in weed or pest management please do not hesitate to contact me on 0403 110 608 or zreikat@campbellchemicals.com.au

Nadeem Zreikat  
 */Information on diseases compiled with the assistance of Sportsturf Consultants Pty Ltd*
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DISEASE/PEST/WEED</th>
<th>RATE PER 100m²</th>
<th>PER BOWLING GREEN (38m x 38m)</th>
<th>RESISTANCE GROUP</th>
<th>MODE OF ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FUNGICIDES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dacogreen “WeatherShield” 720g/L Chlorothalonil</td>
<td>Dollar Spot, Brown Patch, Gray Leaf Spot</td>
<td>130mL-200mL</td>
<td>1.9L-2.9L</td>
<td>M5</td>
<td>Contact</td>
</tr>
<tr>
<td>Emerald 500g/L Fluazinam</td>
<td>Dollar Spot, Helmo Anthracnose, Gray Leaf Spot</td>
<td>10mL-15mL</td>
<td>144mL-216mL</td>
<td>29</td>
<td>Contact</td>
</tr>
<tr>
<td>Ippon 500 500g/L Iprodione &amp; 250 GT</td>
<td>Dollar Spot, Brown Patch, Fusarium, Black &amp; White Helmo, Spring Dead Spot, Leaf Spot</td>
<td>60mL-90mL, 90mL, 45mL, 65mL, 60mL</td>
<td>860mL-1.3L, 180mL-1.3L, 90mL-1.3L, 130mL-1.9L, 120mL-1.7L</td>
<td>2</td>
<td>Locally Systemic</td>
</tr>
<tr>
<td>Monstar 464g/L Flutolanil</td>
<td>Fairy Ring</td>
<td>150mL-200mL</td>
<td>2.1L-2.9L</td>
<td></td>
<td>Locally Systemic</td>
</tr>
<tr>
<td>Tridim 250g/L Triadimenol</td>
<td>Dollar Spot, Black Helmo, Take all patch, Winter Fusarium</td>
<td>60mL</td>
<td>860mL</td>
<td></td>
<td>Acropetally Systemic</td>
</tr>
<tr>
<td>Protak 450g/L Prochloraz</td>
<td>Dollar Spot</td>
<td>65mL</td>
<td>940mL</td>
<td></td>
<td>Locally Systemic</td>
</tr>
<tr>
<td>Proplant 605/L Propamocarb</td>
<td>Pythium (Damping Off)</td>
<td>45mL-65mL</td>
<td>650mL-940mL</td>
<td>28</td>
<td>Acropetally Systemic</td>
</tr>
<tr>
<td>Vorlon 500g/L Thiabendazole</td>
<td>Dollar Spot, Winter Fusarium</td>
<td>56mL, 76mL</td>
<td>810mL, 1.1L</td>
<td></td>
<td>Acropetally Systemic</td>
</tr>
<tr>
<td>Flowable TMDT 600g/L Thiram</td>
<td>Brown Patch, Black Helmo, Leaf Spot, Fusarium Patch, Damping off</td>
<td>160mL, 200mL</td>
<td>2.4L, 2.9L</td>
<td></td>
<td>Contact</td>
</tr>
<tr>
<td>Liquid Dek 420g/L Mancozeb</td>
<td>Brown Patch, Black Helminthosporium, Fusarium Patch</td>
<td>335mL-415mL</td>
<td>4.8L-6L</td>
<td></td>
<td>Contact</td>
</tr>
<tr>
<td><strong>INSECTICIDE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biff 100g/L Bifenthrin</td>
<td>Black Beetle, Stem Weevil, Billbugs, Grass eating caterpillars</td>
<td>25-36mL, 12mL, 12mL</td>
<td>361-520mL, 173mL, 173mL</td>
<td>3A</td>
<td>Contact</td>
</tr>
<tr>
<td>Pennside 240g/L Diazinon (Microencapsulated)</td>
<td>Black Beetle, Stem Weevil, Mole Cricket, Grass eating caterpillars</td>
<td>125mL, 125mL-250mL, 200mL, 30mL</td>
<td>1.8L, 1.8L-3.6L, 2.9L, 430mL</td>
<td>1B</td>
<td>Contact and Stomach</td>
</tr>
<tr>
<td><strong>HERBICIDES</strong></td>
<td></td>
<td></td>
<td>650mL</td>
<td>I</td>
<td>Disrupts cell growth</td>
</tr>
<tr>
<td>Methar Tri-Kombi Mecoprop, 2,4-D, Dicamba</td>
<td>Mecoprop, MCPA, Dicamba</td>
<td>42mL, 4.2L/ha</td>
<td>650mL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sportsground Mecoprop, MCPA, Dicamba</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passtox Clear 220g/L DSMA</td>
<td>Paspalum, Crab Grass, Summer Grass, Sedges, Nut grass, Mullumbimby Couch</td>
<td>250mL-660mL (depending on grass type)</td>
<td>3.8L-10L (depending on grass type)</td>
<td>K</td>
<td>Diverse mode of action</td>
</tr>
<tr>
<td>Poachek 175g/L Endothal</td>
<td>Winter Grass (Poa annua)</td>
<td>15mL, 1.5L/ha</td>
<td>216mL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This is only a guide to Winter Fusarium & Helmo management and can vary considerably for differing temperature zones throughout Australia with the occurrence of the disease. Always read the label before using any product.
DOLLAR SPOT RESISTANCE MANAGEMENT

**Protak® 450EC**
*Systemic Fungicide*
- Active Constituent: 450g/L Prochloraz
- Group 3 Fungicide
- Dollar Spot: 65mL per 100m²

**Diseases controlled by Protak:**
- Dollar Spot

**Protak® 250GT**
*Systemic Fungicide*
- Active Constituent: 450g/L Prochloraz
- Group 3 Fungicide
- Dollar Spot: 65mL per 100m²

**Diseases controlled by Protak:**
- Dollar Spot

**Ippon® 250GT**
*Systemic Fungicide*
- Active Constituent: 450g/L Prochloraz
- Group 3 Fungicide
- Dollar Spot: 65mL per 100m²

**Diseases controlled by Ippon:**
- Dollar Spot

**Protak® 450EC**
*Systemic Fungicide*
- Active Constituent: 450g/L Prochloraz
- Group 3 Fungicide
- Dollar Spot: 65mL per 100m²

**Diseases controlled by Protak:**
- Dollar Spot

**Tridim® 250EC**
*Systemic Fungicide*
- Active Constituent: 250g/L Triadimenol
- Group 3 Fungicide
- Dollar Spot: 60mL-90mL

**Diseases controlled by Tridim:**
- Dollar Spot, Fusarium, Take All patch & Black Helmo

**Vorlon® 500SC**
*Fungicide*
- Active Constituent: 500g/L Thiabendazole
- Group 1 Fungicide
- Dollar Spot: 56mL per 100m²

**Diseases controlled by Vorlon:**
- Dollar Spot

**DOLLAR SPOT MONTHLY PREVENTATIVE SPRAY GUIDE (GROUP)**

<table>
<thead>
<tr>
<th>Month</th>
<th>Ippon Rate per 100m²</th>
<th>250GT Rate per 100m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>60mL-90mL</td>
<td>120mL-180mL</td>
</tr>
<tr>
<td>August</td>
<td>45mL</td>
<td>90mL</td>
</tr>
<tr>
<td>September</td>
<td>90mL</td>
<td>180mL</td>
</tr>
<tr>
<td>October</td>
<td>65mL</td>
<td>130mL</td>
</tr>
<tr>
<td>November</td>
<td>60mL</td>
<td>120mL</td>
</tr>
<tr>
<td>December</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is only a guide to Dollar Spot management and can vary considerably for differing temperature zones throughout Australia with the occurrence of the disease. Always read the label before using any product.
**Alkaline Hydrolysis**

High pH of water can cause some chemicals to break down. This is referred to as Alkaline Hydrolysis. It is very important to test the pH of your water each time before using any chemical. Having the wrong pH can greatly reduce the effectiveness of your chemical.

<table>
<thead>
<tr>
<th>Product</th>
<th>Formulation</th>
<th>pH stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dacogreen*</td>
<td>SC</td>
<td>5-9</td>
</tr>
<tr>
<td>Dek*</td>
<td>DF</td>
<td>stable over wide range</td>
</tr>
<tr>
<td>Flowable TMTD*</td>
<td>SC</td>
<td>stable over wide range</td>
</tr>
<tr>
<td>Monstar*</td>
<td>SC</td>
<td>3-11</td>
</tr>
<tr>
<td>Vorlon*</td>
<td>SC</td>
<td>stable over wide range</td>
</tr>
<tr>
<td>Ippon &amp; 250GT**</td>
<td>SC</td>
<td>5-6</td>
</tr>
<tr>
<td>Monstar*</td>
<td>SC</td>
<td>stable over wide range</td>
</tr>
<tr>
<td>Protak*</td>
<td>EC</td>
<td>stable over wide range</td>
</tr>
<tr>
<td>Tridim*</td>
<td>EC</td>
<td>4 - 8.5</td>
</tr>
<tr>
<td>Proplant*</td>
<td>SL</td>
<td>3-7</td>
</tr>
<tr>
<td>Pennside*</td>
<td>CS</td>
<td>4 - 8.5</td>
</tr>
<tr>
<td>Methar Tri Kombi*</td>
<td>SL</td>
<td>4 - 8.5</td>
</tr>
<tr>
<td>Sportsground*</td>
<td>SL</td>
<td>4 - 8.5</td>
</tr>
<tr>
<td>Poachek*</td>
<td>SL</td>
<td>stable over wide range</td>
</tr>
<tr>
<td>Passtox Clear*</td>
<td>SL</td>
<td>stable over wide range</td>
</tr>
</tbody>
</table>

If water is below or above pH add appropriate buffers/acidifiers. Always use spray solution within day of making up mixture.

**Procedure for Tank Mixing:**
1. Half fill tank with water and start agitation
2. Add water conditioners such as pH buffers/defoaming agents if needed
3. Add pesticides in the following order:
   a) Wettable Powder (WP)
   b) Water Dispersible Granule (WDG)
   c) Dry Flowable (DF)
   d) Suspension Concentrate (SC)
   e) Capsule Suspension (CS)
   f) Emulsifiable Concentrate (EC)
   g) Soluble Liquid (SL)
4. Add adjuvants (oils, surfactants) if needed
Fungicides are a vital tool in management practices and are essential in disease control. Fungicide resistance is a topic that is not as well understood as it could be. This article aims to provide an understanding of resistance, how it occurs, the mode of action of fungicides and strategies to help in managing resistance.

Bear in mind the only way to prove resistance is to get scientific tests done.

**What is Resistance & how it occurs?**

Resistance occurs when a fungus which was sensitive to a fungicide becomes resistant to it (Vargas). Another definition is “resistance is a genetic adjustment by a fungus that results in reduced sensitivity to a fungicide.” (Damicone)

There are 2 strains of fungus in turf. These are the:

- Wild Type Strain &
- Resistant Strain

The Wild Type strain is the natural fungus in the turf that has been present before any fungicide has ever been used. The fungus is sensitive to the fungicide and thus the fungus is eliminated.

The Resistant Strain is the fungus that is not eliminated by the fungicide. The build up of the resistant strain is caused by repeated use of the fungicide and the selectivity of the fungicide *against* the wild type strains and *for* the mutant resistant strain. Thus the fungicide only works on the sensitive strain and not the resistant strain, which in turn becomes an increasing proportion of the total fungus population, as long as that fungicide is continually used as a selection agent.

Keep in mind that it is the mutation of genes that causes resistance. The fungicide applied works on the fungus that is the wild type strain thus allowing an increase in the resistant strain. Once the resistant strain is dominant and the wild type strain is the minority the fungicide will no longer be able control the fungus, hence resistance. Another way of putting it is “The fungicide selectively inhibits sensitive strains (Wild Type) but allows the increase of resistance strains (Damicone).”

**Fungicides:**

There are 2 categories that the fungicides can be split into:

- Single site fungicides or
- Multi site fungicides.

**Single Site (SS):**

SS fungicides only stop the fungus from growing by attacking only one or a few vital systems of the fungus (Vargas). They work with a single mode of action. These types of fungicides are referred to as systemic fungicides (e.g. Triadimenol (Tridim°),
Iprodione (Ippon 500®) etc. With this in mind SS fungicides only need a mutation of a single gene for the fungus to become resistant to the fungicide. These fungicides may be from different groupings but each group has a specific single mode of action. Example Groups 1,2,3.

**Multi Site (MS):**

MS fungicides attack many different vital systems of the fungus and have multiple modes of action. Common MS fungicides belong to Group Y e.g. Thiram (Flowable TMTD®), Chlorothalonil (Dacogreen®), Propamocarb (Proplant®). To become resistant to MS fungicides a fungus has to have simultaneous mutations of the genes that control the metabolic pathways or conditions that the fungicide is interfering with. Hence this is the reason why resistance is difficult with this group.

Fungicides are either contact or systemic.

**Contact**

- Contact fungicides are the multi site fungicides. (Group M Fungicides) They work by forming a protective barrier around the plant tissue (i.e. chemical barrier between the fungus and the plant). They do not penetrate the plant. They generally last only 7-14 days depending on the physical removal by mowing, physical wear by players, sunlight and rainfall/watering New shoots are not protected. Examples are Flowable TMTD, Dek and Chlorothalonil (Dacogreen®).

**Systemic Fungicides**

**Systemic**

- Systemic fungicides are absorbed by the plant. The fungicide works inside the plant to control the fungus and stop the plant from being infected and will also protect new growth. The residual effect comes from the fact that the plant has absorbed the fungicide and, once absorbed water and sunlight is not an issue. However, degradation by the plant metabolism may still occur. Fully systemic fungicides move up and down the plant.

**Basipetal systemic**

- Basipetal systemic fungicides are translocated throughout the plant in a downwards direction through the phloem (sap).

**Acropetally systemic**

- Acropetally systemic fungicides are translocated throughout the plant in an upwards direction through the xylem (water transport). Hence it is important to wash these fungicides off the leaf surface so they can be absorbed by the roots. Examples are Tridim and Proplant.
Locally systemic or meso systemic

- Locally systemic fungicides move below the plant surface but will only move very short distances. They have similar characteristics to contact fungicides in that they protect the plant at the point of contact but, unlike contact fungicides, they move into the plant tissue. These are also commonly known as translaminar because, when applied to one surface of the leaf, they are able to move through the leaf to the other surface of the leaf. Examples are Ippon and Protak.

Be aware, even though systemic fungicides have a residual of up to 28 days they may last much less than this depending on disease pressure at the time. If disease pressure is high with wet day/nights, high night/day temperatures and high humidity, the fungicide may not control for 28 days and subsequent applications may be needed.

MS fungicides can prevent the germination of the fungus spore or kill the germinating spore once the germ tube and the fungicide come into contact. Once the residual of the fungicide has gone, spores can germinate and infect the plant. This is where the SS fungicide becomes a useful weapon because once the spore has germinated the SS fungicide can have a curative effect by stopping the progression of the germ tube or by having an adverse effect on a metabolic pathway of the fungus that is vital to its further development.

Mode of Action:

**Group 1-** cell division of the fungus. When the fungus cannot divide and produce new cells, and the energy stored is used up then the fungus dies. This group needs the fungus to have germinated to have an effect.

**Group 2-** Inhibit spore germination and cause hyphal bursting where the germ tube bursts and the fungus spore cannot complete germination.

**Group 3-** This fungicide group works by preventing fungi from developing cell membranes. Without the membranes, cells cannot be made and thus the fungus dies. This group needs the fungus to have germinated to have an effect.

**Group 4-** inhibit mycelium growth and spore production. Interferes with the function of RNA polymerase enzymes which are essential for building proteins necessary for cell structure.

**Group 7-** Stops fungi from producing energy following infection hence the fungi cannot grow and reproduce.

**Group 11-** fungicides- inhibit spore germination and stops energy transfer of the disease. Works on the early stages of mycelium growth.

Continued on next page
Group 28—multi site properties with low risk resistance
Attacks the cell membrane of mycelium, eliminates the fungi and prevents any new spores from germinating. Works on a preventative and curative basis

Know your fungicide—Always read the label
It is essential that you know the product label. The label states information about:
• What the product contains (active constituent);
• What it is used for, and;
• How to use it.

The label of a product is a legal document and must be adhered to. For resistance purposes you need to look at the box under the name specifying what group the product is. The box is black in colour with white print.

When filling out a spray diary it is always beneficial to record what Resistance Groups were used along with the rates and product used. This will ensure that you do not consecutively use the same fungicide group too many times, and be able to adapt your fungicide program as needed.

One of the most common complaints of fungicides is that “the product did not work or work as well as expected”. There are many factors that are the more likely to cause this rather than resistance. Resistance can only be proven by scientific means.

Keep in mind:
• Right rates are used
• The fungicide is applied correctly with the correct equipment and water volume and timing. Understand how the chemical you are using works.
• The spray equipment is calibrated correctly and running efficiently.
• Especially make sure the nozzles are in good working order and they are the correct type.
• The more established the disease the harder it is to eradicate it—hence there may not be as long residual as expected from the fungicide and follow up applications at shorter intervals will need to be made.
• If the grass is too weak not even the best fungicide will revive it—hence recovery is essential to minimise re-occurrence of the disease.

Strategies in dealing with resistance.
So far there is no fool proof way to deal with resistance but there are guidelines available. Keep in mind you cannot eliminate resistance but can only seek to delay the onset of it.

Two common strategies are:
• Use a combination of Single site systemic with a contact (multi site)
According to Vargas, for these theories to work the MS (Multi Site) fungicide will have to eliminate the resistant strain of the fungus that develops to the SS fungicide. MS fungicides do not do this. They do not select or eliminate one strain over another, but remove the selective effort of the SS fungicide for the “resistant” strains. In natural systemics the “Wild type Strain” is often the more aggressive of the two types and will out compete the “resistant” strain once the influence of the offending (often the SS fungicide) is removed.

As well, when applying a SS systemic and a contact fungicide together, there is still selective pressure on the fungal population for at least 7-14 days. Why? Because the residual of contacts being 14 days and SS systemics being up to 28 days. For example putting together a MS fungicide that controls brown patch and dollar spot with a SS product for dollar spot may give you up to 28 days control for the dollar spot but only up to 14 days control of brown patch. This is due to the fact the MS fungicide controls brown patch while the SS only does dollar spot. Thus another spray for brown patch is needed within 2 weeks of the application.

Other strategies include:
- Alternate between groups- standard recommendations from CROPLIFE state if you are going to spray same group twice tank mix second spray With a product from a different group.
- Use good cultural practices to reduce fungicide applications such as allowing good air movement throughout the green with plenty of light and deep watering to increase root depth to naturally fight off the disease.

This article has pointed out a basic understanding about fungicide resistance, how it occurs and the way to control fungus disease with information relating to the mode of action and classifications of fungicides. The topic of fungicide resistance is fairly vigorous and more information is attainable in various turf related publications. As well, there are various strategies that can be used in managing fungicide resistance but, more importantly, it is essential that you use your fungicide as it is stated on the label and to alternate the fungicide groups used to ensure longevity of the products and best results.

For anyone wanting advice on fungicide programs please do not hesitate to contact us.

By Nadeem Zreikat( 0403 110 608) Colin Campbell (Chemicals) Pty Ltd ©2008
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References
Management of Turfgrass Diseases 2nd Ed J.M Vargas Jnr 1994
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Found www.askjeves.com June 2004
CROPLIFE Found www.croplifeaustralia.org.au June 2004
### WEED & PEST MANAGEMENT TIMING APPLICATIONS

<table>
<thead>
<tr>
<th>Month</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>Methar Tri-Kombi® / Sportsground®  for Broadleaved Weeds &amp; Flat weeds  Rate 4.2L/ha</td>
</tr>
<tr>
<td>February</td>
<td>PASSTOX® Clear  for summer grass, paspalum, mullumbimby couch, sedges, nut grass crab grass Rate 25L-66L/ha</td>
</tr>
<tr>
<td>March</td>
<td>1.2L-2.43L/ha(12 - 24mL/100m²)  for control of Black Beetle, Mole Cricket, Stem Weevil, Armyworm &amp; Cutworm  Rate 12.5L-25L/ha</td>
</tr>
<tr>
<td>April</td>
<td>POACHEK® for winter grass (poa annua)  Rate 1.5L/ha</td>
</tr>
<tr>
<td>May</td>
<td>PENNSIDE® for control of Black Beetle, Mole Cricket, Stem Weevil, Armyworm &amp; Cutworm  Rate 12.5L-25L/ha</td>
</tr>
<tr>
<td>June</td>
<td>BIFF® for control of Adult Black Beetle, Bilbug Mole Cricket, Stem Weevil, Armyworm &amp; Cutworm, ants  Rate 1.2L-4.4L/ha</td>
</tr>
<tr>
<td>July</td>
<td>POACHEK® for winter grass (poa annua)  Rate 1.5L/ha</td>
</tr>
<tr>
<td>August</td>
<td>PASSTOX® Clear  for summer grass, paspalum, mullumbimby couch, sedges, nut grass and crab grass Rate 25L-66L/ha</td>
</tr>
<tr>
<td>September</td>
<td>PENNSIDE® for control of Black Beetle, Mole Cricket, Stem Weevil, Armyworm &amp; Cutworm  Rate 12.5L-25L/ha</td>
</tr>
<tr>
<td>October</td>
<td>BIFF® for control of Adult Black Beetle, Bilbug Mole Cricket, Stem Weevil, Armyworm &amp; Cutworm, ants  Rate 1.2L-4.4L/ha</td>
</tr>
<tr>
<td>November</td>
<td></td>
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<td>December</td>
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**DIRECTIONS FOR USE**

Biff is a contact and residual insecticide/miticide. It can be used as a protective treatment when applied at immediately prior to or after heavy rain to avoid run-off of the chemical.

Insecticide Resistance Warning

GROUP 3A INSECTICIDE POISON variability in any insect population. The resistant individuals can eventually dominate the insect population if Biff and other Group 3A insecticides are used repeatedly. The effectiveness of Biff on resistant individuals could be significantly reduced.

**CROP PEST RATE CRITICAL COMMENTS**

- Two spotted mite (*Tetranychus urticae*) in carnations
- Caterpillars and loopers, including heliothis (corn ear worm, native budworm) (*Helicoverpa spp*), Poinsettia whitefly (*Bemisia tabaci*), geranium plume moth (*Acrobasis nymphaeae*), Asian citrus psyllid (*Diaphorina citri*), two-spotted spider mite (*Tetranychus urticae*), leaf curl whitefly (*Bemisia tabaci*), greenhouse whitefly (*Trialeurodes vaporariorum*)
- Two-spotted spider mite (*Tetranychus urticae*) in strawberries
- Pink bollworm (*Pectinophora gossypiella*)
- Meshed leaf miner (*Cydia melana*),management of citrus mealybug (*Phenacoccus solenopsis*)
- Whiteflies (*Bemisia tabaci*) in tomatoes
- Spotted gum thrips (*Scirtothrips citri*)
- Spotted gum thrips (*Scirtothrips citri*) in Citrus

**GROUP 3A INSECTICIDE POISON**

**POISON**

- Pesticides and other Group 3A insecticides should be used with caution to avoid the development of resistant populations.
- Insecticide resistance management strategies should be implemented to minimize the risk of resistance development.

**KEEP OUT OF REACH OF CHILDREN**

- Do not allow re-entry into treated areas until the spray deposits have dried or have been covered by ground cover or a spray volume of 150 to 200 microns. DO NOT apply as a fog or mist.
- Mix Biff in water and apply evenly over the area to be treated using spray application equipment. Apply to areas where pest infestations are present.
- Spray in the night or early morning when bees are not actively foraging.
- Calibration of the spray equipment is necessary to achieve the correct spray volume.
- 20mL/100L Apply at first sign of pest infestation and before pest populations and pest pressure is high reducing the spray interval to 3-4 days while pest pressure persists. More than three sprays may be necessary to achieve effective control.

**PROTECTION OF WILDLIFE, FISH, CRUSTACEA AND THE ENVIRONMENT**

- Dangerous to fish and other aquatic organisms. DO NOT contaminate streams, rivers or waterways with the chemical or used containers.
- Spray in the night or early morning when bees are not actively foraging.
- For crops grown for human consumption, usage times of these products can vary in different climatic conditions. Always read the label before using any product.

**PROTECTION LIVESTOCK**

- This is only a guide and should be taken as such. Usage times of these products can vary in different climatic conditions. Always read the label before using any product.

**Spray Indicator**

- Tru Blue®  Patented non-staining blue spray indicator
- Blazon®  Patented non-staining blue spray indicator

**Microencapsulated Insecticide**

- Blockside®  3 Way Action Weed Control

**Insecticide Resistance Warning**

- Resistance to Group 3A insecticides can develop over time if these products are used repeatedly. It is recommended to rotate to other insecticides and to use appropriate management strategies to prevent resistance development.

**Further information can be obtained from the Material Safety Data Sheet.**

**FIRST AID**

- In case of spillage, confine and absorb spilled product with absorbent material such as sand, clay or cat litter. Dispose of waste as indicated below or according to Australian Standard AS2507 – Storage and Handling of Pesticides.
- DO NOT allow spilled product to enter sewers, drains, creeks or any other waterways.
- Triple or preferable recycling break, crush, or puncture and bury empty containers in a local authority landfill. If no landfill is available, instructions for local council or other appropriate authorities should be followed.

**Material Safety Data Sheet**

- Biff contains a surfactant. Additional surfactant may be necessary on hard to wet plants and in areas of high pest pressure.

**Contents**

- 5L

**Storage and Transport**

- Not classified as a dangerous good for storage and transport in Australia. For sale to registered pest control operators and qualified users.

**Batch Number**

- 5 Blackfriar Place, Wetherill Park NSW  Phone: (02) 9725 2544

**Colin Campbell (Chemicals) Pty. Ltd.**

www.campbellchemicals.com.au  (02) 9725 2544

This is only a guide and should be taken as such. Usage times of these products can vary in different climatic conditions. Always read the label before using any product.
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