Management of fruit rot diseases and fungicide resistance

Apollo Gomez, Queensland Department of Agriculture and Fisheries

Apollo Gomez is a research scientist for Queensland DAF and have been involved in several DAF strawberry disease management projects since 2002. He is also a member of the Australian Strawberry Breeding Program focused on developing new strawberry varieties with resistance to important strawberry diseases.

- It is critical to understand and use fungicides correctly to manage disease and avoid the development of fungicide resistance.
- Reliance or repeated use of products from the same fungicide groups increases the risk of fungicide resistance
- Fungicide resistance must be avoided as it will put pressure on other fungicide groups, potentially leading to significant yield losses.

New fungicide registrations for strawberry production will provide more disease management options for producers to manage fruit diseases. It is critical to be aware of these new products, along with having good cultural and hygiene farm practices to optimise disease management and equally important, to avoid the development of fungicide resistance.

Fruit diseases are part of strawberry production, whichever part of the country you are in and what production systems you are using. Diseases such as grey mould, powdery mildew, black spot, leather rot, etc. tend to appear when conditions such as extended periods of wet weather, or dry but high humidity conditions are present.

For most fruit producers, fungicides are an important component of strawberry disease management. Recent fungicide registrations for strawberry production include Botector®, Flute®, Kenja® and Serenade® Opti, and also Miravis® Prime, expected to be registered sometime in 2021. It is important to understand how fungicide products work in order to maximise disease management. Equally important is to ensure they are used correctly to avoid fungicide resistance developing.

How do fungicides work?

Fungicides protect plants by destroying or inhibiting the growth and development of fungal pathogen. A pathogen is an organism that can cause disease, e.g., Botrytis cinerea is the fungal pathogen that causes grey mould disease. Fungicides will not work against other pathogens, such as bacteria, viruses, nematodes or phytoplasmas.

Different fungicides attack pathogens in different ways. This is commonly referred to as their mode of action (MOA) and the basis of how fungicides are grouped. For each fungicide product, a number or a number/letter combination represents the MOA and is indicated in the label (see Figure 1). The MOA is also referred to as the fungicide group or FRAC Code (FRAC stands for Fungicide Resistance Action Committee, which provides guidelines on fungicide chemistry and resistance management internationally). There are many fungicide products in the market. Fungicides with the same number have the same or similar mode of action, therefore the same fungicide group/FRAC Code.

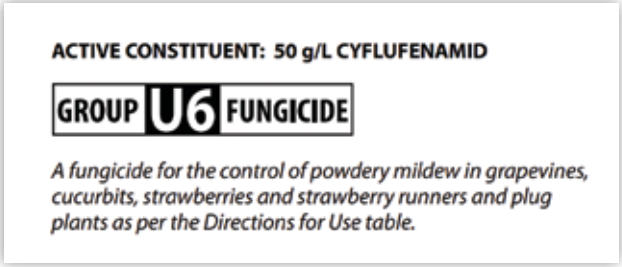


Figure 1. Part of a fungicide product label showing the FRAC Code or fungicide Group

Multi-site and single-site fungicides

Multi-site fungicides, also generally known as 'protectants', act as a shield on the surface of the leaves and fruit. These fungicides can affect multiple target sites (such as proteins and enzymes) of the fungus. Examples include Captan, Thiram, Eco-carb, Serenade® Opti and Botector®, and the risk of resistance to these fungicides developing is low.

On the other hand, single-site fungicides, also known as 'systemics', are able to be absorbed and moved around by the plant internally and target only one specific site of the fungus. If a mutation occurs in that one site the fungicide will no longer be effective i.e., resistance has developed. Single-site fungicides are considered 'high-risk' in terms of developing resistance. There are maximum sprays allowed per season for a fungicide/fungicide group (e.g., Flint, Systhane®, Scala®, Flute®, etc) to help manage the risk.

Why is fungicide resistance a concern?

- Reliance or repeated use of a fungicide or products from same fungicide group, particularly single-site fungicides, increases the risk of pathogen populations becoming resistant.
- There is genetic variability in pathogen populations and that variability gives protection and may allow those populations with resistance to survive and multiply if the same fungicides are used.
- As a result, over-time, the effectiveness of a fungicide product or products within the same group will be reduced.
- In the worst-case scenario, the fungicide will no longer be effective in controlling the pathogen that causes the disease.
- For strawberry production, fungicide resistance should be avoided as it will put significant pressure on other fungicide groups, potentially leading to significant yield losses.

What fungicides are currently available for strawberry fruit production?

The registered products available for strawberry production are presented in Table 1.

What can we do to avoid fungicide resistance from developing?

- Only use products registered for use in strawberry production.
- Always follow product label instructions, with regards to application, rates, withholding periods, maximum sprays, storage, etc., including restrictions and other spray conditions stated.
- Rotate fungicides with different activity groups/ FRAC Code throughout the crop growing season.
- Manage the use of different fungicide products that are in the same group.
- Manage the use of co-formulated products. These are products that have two ingredients; hence two fungicide groups are applied at a time. For example, the soon to be registered product Miravis® Prime has two active ingredients. One belongs in Group 7 (same group as products Fontelis® and Kenja®) and the other in Group 12, which is also a component of another co-formulated product, Switch fungicide.
- Spray coverage is critical to control/manage both powdery mildew and grey mould, where infection occurs mainly on the lower side of the leaves and on fruit that may be within or under the plant canopy
- Reduce the amount of disease inoculum through cultural and hygiene practices, such as regular disease monitoring, removal of diseased fruit or plant debris within the production area, and adequate plant spacings to reduce moisture and humidity around the plants.
- CropLife Australia promotes the responsible use of pesticides to ensure sustainable outcomes and is a good resource for more information on fungicide resistance management (www. croplife.org.au).
- Early detection of pathogen populations for fungicide resistance is important to consider changes in fungicide practices and prevent yield losses.

Table 1. Fungicides for strawberry fruit production

Source: APVMA, CropLife Australia, Australian Berry Journal Summer 2020 edition and product label.

FRAC Code/ Group	Active Constituent	Product names	Registered for	Some conditions to note
2	iprodione	Various, e.g Rovral®	Grey mould	1-day WHP
3	myclobutanil	Various, e.g. Systhane®	Powdery mildew	4 max. sprays of Group 3/season
7	penthiopyrad	Fontelis®	Grey Mould and Powdery Mildew	3 max. sprays of Group 7/season
7	isofetamid	Kenja®*	Grey mould	3 max. sprays of Group 7/season
7 + 12	pydiflumetofen + fludioxonil	Miravis® Prime*#	Grey mould and powdery mildew	3 max. sprays of Group 7 and 12/season
9	pyrimethanil	Various, e.g. Scala®	Grey mould	1-day WHP; 3 max. sprays of Group 9/season
9 + 12	cyprodinil + fludioxonil	Switch	Grey mould and Colletotrichum crown rot	3-day WHP, 3 max. sprays of Group 9 and 12/season
11	trifloxystrobin	Various, e.g. Flint	Powdery mildew	1-day WHP; 3 max. sprays of Group 11 /season
17	fenhexamid	Various, e.g. Teldor®	Grey mould	1-day WHP
U6	cyflufenamid	Flute®*	Powdery mildew	2 max. sprays of Group U6/season
M2	sulphur	Various, e.g. Thiovit®	Powdery mildew	NSW and WA only
M2	potassium bicarbonate	Various, e.g. ecocarb	Powdery mildew	
M2	potassium bicarbonate + potassium silicate	ecocarb PLUS	Powdery mildew	
M3	thiram	Various, e.g. Thiram	Grey mould, and black spot	2-day WHP
M4	captan	Various, e.g. Captan	Grey mould, black spot, scorch, leaf blight and leather rot	1-day WHP
BM02	Bacillus amyloliquefaciens strain QST 713	Serenade® Opti*	Grey mould	
	Aureobasidium pollulans	Botector®*^	Grey mould, anthracnose fruit rot, Phomopsis fruit rot, and Rhizopus fruit rot	

**'Protected cropping' stated in the label; #Expected to be registered early 2021; ^Not yet classified; FRAC = Fungicide Resistance Action Committee; WHP = withholding period.*

Suggested grey mould strategy

A general strategy is to rotate multi-site products to provide protection when flowers start to appear and when disease pressure is low.

Apply single-site fungicides when conditions that favour disease development (e.g., rainy periods) are imminent and rotate with other fungicide groups when disease persists. Removal of diseased fruit will help reduce the amount of inoculum.

Severity of grey mould disease is generally dependent on wet periods. Rotation of multi-site products may be enough if disease pressure is low combined with on-farm practices to reduce inoculum.

In protected cropping systems, the incidence of grey mould is generally lower than in plants grown outdoors.

Suggested powdery mildew strategy

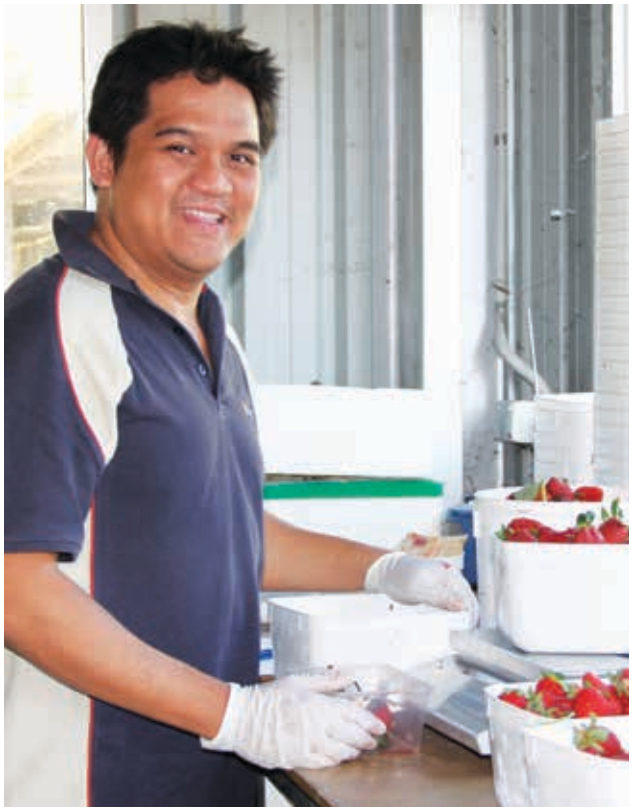
Management of powdery mildew differs to that of grey mould. Different production systems (open-field, substrate/tabletops, tunnels, cloches) and the length of the season in different production areas must be considered. Crop consultants can provide a specific and strategic approach for management of powdery mildew relevant to different production areas and systems.

Fungicide options for powdery mildew are limited for strawberry, hence why powdery mildew ranks as a high priority in the Strategic Agrochemical Review Process (SARP) for strawberry. New fungicides with different modes of action (both multi-site and single-site) are needed.

Disclaimer: While care has been taken to ensure the accuracy of the information provided in this document the APVMA registered label and/or where relevant the APVMA approved permit must always be followed. The strategy discussed in this article is only a guide. DAF do not specifically endorse any of the products mentioned and is not liable for any loss or damage suffered.

Queensland Government

Fruits infected with grey mould.
Photo credit: Chris Menzel, DAF.



Apollo evaluating yield.
Photo credit: Chris Menzel, DAF.