Field Guide

to common diseases and disorders of passionfruit in New Zealand

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FOREWORD

Purpose of this booklet

Passionfruit vines are affected by a range of fungal, bacterial and viral diseases, which can cause high plant and crop losses. Accurate disease diagnosis of passionfruit diseases is essential for effective control. Their identification is difficult, particularly for growers that are new to the industry. This booklet was produced to help the passionfruit growers of New Zealand to identify the common diseases affecting their crop and to provide guidance on their control. It is an outcome of the Sustainable Management of Passionfruit Diseases Project funded by the Ministry of Agriculture and Forestry Sustainable Farming Fund (Grant no. 06/094), The N.Z. Passionfruit Growers Association Incorporated and the New Zealand Fruitgrowers Charitable Trust.

Outline of booklet

This booklet describes the most common diseases of the purple passionfruit, *Passiflora edulis* Sims, which is the only species of commercial importance in New Zealand. The booklet focuses on diseases, and they have been grouped into *Canopy diseases* and *Crown and root diseases*. Some common disorders not caused by pathogens, and injuries caused by insects, have been included as a third section in *Other disorders and insect injuries*.

For each disease, a written description and photograph(s) of the general symptoms, a note on control options and a diagram of the disease cycle are provided. Few detailed studies of the disease cycles of the various pathogens of passionfruit have been conducted. The illustrated disease cycles are mostly based on knowledge from other crops and describe the likely cycle of the diseases on passionfruit. Most of the photographic material was collected during the Sustainable Management of Passionfruit Diseases Project. Over this period, a few diseases were not observed in the field although they have frequently been reported in other studies. Photographs of the symptoms of these diseases have been obtained from other sources and are acknowledged for each photograph.

The majority of the diseases occurring in the canopy are managed using the same control measures. Instead of repeating these measures for every disease, a chapter on the general options for the control of canopy diseases is provided at the end of the booklet.

CANOPY DISEASES

1 BROWN SPOT

Other names: none

Causative organism

Alternaria passiflorae J.H. Simmonds

This fungal disease is the most common disease of passionfruit leaves, stems and fruit in New Zealand.

Symptoms

Spots on fruit are light brown, concave and circular in the early stages and develop into a wrinkled and depressed rot that may cover up to half the fruit. On leaves, spots are typically 5–10 mm diameter, at first chestnut brown, drying out to lighter shades and often with a pale yellow halo in the surrounding leaf tissue. They often become irregular or angular in shape. Conidiospores are often visible as a dusky covering in the centre of the spots on fruit and leaves. In contrast to affected fruit, which remain attached to the vine, infected leaves soon drop and in severe cases, vines may become completely defoliated. Infection of the canes typically occurs in the region of the leaf axils, from where it spreads along the cane, forming dark-brown lesions. The cane may become girdled, resulting in the wilting and collapse of attached fruit. A high incidence of disease can lead to extensive death of the canopy.

Control

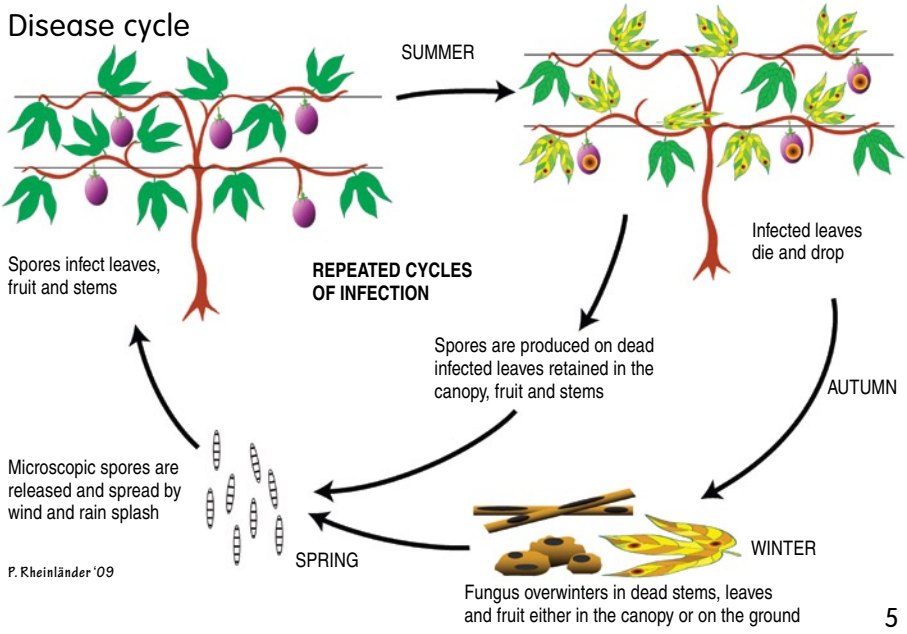
Husbandry practices. Pruning and removing infected canes and leaves and opening up the canopy to allow better air movement will significantly assist control. To avert infection, affected leaves retained in the canopy should be removed to reduce spore numbers.

Fungicidal control. Refer to the chapter on Control of canopy diseases.



Photos: P. Rheinländer

Disease cycle



2 ALTERNATA SPOT

Other names: none

Causative organism

Alternaria alternata (Fr.) Keissl.

This disease is very similar to brown spot but is caused by a different species of *Alternaria*. The symptoms and infection biology of these two species are very similar. Alternata spot is less common than brown spot.

Symptoms

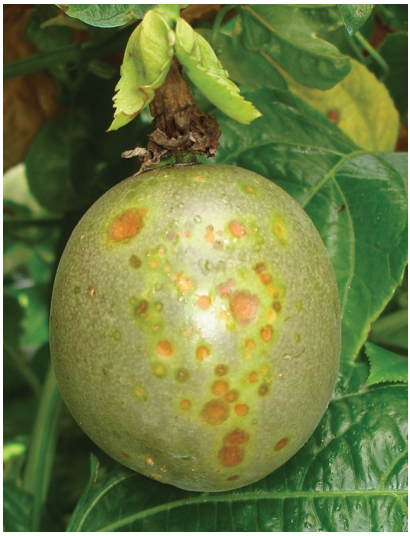
Circular spots on fruit are smaller than those of brown spot. They are at first minute, with a brown centre and a green, greasy margin. At later stages, the spots become sunken and lighter brown in colour with a diameter of approximately 1 cm. On leaves, spots are generally up to 5 mm in diameter and often surrounded by a yellow halo. Spots can coalesce and form large lesions. Similarly to brown spot, infected leaves drop while infected fruit remain attached to the vine. Stems also become infected, usually next to leaf petioles, resulting in lesions. However, *A. alternata* is generally thought not to cause stem girdling.

Control

The same control measures used for brown spot apply to Alternata spot.

Husbandry practices. Thinning vines to allow ventilation and penetration of fungicides through the canopy and removing infected leaves and fruit will help to reduce infection.

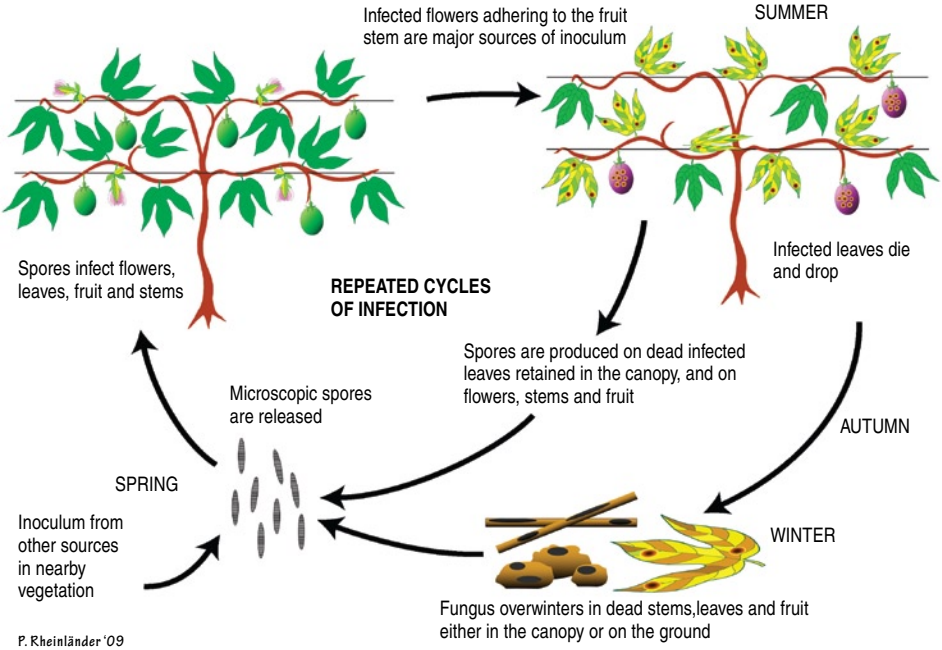
Fungicidal control. Refer to the chapter on Control of canopy diseases.





Photos: P. Rheinländer

Disease cycle



3 ANTHRACNOSE

Other names: Glomerella spot, bitter rot

Causative organism

Glomerella cingulata (Stoneman) Spauld. & H. Schrenk
(anamorph *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.)

Symptoms

Anthracnose is a very common disease of passionfruit vines and all aerial parts of the plant can become infected. In fruit, lesions can cover large areas of the surface. At first, infection is superficial but as the fruit matures, lesions may extend into the pulp. The skin of the fruit typically becomes papery and sometimes oily, and numerous fruiting bodies are formed. These are visible as small dots. Under wet and warm weather conditions, orange spores are produced in the fruiting bodies. In leaves, the disease can cause brown spots but these are not common. The spots are initially 2–3 mm in diameter and become round or irregular shaped lesions of >1 cm. The centre of the spot is often brittle and breaks apart. Infection of tendrils and the canes can be seen as dark brown lesions 4–6 mm in diameter and can result in die-back of canes and tips. Fruiting bodies can often be seen as small dots along infected canes.

Asymptomatic infection by the fungus is common in all above-ground plant organs. Often, no sign of infection is visible until the plant tissue senesces, at which stage numerous fruiting bodies form if weather conditions are humid and warm. Postharvest rots caused by the fungus are typically a result of infection of immature fruit that has remained latent until fruit maturity. The fungus often occurs in plant tissues weakened by physiological stresses or infection by other pathogens, e.g. *Fusarium sambucinum* (crown rot).

Control

Husbandry practices. Pruning to remove affected canes and leaves and to open up and improve ventilation of the canopy helps to control the disease. Pruning should be followed with an application of a protective fungicide.

Fungicidal control. Refer to the chapter on Control of canopy diseases.

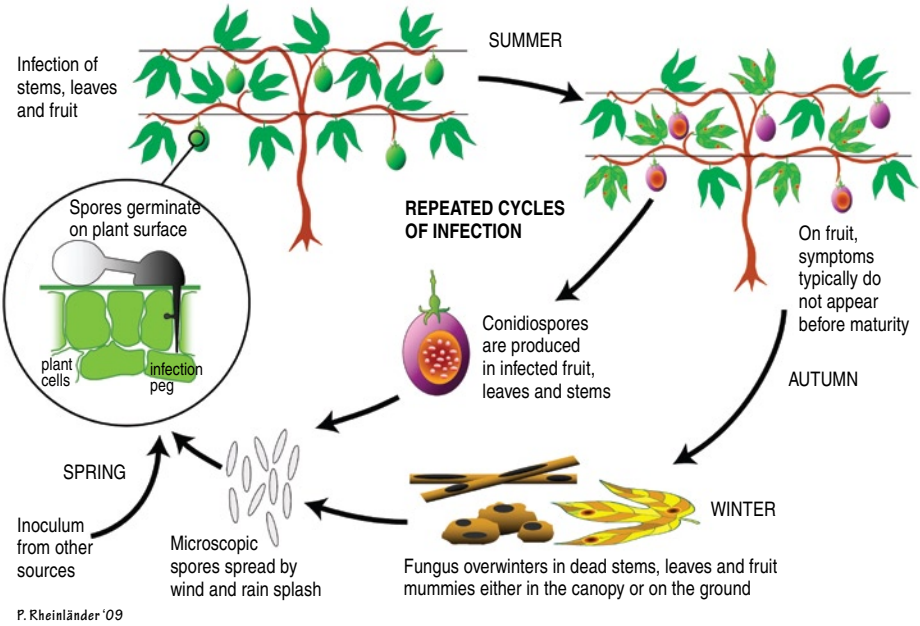






Photos: P. Rheinländer

Disease cycle



4 SCLEROTINIA

Other names: none

Causative organism

Sclerotinia sclerotiorum (Lib.) de Bary

Symptoms

This fungal disease is considered to be a minor disease of passionfruit. However, in some years it causes problems. The fungus predominantly affects the stems and symptoms typically appear in late spring and early summer, especially following wet periods with temperatures of 15–20°C. Infection can be seen as lesions that enlarge and may lead to girdling of the stem and wilting of the cane above the lesion. Mycelium (mass of threadlike fungal tube-cells) can sometimes cover infected tissue. Fruit can also be affected. Lesions are at first round, water-soaked and pale brown in colour. As the rot progresses, white fluffy mycelium and eventually sclerotia develop. Sclerotia are small, dark, rounded resting bodies, which are the means by which the fungus overwinters.

Control

Husbandry practices. Prune infected stems below the lesion. Sclerotia can survive in the soil for many years, so prunings of infected vines should not be left on the ground. Remove them from the orchard or burn them. Likewise, infected fruit that have fallen to the ground should be picked up and destroyed. The sclerotia are unable to endure the high temperatures that develop in proper designed compost units.

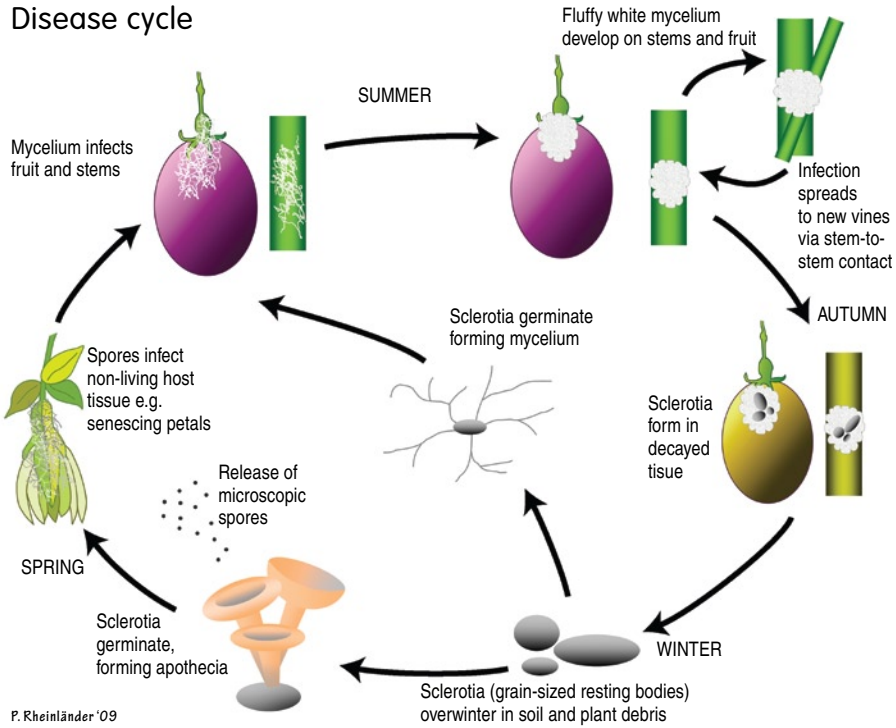
Fungicidal control. If *Sclerotinia* has been a problem in the previous season, it is worth applying a protectant fungicide after pruning in November. Refer to the chapter on Control of canopy diseases.



Photos: P. R. Sale

Early infection symptoms on the left. Same fruit at a later stage with fluffy mycelium and sclerotia on the right

Disease cycle



5 SEPTORIA SPOT

Other names: Septoria blotch

Causative organism

Septoria passifloricola Punith.
Septoria passiflorae Syd. ?

Symptoms

Disease symptoms on leaves and the surface of fruit are small, sunken, light brown spots 0.1–1.0 cm in diameter. On fruit, the spots can have a dark green border. When the spots are situated close to one another, they can merge, creating larger irregularly shaped woody lesions. As the disease progresses, the plant tissues may become dry and shrivelled. On leaves, the spots may be surrounded by a yellowish zone. Infection results in leaf drop. The disease is reported to be more common on leaves than on fruit.

The species and the nomenclature of *Septoria* occurring in New Zealand are currently under scientific revision. A related species, *S. passiflorae* Syd., has been reported in New Zealand but this species was possibly misidentified. Consequently, published descriptions of symptoms vary and are confusing.

Control

The control measures recommended for brown spot also apply to Septoria spot.

Husbandry practices. Vines should be pruned and trained to open the canopy and allow better air movement. Infected canes and leaves should be removed and burned.

Fungicidal control. Refer to the chapter on Control of canopy diseases.



Photo: R. Fullerton



Photo: Landcare Research

Disease cycle

The disease cycle is not known in detail but it is likely to resemble that of anthracnose (page 9). The fungus is spread by spores that are dispersed by wind and rain splash. The fungus probably overwinters in decayed infected leaves, stems and fruit mummies. Heavy rain and mild temperatures favour sporulation and infection.

6 CLADOSPORIUM SCAB

Other names: Cladosporium rot

Causative organism

Cladosporium oxysporum Berk. & M.A. Curtis

Symptoms

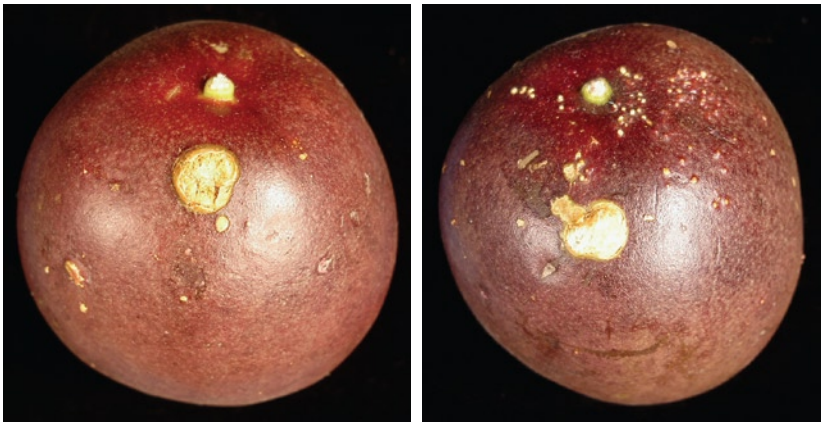
This fungal pathogen causes round, corky scabs up to ~5 mm in diameter on fruit. At early stages, the spots are translucent but later they become raised and covered by a corky tissue. The lesions do not reach the pulp. On leaves, round spots are light brown, translucent and 3–5 mm across. The spots can perforate the leaf and may in some cases result in leaf drop. Stem and flowers also become infected. Spots on stems and tendrils are small and brown and can in later stages be sunken and develop into a canker. Lesions on flower buds are approximately 5 mm in length and brown. Severe disease can reduce the number of flower buds.

Cladosporium scab does not seem to be a common disease in New Zealand.

Control

Husbandry practices. Measures recommended for the control of brown spot and anthracnose are also recommended for Cladosporium scab.

Chemical control. Regular fungicide applications when infection conditions are favourable (rainy with temperatures of ~20°C) during summer months are recommended. Refer to the chapter on Control of canopy diseases for further details.



Photos: P. Rheinländer

Disease cycle

The disease cycle for this pathogen has not been studied in detail for passionfruit but it is likely to resemble that of brown spot (page 5).The fungus is spread by spores that are dispersed by wind and rain splash and favours wet warm weather (optimum temperature ~20°C). It is a widespread pathogen of a range of crops. Spores can therefore be introduced by wind from neighbouring vegetation. It probably overwinters in plant debris.

7 GREASE SPOT

Other names: bacterial grease spot

Causative organism

Pseudomonas syringae pv. *passiflorae* (Reid) Young *et al.*

Symptoms

This is a common disease in many orchards. Fruit are affected from summer to autumn but leaves and stems can be affected all year round. Infection is favoured by heavy rain. Lesions in fruit can cover extensive areas of the fruit, sometimes covering almost the entire surface. Spots are initially small, dark green and oily and develop into round greasy and/or water-soaked lesions. In the summer months, the patches appear to dry out and develop into hard brownish lesions ('hard grease spot'). Fruit drop has been observed in some cases. The diseased tissue of the fruit can become colonised by other pathogens (e.g. *Glomerella cingulata* and possibly *Septoria passifloricola*), and their fruiting bodies can often be seen as small dots in the lesions.

On leaves, the bacterium causes spots, which are irregular in shape, olive-green to brown and oily in appearance. Usually the spots are surrounded by a light yellow halo. Lesions on stems are water-soaked and depressed, typically light brown in colour.

Control

Husbandry practices. Plant only disease-free vines and avoid introducing plant material from affected orchards. Once the disease has established in an orchard it is difficult to control. Remove and burn infected plant parts. The bacterium can enter the vines via wounds, so disinfect secateurs using bleach or household spirits between diseased and healthy vines when pruning, to avoid spreading the disease. Disinfecting hands after handling diseased plants is also recommended

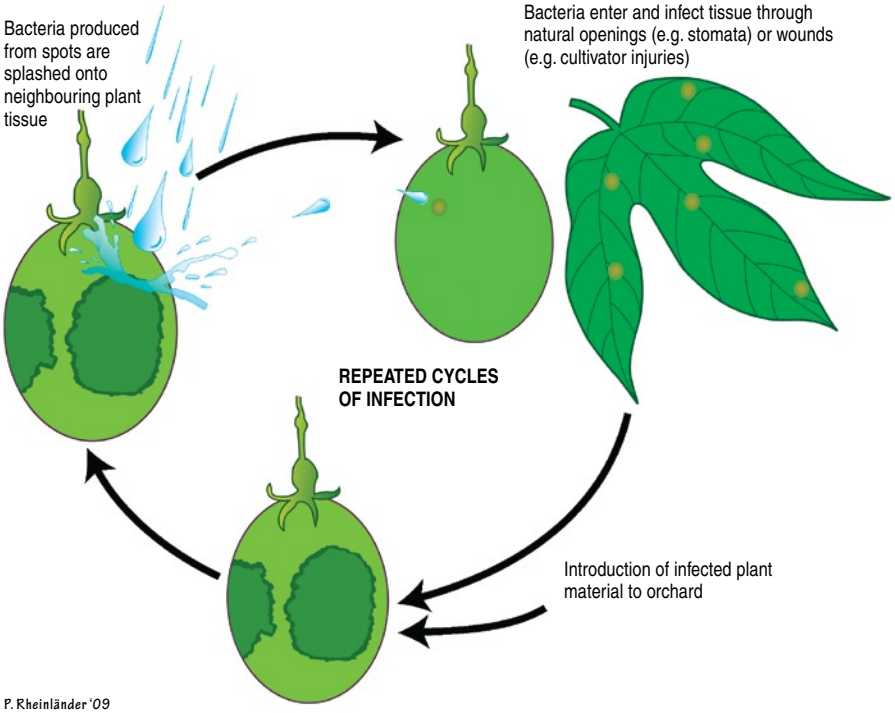
Chemical control. Refer to the chapter on Control of canopy diseases.





Photos: P. Rheinländer

Disease cycle



8 WOODINESS

Other names: none

Causative organisms

Passionfruit woodiness virus (PWV)
Cowpea aphid-borne mosaic virus (CABMV)

PWV and CABMV are known to cause woodiness symptoms in fruit and in leaves. In New Zealand, Alfalfa mosaic virus has also been isolated from affected vines. Cucumber mosaic virus was previously thought also to cause woodiness symptoms in the fruit, but recent research has shown that this virus only affects the leaves.

Symptoms

Woodiness is a widespread disease. Infected fruit become distorted, with a thick, hard, and woody rind. Sometimes the distortion causes the fruit to crack. Pulp yields are much reduced and the fruit are not marketable. Leaves of infected vines become crinkled and distorted. Other signs of infection include yellow spots, flecks or mottling. Growth becomes stunted, the stems are shortened and bunching of foliage is common. The symptoms are typically most apparent from late autumn to early spring when growth is less vigorous.

Control

Once vines become infected, there is no known control.

Husbandry practices. Plant only virus-free vines; remove and replace severely infected vines. Some vines appear resistant to the viruses. Disinfect secateurs when pruning using bleach, trisodium phosphate (a cleaning agent) or skim milk (yes, you read correctly), which inactivates the virus. The disease can be transferred via cuttings so avoid using plant material from infected vines for grafting.

Chemical control. The disease cannot be controlled chemically. Attempting to reduce the spread of the disease by chemical control of the vector (the organism transmitting the disease, usually an insect) is not recommended. It is not economic and transmission, in most cases, will already have taken place before the pesticide eliminates the vector. Also, use of pesticides may result in residue problems on the fruit.



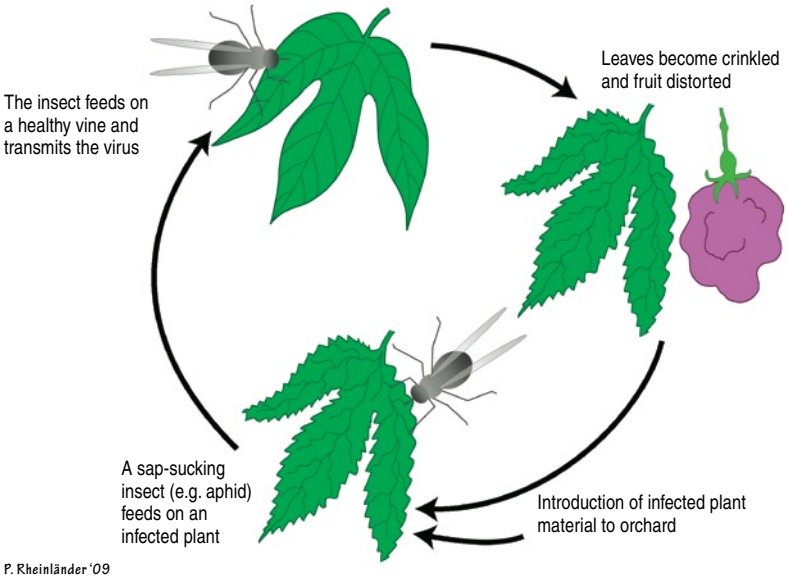
Photo: P. Rheinländer



Photo: T. Holmes, Plant & Food Research

Disease cycle

The viral disease is transmitted by sap-sucking insects (e.g. aphids). It can also be transmitted via pruning equipment or cuttings.



P. Rheinländer '09

CROWN AND ROOT DISEASES

9 CROWN ROT

Other names: crown canker, stem canker, black leg

Causative organism

Fusarium sambucinum Fückel
(teleomorph *Gibberella pulicaris* (Fr.) Sacc.)

F. sambucinum was the species most frequently isolated from affected vines in a recent study (Rheinländer *et al.* 2009). However, other species of *Fusarium* have been found in association with crown rot, including *F. redolens*, *F. avanaceum*, *F. lateritium* and *F. graminearum* (Sale & Alexander 1986).

Symptoms

The disease only appears in winter and early spring, typically from May to October when weather conditions are wet and cold. Early signs of the disease are purplish spots on the bark of the trunk. As the rot progresses, the lower part of the trunk become girdled, resulting in leaf and stem wilting. The roots and whole plant eventually die. The canker typically occurs on the trunk within 50 cm of ground level. On older plants, cankers can also occur further up the trunk and on canes. Masses of pink/orange coloured spores develop on the trunk at advanced stages of the disease.

The bark of the lower part of the trunk is sometimes colonised by sooty mould or *Cladosporium* sp. These are secondary colonisers (saprotrophic fungi) that can give the trunk a dark colour.

An unpleasant odour is often associated with grey-coloured, water-soaked areas of necrotic tissue of the crown rot. The smell is likely to be caused by soft rot bacteria that colonise the dead tissue.

Control

To date, no fungicides have been found to have any efficacy against this disease. Overseas studies on the control of the same organism in hops have suggested that reducing water accumulation around the roots by planting in raised beds can decrease infection. Other measures to reduce crown wetness include removing sucker growth that can shade the crown, and reducing mulch.



Photos: P. Rheinländer

Disease cycle

The disease cycle and infection pathway are presently unknown. The fungus is spread by spores that are dispersed from spore masses on the trunk by rain splash. Disease severity appears to be correlated with high precipitation and low temperatures. The fungus seems to become inactive when temperatures increase in spring and vines start growing vigorously.

10 PHYTOPHTHORA ROOT ROT

Other names: Phytophthora blight

Causative organism

Phytophthora cinnamomi Rands

Other species of *Phytophthora* may possibly be associated with this disease in New Zealand.

Symptoms

Phytophthora cinnamomi is known to cause root rot, stem canker, wilt, damping off, leaf blight and fruit rot in passionfruit. In New Zealand, this water mould has mostly been associated with root rot.

Infected plants are unthrifty, wilt and suddenly collapse. Symptoms appear predominantly in warm weather in late spring. The bark in the crown area is typically completely rotted and the tissue of the main roots becomes discoloured. Small brown lesions can be found in secondary roots when they are still alive. Leaves become water-soaked and light olive-brown in colour. They readily fall off, leading to defoliation of the vine. Symptoms on fruit are large water-soaked lesions and fruit drop.

Control

P. cinnamomi has many hosts, especially among the woody ornamental plants. It can therefore be introduced from neighbouring vegetation.

Husbandry practices. Improving soil drainage can greatly reduce the risk of *Phytophthora* infection. In other crops, high organic matter content in the soil have been shown to suppress infection.

Fungicidal control. Inorganic copper is registered for control of *Phytophthora* stem canker in passionfruit vines. Ensure that the label specifications are followed.

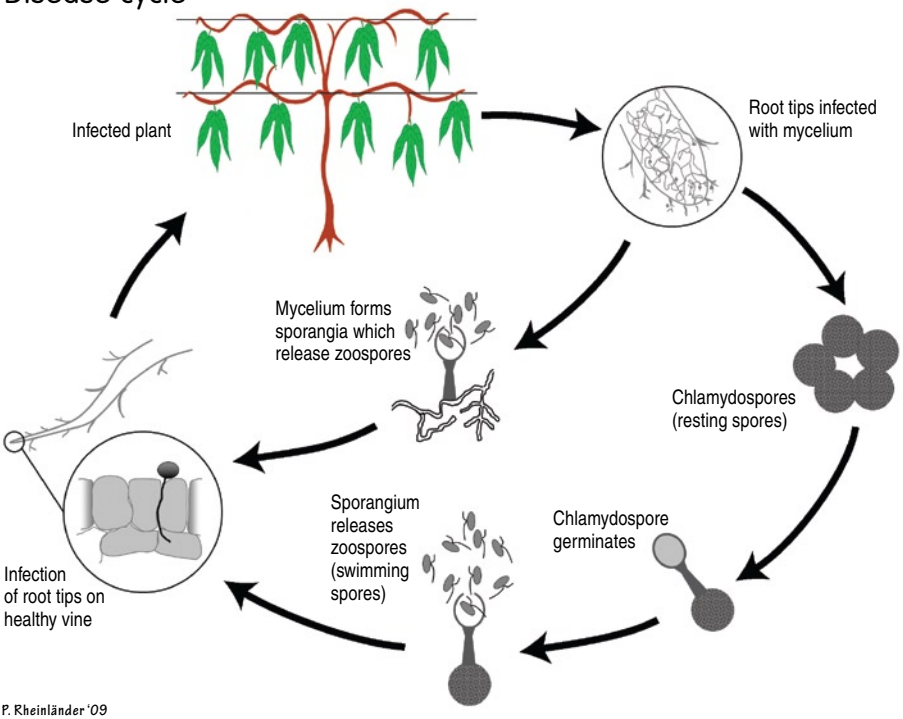
Phosphorous acid (also known as phosphite) is routinely used for the control of *Phytophthora* in other crops where it is applied as a foliar spray, a soil drench or by injection of the trunk. However, this agrichemical is not registered for passionfruit. Injection of the trunk is not common practice in passionfruit and it is unknown whether it could cause phytotoxic effects.



Photo: B.R. Young, LandCare Research Archives

Infected vines on the right, with reduced and discoloured root systems, and crown areas. The vine on the left is uninfected.

Disease cycle



OTHER DISORDERS AND INSECT INJURIES

11 FROST DAMAGE

Cause

Damage caused by temperatures below –2°C. Passionfruit tolerates frost of –1-2°C but only for short periods.

Symptoms

Shoots and the delicate tissue of new leaves and stems are most prone to frost damage. The tissue at the tips becomes brown and soft and dies. Young leaves become brown and wither. Severe frost can split stems and kill the entire vine.

Control

Husbandry practices. Low-lying sections of an orchard block can be particularly prone to frost. Natural and artificial wind-breaks are wellknown means to increase orchard temperatures. However, wind-breaks can also trap cold air. Some growers set up screen fabric as an overhead canopy, which provides some frost protection as well as a shelter from hail and sunburn. There are many other options for frost protection (e.g. sprinklers and wind machines) but these are usually costly. It used to be common practice to insulate the trunk and main leaders using fronds from the bracken fern during winter.

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12 WIND RUB

Cause

Physical damage to the skin caused by the fruit rubbing against canes, wire or other fruit.

Symptoms

The physical injury incurred when young fruit rub against a hard surface can develop into corky raised brownish lesions as the fruit expand. Such fruit are not marketable. Wind rub to older fruit typically results in purple scratch marks. The injury from wind rub facilitates infection by pathogens such as grease spot.

Control

Husbandry practices. Ensure that the fruit are well supported. Trellising of the vines and the use of wind-breaks are effective in reducing the incidence of wind rub.

11





Photos: P. Rheinländer

12





Photos: P. Rheinländer

13 FRUIT CRACKING

Cause

Physiological disorder caused by drastic changes in precipitation.

Symptoms

Symptoms develop during fruit development after heavy rain following extended periods of dry weather. The fruit skin cracks because of the abrupt changes in water turgor pressure and the sudden expansion of the fruit. As the fruit grows, the cracks become corky.

Control

Irrigation and stable soil moisture would help reduce the incidence of fruit cracking.

---

14 CICADA SCARRING

Causative organism

Cicada
Possibly the Chorus cicada, *Amphipsalta zelandica* Boisduval, which is one of the most common cicada species in New Zealand.

Symptoms

This disorder has been observed in some orchards in years in which there is a high abundance of cicadas. When these insects land on the fruit, their legs scrape the fruit surface, creating scarred lines. The injuries can be entry points for pathogens such as grease spot.

Control

Cicadas are difficult to control, as they migrate into the orchard from neighbouring vegetation. The relatively low level of damage that they cause on passionfruit does not usually warrant any use of pesticide.

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Photos: P. Rheinländer

14



Photo: P. Rheinländer

15 LEAFROLLER SCARRING

Causative organism

Leafroller
Lepidoptera: Tortricidae

Symptoms

This is not a common problem of passionfruit. The feeding from the leafroller larvae on young passionfruit results in a corky scarring. In severe cases, the pest can cause distortion of the rind, leaving the fruit unmarketable.

Control

Because this is not a common disorder, management of this insect is usually unnecessary. However, leafrollers have been reported to cause quarantine problems on export fruit. Populations should be monitored close to harvest and an appropriate insecticide can be applied if needed.

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16 FLOWER THRIPS SCARRING

Causative organism

New Zealand flower thrips
Thrips obscuratus (Crawford)

Symptoms

The eggs are laid under the epidermis of the young fruit, resulting in small specks on the surface of the mature fruit.

Control

If there has been a build up of populations of flower thrips in spring, it may be necessary to spray with an appropriate insecticide before flowering or at early flowering. A non-chemical alternative is reflective mulch, which has been reported to reduce thrips numbers significantly in other crops.

15





Photos: P. Rheinländer





Photos: T. Holmes, Plant & Food Research

16



Photo: P. Rheinländer



Photos: T. Holmes, Plant & Food Research

CONTROL OF CANOPY DISEASES

Without an effective control programme, diseases can severely affect passionfruit plantings, making commercial production unviable. Many of the above-ground diseases can be controlled using the same control strategies. In this chapter, the general measures used for the control of common above-ground passionfruit diseases are described.

Control options

Optimal disease control involves prevention of infection, minimising the inoculum (sources of infection) and breaking the disease cycle.

These steps can be achieved by three essential control strategies: (1) canopy management, (2) orchard hygiene, and (3) a fungicide spray programme.

Canopy management

Fungal diseases need extended wet periods for sporulation, spore germination and infection to occur. Prune and open up the canopy to:

- Promote rapid drying
- Make the microclimate unfavourable for fungi
- Avoid dense tangled canopies that trap dead leaves, which can be inoculum sources.

The last-mentioned is particularly a problem for the Tatura trellis training system ('A' frames), where dead stems and leaves easily become trapped at the base of the trellis.



Photo: P. Rheinländer

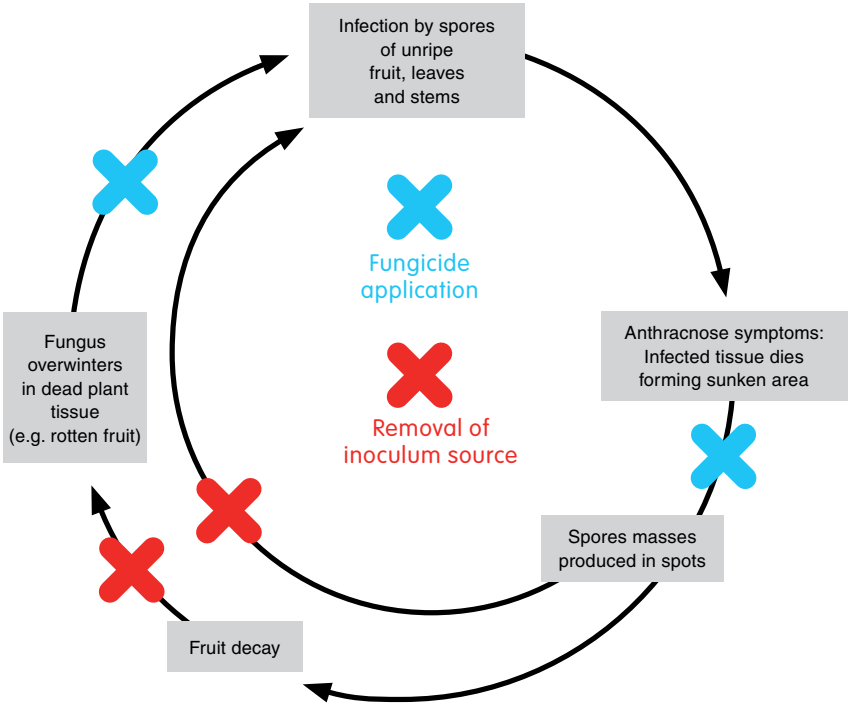
Dead leaves trapped in a canopy trained to the Tatura trellis system. Such leaves are major inoculum sources.

Orchard hygiene

Passionfruit vines are subject to infection by a variety of diseases throughout the year and minimising inoculum sources by proper orchard hygiene is essential for effective control. Reduce sources of inoculum by:

- Pruning out dead canes and leaves
- Remove prunings and diseased fruit
- Burn or compost infected plant material including reject fruit. Place compost unit well away from cropping areas. The high temperatures that develop in proper designed compost units kill most plant pathogens.

The removal of inoculum sources is a way to break the disease cycle by eliminating a step in the cycle, as illustrated in the figure below.



Principle of measures used to break the disease cycle and thereby to control diseases, using anthracnose (*Glomerella cingulata*) as an example. Removal of inoculum or targeted application of fungicide can hinder the production of spores and thereby prevent infection of healthy plant material.

The same principle is employed when applying a fungicide which, depending on the mode of action of the chemical, prevents the fungus from establishment or inhibits sporulation. To control a disease, it is therefore essential to know the causative organism and its disease cycle, to determine the optimal timing for fungicide applications and best husbandry practices.

Fungicidal control

A preventative fungicide programme is recommended. It is too late to commence once symptoms appear.

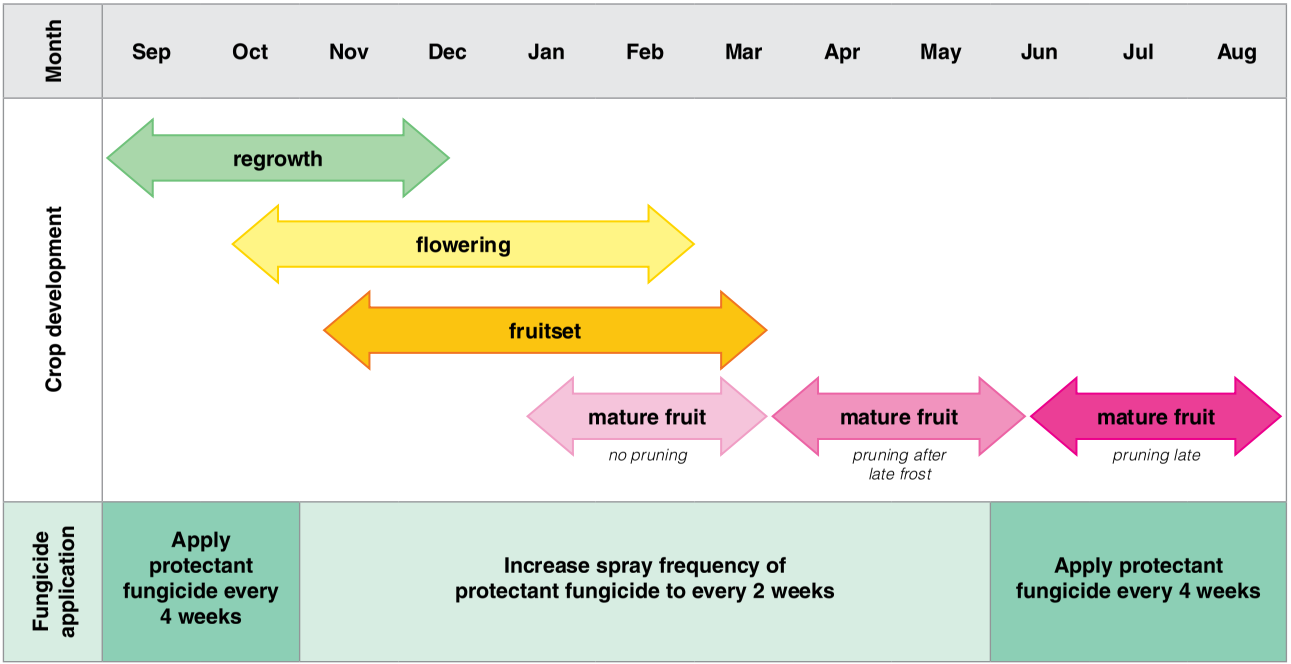
Fungicides are applied in accordance with the seasonal stages of the crop and the likelihood of infection by pathogens. From mid May to November, applying a protectant fungicide every four weeks is generally recommended. The frequency of spraying typically needs to be increased to every two weeks from November to May, or every week if infection conditions are severe.

Fungicide options

Check which fungicides are presently registered for passionfruit by consulting the New Zealand Food Safety Authority website or The N.Z. Passionfruit Growers Association Incorporated The association provides information on the current recommended spray programme for the control of common diseases. Fungicides that are registered for passionfruit in New Zealand are not necessarily accepted in overseas markets. For fruit to be exported, the industry export programme should be followed.

Copper-based agrichemicals (copper hydroxide, copper oxychloride) should be used with moderation, as excessive use leads to accumulation of copper in the soil, with detrimental effects on the natural soil microflora. However, copper sprays are presently the sole means by which bacterial grease spot can be controlled and need to be included in the spray programme in affected orchards.

Seasonal stages in passionfruit crop development and recommendations for disease control



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