NORTHERN
OCTOBER 2017

GRDC™
GROWNOTES™

GRDC™
GRAINS RESEARCH & DEVELOPMENT CORPORATION

PEANUTS

SECTION 9

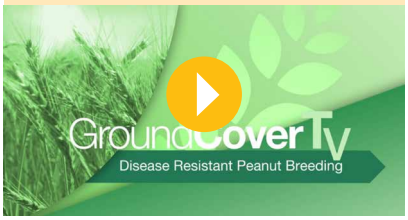
DISEASES

CAUSES OF CEREAL DISEASES | THE DISEASE TRIANGLE | RUSTS | BARLEY YELLOW DWARF VIRUS | RHIZOCTONIA | CROWN ROT (FUSARIUM GRAMINEARUM) | BACTERIAL BLIGHTS | OTHER DISEASES

VIDEOS

Disease management

GCTV14: Peanut Disease Resistance



Diseases

Peanuts are susceptible to several foliar diseases, especially leaf spot, rust and net blotch. Protective fungicides are available to keep most foliar diseases at bay. [1]

It is common to see some peanut plants dying throughout the season from a range of causes. Only when the plant population is significantly reduced should concern be raised. [2]

Peanuts are also susceptible to several soil-borne diseases, especially Sclerotinia blight, white mould and Cylindrocladium black rot (CBR). Good rotational practices, crop management and hygiene are the best defence against these diseases. Effective fungicides are available to control the foliar diseases; however, fungicide options are limited for control of the soil-borne diseases. [3]

Conditions favouring rapid crop growth also favour the development of disease. [4]

The young seedling is normally protected by the seed dressing (a fungicide). A common seedling disease in peanuts is crown rot, caused by *Aspergillus niger*, which is endemic in most soils. Crown rot often kills very weak seedlings and is very prevalent when soil temperatures are high. [5] Note that this is a different disease from that affecting cereal crops (caused by the *Fusarium* pathogen).

9.1 Damage caused by disease

Inherent problems of kernel quality and aflatoxin contamination caused by *Aspergillus flavus* can be aggravated by poor disease control. Peanut producers have access to an excellent range of proven options that work well if recommendations are followed. These include combining important elements of Integrated Disease Management (IDM) that will assist overall disease control. Stick to the rules of:

- control of peanut volunteers, which harbour disease between crop cycles
- prevention not cure—fungicides are much more effective if used preventatively
- thorough and regular disease scouting
- timely routine and strategic fungicide application in line with label recommendations
- rotation of chemistry to avoid resistance
- good spray-application technology
- effective crop rotation—rotations minimise incidence of leaf and soil-borne diseases (less of an issue in cane-farming systems). [6]

9.2 Management of disease

Total prevention is not possible. Peanut volunteers on headlands and in rotation crops can carry diseases, and infected residues from last year's crops can be a source of the leaf pathogens. A three-pronged approach must be taken to manage leaf diseases in all peanut varieties: control of volunteer peanut plants that may harbour the leaf spot and rust pathogens, careful paddock selection, and an appropriate fungicide spray regime. Avoid planting peanuts in the same paddock as the previous

1 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

2 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

3 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

4 GRDC (2010) Managing leaf disease in peanuts. GRDC Fact Sheet, https://grdc.com.au/__data/assets/pdf_file/0030/207687/managing-leaf-disease-in-peanuts.pdf.pdf

5 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

6 GRDC (2010) Managing leaf disease in peanuts. GRDC Fact Sheet, https://grdc.com.au/__data/assets/pdf_file/0030/207687/managing-leaf-disease-in-peanuts.pdf.pdf

MORE INFORMATION

Australian Pesticides and Veterinary Medicines Authority.

VIDEOS

Fungicide use strategies

year and beside paddocks where peanuts were grown the previous year, particularly if late leaf spot was present in the previous crop.

9.2.1 Crop rotation

Crop rotation can have a significant impact on many diseases. For example, where one peanut crop follows another, seedling diseases are generally more common and leaf spot will appear earlier and be more severe.

Peanut diseases spread into new peanut-growing areas in different ways. Rust spores can be blown with the wind for long distances, whereas leaf spot spores travel for shorter distances. Equipment, particularly diggers and threshers, can spread soil-borne diseases.

Some diseases are already present in almost all soils, e.g. *Aspergillus flavus* (the aflatoxin-producing fungus).

In many environments, a fungicide program is needed to control foliar diseases such as leaf spot, rust and net blotch. This may involve 2–10 sprays, depending on district and season. Foliar diseases are a greater problem in more humid areas such as North Queensland and coastal areas than in the inland Burnett and Central Queensland.

Diseases can be divided into categories depending on when and how they attack the peanut plant. Some alternative causes, such as seed damage, are also included.[7]

9.2.2 Fungicide program for high risk areas

To achieve high yields, growers must control leaf diseases. The timing of fungicide sprays will depend on the disease incidence in the region.

In areas where diseases are always present and disease pressure is almost always severe, it is critical that early protectant fungicides are applied as soon as 21 days after emergence (DAE) of the crop. The fungicide program should continue until just before digging.

In the Bundaberg area, application of chlorothalonil products from 21 DAE at 10-day intervals has been shown to effectively control leaf spot and rust in susceptible varieties. Addition of one or two sprays using other products such as Alto® (cyproconazole) or Folicur® (tebuconazole) can also assist. In an average year, 14-day schedules are not frequent enough because the crop grows too quickly in these regions, with new leaves being produced (and therefore unprotected) on the top of the canopy every week. If growing a more tolerant line (i.e. the newly released D281-p40-236A), protective fungicide sprays should still commence from week 4, but the spray interval may be extended up to 21 days later in the crop.

In North Queensland, these schedules are just as important, but more frequent rainfall events require growers to manage fungicide application intervals with a more varied approach. Always seek advice on the latest registrations and recommendations.[8]

9.3 Disease symptoms

Symptoms of disease will be considered as follows:

1. Seedlings dying
2. Leaves with brown spots
3. Leaves with colour variations
4. Branch wilting or plant death
5. Ill-thrift
6. Pods damaged at harvest

7 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

8 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

9.3.1 Causes of seedlings dying (or poor emergence)

Soil-borne fungi including Aspergillus niger *(Aspergillus crown rot) and* Rhizopus arrhizus

Importance: Widespread.

Damage: Can be serious, causing low plant population or creating large gaps in the stand. Remaining plants may not compensate.

Symptoms: Seed does not emerge. Seedlings die. Fungal growth on the seed may or may not be present (Photos 1 and 2).

Spread: Already present in all soils.

Management strategies:

- Chemical: Treat seed with a recommended fungicide.
- Cultural: Plant into warm soil (~18°C). Do not plant if weather conditions are likely to cause soil temperature to fall below 18°C or rise above 50°C. Planting too deep will increase the risk of seedling disease.

Photo 1: *Aspergillus crown rot infection (left). Seedling showing crown rot symptoms (right).*

Photo 2: *Close-up view of crown rot fungus.*

Damaged seed

Importance: Minor.

Damage: Similar effect to soil-borne fungi, except that the losses are unlikely to continue after emergence. Remaining plants may still show poor vigour.

Management strategy:

- **Cultural**: Check planting equipment to minimise damage to seed. Handle seed carefully. Select seed from crops that have not been affected by drought and have been cured slowly. [9]

9.3.2 Causes of leaves with brown spots

Early and late leaf spot (caused by Cercospora arachidicola *and* Cercosporidium personatum*)*

Importance: Major in most peanut areas. Favoured by high rainfall and sprinkler irrigation. The Sutherland variety is resistant to leaf spot.

Damage: Leaves fall off and stems and pegs are weakened if the epidemic starts early and is uncontrolled and weather conditions favour disease spread. Conditions favouring rapid peanut growth also favour the spread of leaf spot. Leaves must be wet from rain, dew or irrigation for long periods (~10 h) to trigger infections. Crop potential is reduced when infected leaves fall off (Photo 3). Harvesting losses increase as infected pegs lose strength and break during pulling and threshing.

9 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

Photo 3: *Leaf drop caused by leaf spot (left) compared with a non-diseased area (right).*

Symptoms: Small, dark spots become brown to black on both sides of the leaf as they enlarge up to 10 mm; there may be a yellow halo around the spots (Photo 4). Spots appear on the lower leaves first, but are not visible for 7–10 days after infection. Symptoms of late leaf spot are similar, but spots do not have a prominent yellow halo, and masses of spores are often seen on the underside of the leaf (Photo 5). Lower leaves are infected first, and infection is only noticed if the dense peanut canopy is parted. Later, stems and pegs may also become infected. Spores are spread mainly when dew dries off in the morning or when rain starts. They do not spread over long distances, so infections will often start from infected crop residues.

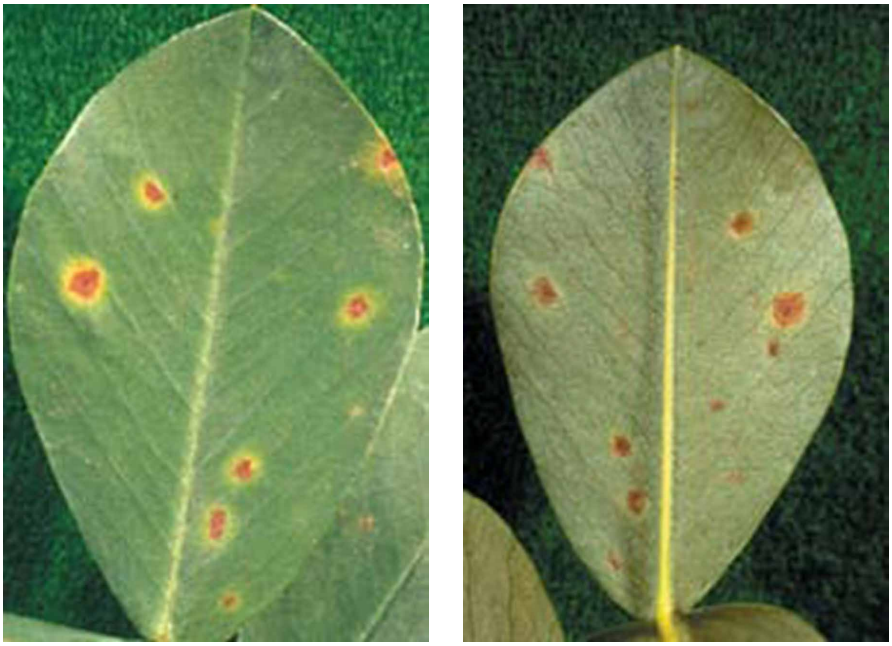


Photo 4: *Early leaf spot: brown spots on upper (left) and lower (right) leaf surfaces, some showing a yellow halo around the spot.*

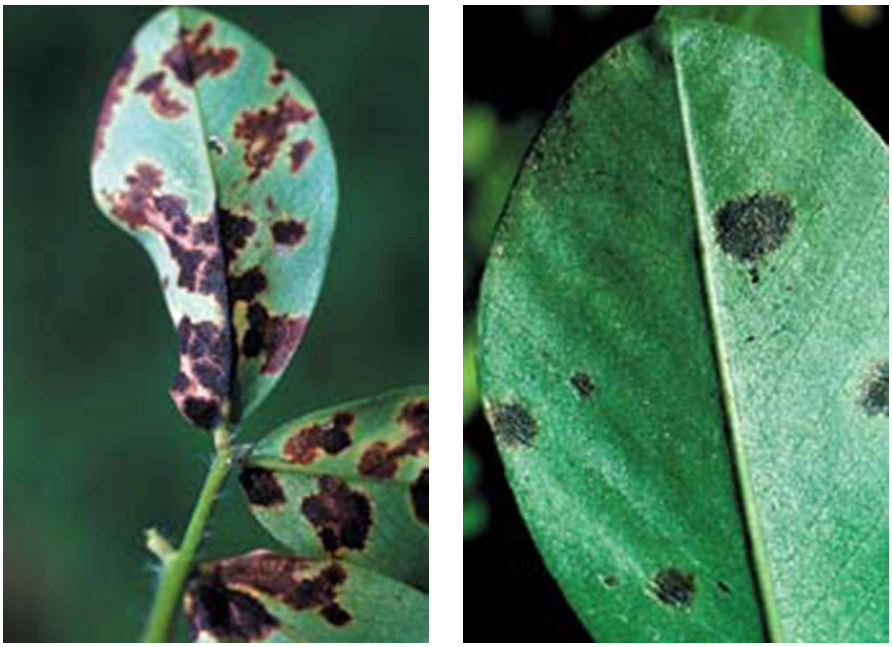


Photo 5: *Late leaf spot: black spot on the underside of the leaf (left) and coalesced black spots near the base of the leaf (right).*

Spread: The fungal spores are spread by wind and rain. However, the residue of previous peanut crops is the main source of inoculum, so peanuts following peanuts are often the most heavily affected.

Management strategies:

- **Chemical**: Both diseases can be controlled by the same fungicides. In high-rainfall areas and for irrigated crops, a spray schedule of 10–14 days is needed. Leaf spot increases rapidly during warm, wet weather and irrigation. Fungicides also break down more quickly under these conditions and a shorter interval between sprays must be used to protect new foliage. Some fungicides can only provide protection, whereas others can control infections that occurred 3–6 days before application. These eradicant fungicides will not control well-established infections. Spray up to 4 weeks before harvest. When choosing fungicides, consider other diseases in the crop and whether the crop will be baled for hay.
- **Cultural**: Total prevention is not possible. Peanut volunteers on headlands and in rotation crops can carry the diseases between crops and they should be destroyed. Avoid peanut–peanut rotations. Sow the Sutherland variety, because it is resistant to leaf spot.

Rust (caused by Puccinia arachidis*)*

Importance: Widespread in most peanut areas north of Kingaroy. The Sutherland variety is resistant to rust.

Damage: Can cause major crop losses if it starts early and is uncontrolled. Once rust starts in a crop, dews and fogs are sufficient to create a serious epidemic.

Symptoms: Small, yellow spots quickly produce typical 'rusty' spores (Photo 6). Spores are not visible for 7–10 days after infection. They are usually found under the lower leaves and spread very rapidly. Infections are often first found as a 'hot spot' with a few plants covered in rust (Photo 7).

Spread: The spores can blow long distances between crops.

Management strategies:

- **Chemical**: Spray with a fungicide until the crop is within 2 weeks of harvest. A spray program similar to that for leaf spot may be needed. Consider other diseases that may be in the crop.

- **Cultural**: Rust spores cannot survive for very long in the absence of living plants, so destroy volunteer peanut plants between crops, especially on headlands, contour banks and around buildings. There are no known alternative hosts for peanut rust.

Photo 6: *Typical rust spores on upper and lower surfaces.*

Photo 7: *Rust-affected crop.*

The first signs of infection, the small yellow flecks on the leaves, soon develop into small orange pustules. The pustules contain numerous red-brown powdery spores that are spread during dry, windy weather. However, like the leaf spots, prolonged leaf wetness from rain, irrigation or dew is necessary for infection. [10]

10 GRDC (2010) Managing leaf disease in peanuts. GRDC Fact Sheet, https://grdc.com.au/__data/assets/pdf_file/0030/207687/managing-leaf-disease-in-peanuts.pdf.pdf

Puccinia arachidis is a different species of rust from those that typically affect cereal crops.

Net (or web) blotch (caused by Didymosphaeria arachidicola*)*

Importance: It is now the major foliar disease in the South Burnett in wet years.

Damage: Causes rapid defoliation (and subsequent yield loss) during cool, showery weather.

Symptoms: A network of very fine brown lines develops on the top surface of the leaf. These join together to form brownish blotches, which may go through the leaf (Photo 8).

Spread: The fungus survives on peanut residues from the previous season.

Management strategies:

- **Chemical**: Spray as soon as symptoms are seen during cool, showery weather. Not all fungicides control net blotch. Spray programs for leaf spot and rust protect against net blotch provided appropriate fungicides are used. In the dryland crops of the South Burnett, an increase in the number of fungicide applications will be needed to manage net blotch in wet years.
- **Cultural**: Net blotch epidemics are difficult to predict, but irrigation may create ideal conditions for infection. It may be necessary to adjust irrigation practices. Spanish varieties are more susceptible than Virginia types, which are more susceptible than Runner types. For variety characteristics, see GrowNotes Peanuts Section 2. Pre-planting.

Growers should not confuse this disease with the net blotch that affects cereal crops.

Photo 8: *Net blotch may occur with slightly differing appearance on affected leaves.*

Pepper spot and scorch (caused by Leptosphaerulina arachidicola*)*

Importance: Minor but widespread.

Damage: Leaves drop off. Is often one of the earliest foliar diseases to infect crops.

Symptoms: The same fungus causes two different symptoms under different weather conditions. Pepper spot occurs when very small spots, <1 mm, develop on the top of the leaf (Photo 9). Scorch occurs when a V-shaped part of the leaf dies (usually on the margin) and a yellow zone forms next to it.

Spread: The fungus survives on peanut residues and is spread by wind.

Management strategies:

- **Chemical**: The fungicides used for controlling the other foliage diseases usually control this fungus. Use a protectant fungicide if no other disease influences the choice.
- **Cultural**: These diseases are not usually serious in traditional production areas using the current varieties.

Photo 9: *Pepper spot looks sooty.*

Physiological spotting

Importance: Minor.

Damage: Leaf symptoms only.

Symptoms: Dark brown markings on leaves, similar to leaf spot. Some of these appear like 'eyebrows' (Photo 10).

Cause: Unknown.

Management strategies: None needed. [11]

11 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

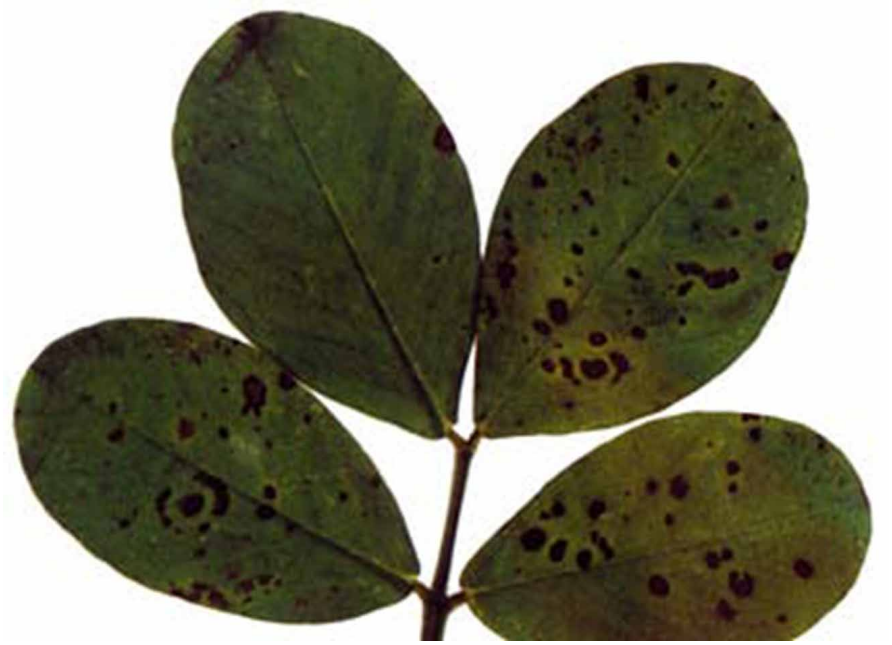


Photo 10: *Physiological spotting; note 'eyebrow' markings.*

9.3.3 Leaves with colour variations

Capsicum chlorosis virus (CaCV)

Importance: Usually minor; sometimes occurs at economically damaging levels in coastal Queensland.

Damage: Affected plants set few kernels and those that do set are small and of poor quality. Severely affected plants are stunted and may die, leaving gaps in rows.

Symptoms: CaCV causes mottling and dark (necrotic) spots on leaves (Photo 11). Internodes are reduced in length and the terminal growing points wilt and die. Affected plants are stunted, particularly when infected early in life, and may eventually die.

Spread: Several thrips species spread the virus, e.g. tomato thrips and melon thrips. CaCV belongs to the same virus group as TSWV and the transmission process for both viruses is almost identical. Thrips acquire the virus from infected plants as immature larvae and transmit to other plants as active adult insects after the virus has circulated and multiplied in the insect. The virus is not spread by other insects such as aphids and jassids. CaCV is not spread by contact, in soil or in seed.

CaCV infects capsicum, tomato and peanut. Billygoat weed (*Ageratum conyzoides*) is a major weed host of the virus throughout coastal Queensland. This weed commonly occurs around cane-fields and along roadsides.

Photo 11: *Capsicum chlorosis virus: mottling and dark (necrotic) spots develop on leaves, internodes are reduced in length, and terminal growing points wilt and die.*

Management strategies:

- **Treatment**: Infected plants cannot be cured. Management aims to reduce disease levels in crops, particularly early infection.
- **Cultural**: Control weeds around and within crops, particularly billygoat weed. Avoid planting new peanut crops adjacent to old crops or near capsicum crops.

Peanut mottle virus (PMV)

Importance: Minor.

Damage: Slight leaf mottling in peanut varieties currently grown.

Symptoms: Leaves show a light mottle through to patches of dark green (Photo 12).

Spread: By aphids.

Management strategies:

- **Cultural**: Use PMV-free seed, if available, in new and isolated areas. Only seed shown to be PMV-free can be grown in the Burdekin Bean Seed Quarantine Area.

Photo 12: *Peanut mottle virus: leaves showing a light mottle through to dark green.*

Tomato spotted wilt virus (TSWV)

Importance: Minor, but potentially serious under certain conditions.

Damage: The incidence of infected plants is usually low. Plants infected early may be stunted and produce few nuts. Plants infected after 40 days are usually not stunted, but some branches may be affected.

Symptoms: This virus produces distinctive patterns on leaves, usually including concentric yellow rings or lines (Photo 13).

Spread: Thrips spread the disease from host plants—capsicum, tomato, lettuce and broadleaf weeds such as stinking roger and cobbler's pegs. Only adult thrips that develop from infected larvae can transmit the virus. These thrips can be blown long distances.

Management strategies:

- **Cultural**: Control weeds in and near the crop. Avoid planting young crops next to old crops where disease is present, because significant movement of thrips occurs over relatively short distances.
- **Chemical**: Control thrips if possible. Often, however, insecticides are not effective against TSWV because thrips feeding times that lead to transmission are short, about 5 minutes, and spread is often from incoming thrips that feed but do not settle and breed in the crop.

Photo 13: *Tomato spotted wilt virus: affected plants are stunted with small, distorted leaves (top) showing green and yellow mosaic patterns, often circular (bottom).*

Verticillium wilt (caused by Verticillium dahliae*)*

Importance: Minor overall, but can be serious on some farms in some seasons. Often occurs on crops grown on the best soils in the South Burnett and in irrigated crops in low-rainfall areas.

Damage: Infection before early podfill may reduce yield, but the impact is small if leaf symptoms appear after this time.

Symptoms: Pale-green blotches appear between the veins and around the leaf margins (Photo 14). The margins then become brown and die. Under dry conditions, these areas dry out, giving the plant a scorched appearance. The vascular

tissues in stems and roots are discoloured reddish brown. Wilting and plant death sometimes occur.

Spread: Hosts include the weeds cobbler's pegs, Noogoora burr and Anoda weed, and many crop plants such as cotton.

Management strategies:

- **Treatment**: Once infection occurs, nothing can be done to control Verticillium wilt.
- **Cultural**: Remove weed hosts and infected crop residues. Making hay may be warranted if a large amount of fungal inoculum is present in the leaves and stems throughout the paddock. Dig the crop as early as possible. [12]

Photo 14: *Verticillium wilt: close-up view of yellow leaves with green veins and water-soaked margins (top); plant stunted by Verticillium wilt (bottom).*

12 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

9.3.4 Branch wilting or plant death

Sclerotinia blight (caused by Sclerotinia sclerotiorum *and* S. minor*)*

Importance: Major and expanding. *Sclerotinia minor* is the main problem in the South Burnett, and *S. sclerotiorum* is the main problem on the Atherton Tableland and at Coominya, south-eastern Queensland.

Damage: These diseases can devastate a crop in a few days if it is continuously wet. *Sclerotinia sclerotiorum*, particularly, shows up first in wetter parts of the paddock where the bushes are larger or where there may be shade for longer.

Symptoms: Usually, the first sign of Sclerotinia blight is a wilting branch or bush (Photo 15). The plant will begin to show visible wilting only after it has been infected for many days. Early detection is essential. Both species of *Sclerotinia* produce fluffy, white mould like cotton wool. However, the size of the black resting bodies (sclerotia) formed on and in stems is different; those of *S. sclerotiorum* are larger than a wheat grain, whereas those of *S. minor* are smaller and similar in size to raw sugar crystals (Photo 16). Stems wilt and become dry and bleached where the fungus is present.

The life cycles of the two species differ. *Sclerotinia minor* does not usually produce small mushrooms that release spores into the wind, whereas *S. sclerotiorum* does. Infections of lower stems and pegs develop from germinating sclerotia.

Spread: *Sclerotinia minor* spreads by physical movement of the sclerotia; *S. sclerotiorum* spreads by sclerotia and by wind-blown spores.

Photo 15: *The first sign of Sclerotinia blight is a wilting branch or bush.*

Management strategies:

- **Cultural**: Prevention in future crops is difficult. Avoid damage to plants from inter-row cultivations.
- **Chemical**: Monitor the crop for infection, especially in cool, damp conditions. Spray with a fungicide as soon as the disease is seen. Correct timing is essential to achieve the most effective control. Apply registered fungicide (Rovral®, a.i. iprodione). If the field has a history of Sclerotinia blight, consider spraying as a precaution when the row has half-closed. More than one spray may be needed. Avoid the continued use of chlorothalonil to control leaf diseases in fields where Sclerotinia blight is a problem. Continue to use chlorothalonil if the damage from leaf spot, rust and net blotch is likely to be worse than the Sclerotinia blight.

Photo 16: *The white fluffy mycelium of* Sclerotinia sclerotiorum *is similar to* S. minor. *Note the relatively large black sclerote of* S. sclerotiorum*, which is the main type on the Atherton Tableland and at Coominya (left). Small black sclerotes are produced by* S. minor*, which is the most common in peanuts in the South Burnett (right).*

Cylindrocladium black rot (CBR) (caused by Cylindrocladium crotalaria*)*

Importance: Major in the Burnett and Atherton Tableland.

Damage: The disease is caused by a soil-inhabiting fungus. Although wet conditions allow infection, particularly when plants are young, CBR is more evident when conditions turn dry and bushes start to wilt and die.

Symptoms: The taproot and side roots start to decay from the tip towards the main crown of the plant (Photo 17). There is internal, dark brown discoloration of the roots, and sometimes the stems, but the only symptom seen on foliage is a general yellowing. Eventually, the plant dies from loss of the root system. Red fungal structures (about pinhead size) may form on dead or diseased tissue. These structures do not usually occur on infected tissue in the South Burnett.

Spread: By infected plant parts and soil.

Management strategies:

- **Treatment**: Nothing can be done for the current crop. The future of growing peanuts on that land likely depends on surviving one or two bad crops, after which losses may be acceptable.

- **Cultural**: Some growers on the Atherton Tableland use irrigation and fertiliser to reduce the effects of CBR. The lateral roots feed on the moisture and nutrients after the taproot has died. A rotation of 2 years of maize followed by peanuts seems effective in keeping the inoculum to a low level on the Atherton Tableland.

In the South Burnett, CBR can be quite severe in affected parts of a field for a few successive crops, but generally, the severity decreases in subsequent crops. This does not appear to be the case on the Atherton Tableland, where the severity of the disease varies from season to season depending on weather conditions.

Damage to the root system by soil insects and nematodes can increase CBR infections.

Soybeans, lupins and lucerne are hosts for CBR.

Photo 17: *Cylindrocladium black rot: roots usually become blackened and die back from the tips (top left). The red resting bodies are typical of CBR, but are not always present (top right). Kernels infected with CBR (bottom).*

White mould (caused by Sclerotium rolfsii*)*

Importance: Major. Widespread across all peanut-growing areas. Worse in some years and in some fields.

Damage: Wilting and dead plants. Prefers to live on dead plant matter. Attacks peanut plants mainly when soil organic matter levels are low. Diseased leaves drop and are responsible for the movement of inoculum between plants.

Under dry conditions, the fungus can live under the soil in the moisture around roots and pods.

Symptoms: Produces fluffy white mycelium, thicker than that of *Sclerotinia* spp. In the mycelium are very small, spherical, white and then brown resting bodies, about pinhead size (Photo 18). Plant stems may be destroyed near soil level, and pegs and pods can be attacked. Pods can be affected without any sign of infection on the soil surface.

Spread: Already present in virtually all soils.

Management strategies:

- **Treatment**: Nothing can be done for the current crop.
- **Cultural**: Avoid damaging the plants or throwing too much soil around the crown when inter-row cultivating. Build up soil organic matter status. Decomposed soil organic matter may reduce the incidence of white mould by stimulating antagonistic organisms. Fresh (or under-composed) organic matter can stimulate white mould and make the problem worse. This is particularly the case where decomposed soil organic matter levels are low. The best control is usually to have a good rotation with grass or cereal crops.

The white mould situation in North Queensland may be different from that in the Burnett. White mould is appearing where crops have been well rotated, soil organic matter levels appear high, and, in particular, where stubble is retained on the soil surface.

In North Queensland, avoid planting peanuts into fresh stubble or crop residues maintained on the soil surface. Give organic matter time to break down or decompose. Deep ploughing may be an option, as sclerotia do not survive deep burying for more than a year.

Photo 18: *White mould: the white mycelium is slightly thicker than that of Sclerotinia and tends to form more on the soil surface (top). Note the sclerotia, which are spherical and white, then turn brown (bottom) (those of Sclerotinia are black and an irregular shape).*

Collar rot (caused by Lasiodiplodia theobromae*)*

Importance: Major problem in the Central and South Burnett, but is known in all peanut growing areas.

Damage: Losses can be severe, up to total crop loss across an entire paddock. The disease seems to be worse where the soil is degraded through erosion or scalping during land levelling.

Symptoms: A rapid collapse of plants from complete rotting of the roots and stems at ground level (Photo 19). Plants die throughout the season.

Infection occurs at soil level where stems and crowns suffer from heat stress, soil abrasion or drought.

Management strategies:

- **Treatment**: Nothing can be done for an affected crop.
- **Cultural**: Maintain light irrigations where possible, so the plant can survive on surface roots. Do not delay harvest. Rotation of at least 2 years in other crops should reduce the level of spores in the soil. To minimise risk, plant early and consider planting on beds to obtain groundcover before the middle of summer.

Photo 19: *Collar rot: bushes rapidly wilt and rot at ground level (top). Affected pods go grey inside in the early stages, then the whole pod rots (bottom left). Note the characteristic small black resting bodies on the stem (bottom right).*

Aspergillus crown rot (caused by Aspergillus niger*)*

Importance: Widespread in all peanut-growing areas.

Damage: Causes serious plant losses in some fields in some years. Plants may be killed at any stage up to harvest, although death of young plants is more common.

Symptoms: In seedlings, the soft, below-ground stem is attacked and can be killed rapidly. The affected tissue becomes yellow and depressed and usually develops a sooty, black mass of spores (Photo 20). The rot frequently develops near old pieces of seed attached to the stem.

In plants, a typical crown rot develops and the sooty growth of the fungus is often present on affected tissues. If the damage is near the base of the underground part of the stem, the plant will survive for a while on roots that grow above the affected area. Such plants generally die during dry weather.

Spread: The fungus is present in all peanut-growing areas. It is most serious where peanuts have been grown in the same area for a number of years.

The fungus is often present in seed that becomes infected in the field or during harvesting and handling.

Management strategies:

- **Chemical**: Use good seed treated with recommended fungicides.
- **Cultural**: Avoid damage to the seed before planting. Do not plant deeper than necessary. Take care when cultivating to avoid damaging plants. Rotate with other crops.

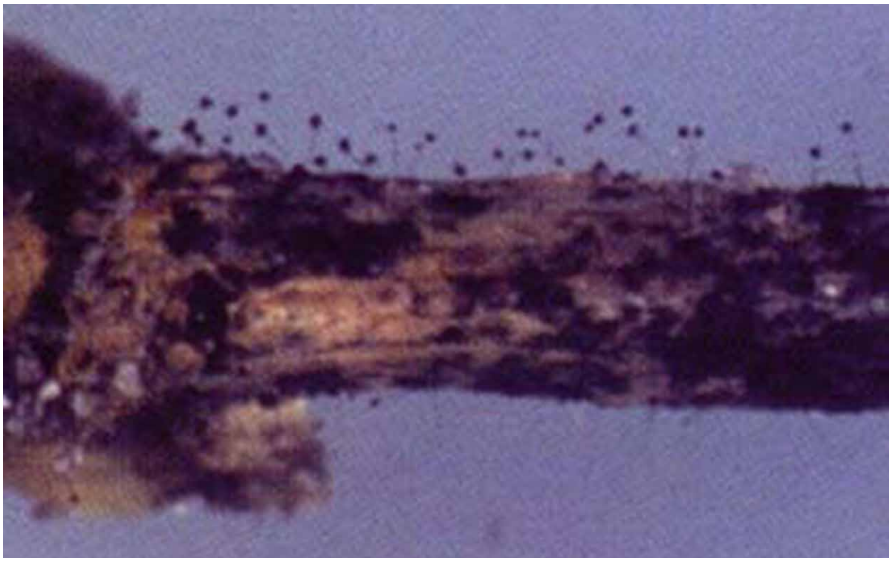


Photo 20: *Aspergillus crown rot can kill plants from seedlings to maturity. The infection usually starts at ground level (top). Note the characteristic black spores (bottom).*

Charcoal rot (caused by Macrophomina phaseolina*)*

Importance: Not normally a major problem. May become serious in crops where soil temperature becomes very high during the growing season. It also appears to be drought-induced.

Damage: Plants die progressively during the season.

Symptoms: Root tissues are discoloured beneath the bark layer. Developing pods can rot (Photo 21).

Spread: Already present in most soils.

Management strategies:

- **Cultural**: If possible, keep the soil surface moist to minimise stress due to high soil temperatures or drought. To minimise risk, plant early and consider planting on beds to obtain groundcover before the middle of summer.

Photo 21: *Charcoal rot.*

Rhizoctonia stem rot (caused by Rhizoctonia solani*)*

Importance: Rarely causes problems under traditional dryland peanut production conditions in Australia. May be a problem under sprinkler irrigation where the soil surface stays cool and moist.

Damage: Plants can be killed from seedling to maturity.

Symptoms: Distinctly zonate brown sunken lesions, which can completely girdle stems, causing part or all of the plant to die (Photo 22). Pegs and pods may also be affected.

Spread: The fungus is already present in many soils and can survive in soil for many years.

Management strategies:

- **Cultural**: Little can be done, except to irrigate so that the plant is wet for the least possible time. Gypsum application may reduce pod rots. Avoid covering the crown and branches of the plant with soil during cultivation. Rotate crops to increase or maintain levels of soil organic matter. [13]

Photo 22: *Rhizoctonia stem rot.*

Photo used with kind permission of Chip Lee, Texas A & M University, College Station, TX, USA

9.3.5 Ill-thrift

*Root-lesion nematodes (*Pratylenchus brachyurus*)*

Importance: Most widespread nematode affecting peanuts in Australia.

Damage: Can cause significant reductions in yield and quality. Pods are discoloured (Photo 23); therefore, the crop will not achieve nut-in-shell quality.

Symptoms: Stunted bushes. Small lesions on roots, pegs and shells may not be obvious.

13 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

Management strategies:

- **Chemical**: Nothing can be done in the current crop, except to identify nematodes as the cause. No chemicals are registered for use against nematodes in peanuts.
- **Cultural**: Crop rotation can reduce nematode population significantly. Maize is the most effective rotation crop.

Photo 23: *Root-lesion nematodes: the dark markings on these pods are caused by nematodes burrowing into the shell. The small white lumps are lenticels (or pores), which swell up in wet soil.*

*Root-knot nematodes (*Meloidogyne hapla*)*

Importance: Not a major problem in traditional peanut areas, but may become important in new production areas.

Symptoms: Typical root galls are formed (Photo 24), and in severe cases, plants are stunted.

Management strategies:

- **Chemical**: No action is possible in an affected crop, except confirming nematodes as the cause of the damage. No chemicals are registered for use against nematodes in peanuts.
- **Cultural**: Rotation with cotton, sorghum or maize will reduce the population. [14]

14 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

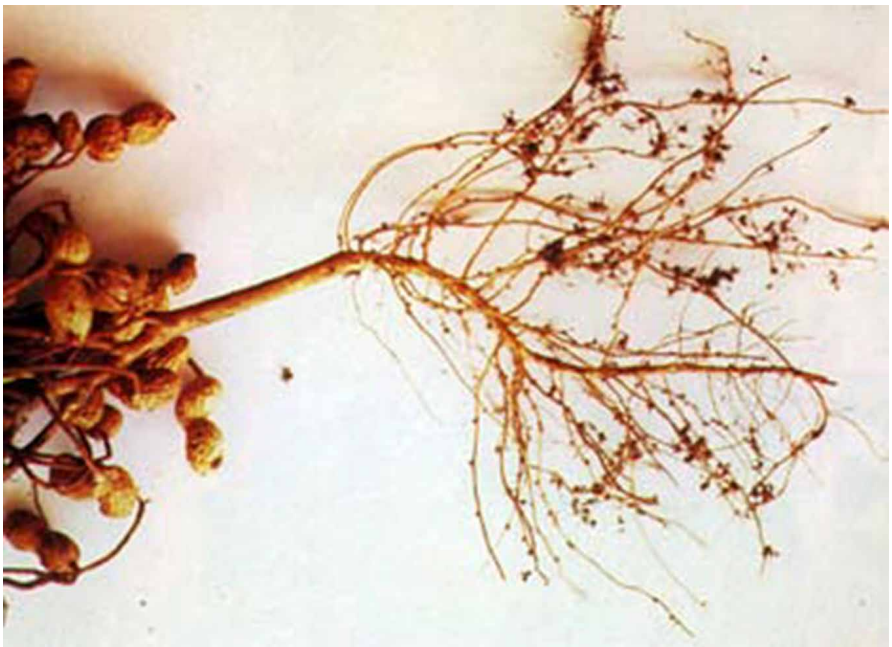


Photo 24: *Root-knot nematodes: the typical root galls should not be confused with N-fixing nodules.*

9.3.6 Pods damaged at harvest

Soil insects

Lucerne seed web moth (*Etiella*), white grub larvae and white-fringed weevil larvae all damage pods (see GrowNotes Peanuts Section 7. Insect control).

Pod-rotting fungi, including Lasiodiplodia theobromae, Pythium *spp. and* Rhizoctonia solani

Importance: Major and widespread.

Damage: Many pods (and pegs) are mouldy and/or decayed, causing serious yield and quality losses.

Management strategies:

- **Cultural**: Harvest quickly to reduce losses.

*Aflatoxin-producing fungi (*Aspergillus flavus *and* A. parasiticus*)*

Importance: Major and widespread, particularly in dryland crops.

Damage: Kernels contaminated with aflatoxin bring a reduced price and, in cases of very high levels, may be downgraded to oil quality (Photo 25).

High soil temperatures and drought during flowering and podfill are the major causes of aflatoxin contamination. Pods damaged by insects, disease or rain after a dry period or after harvest allow the fungus access to the kernels.

Aspergillus flavus develops most rapidly at 25°–35°C and when pod moisture is 14–35%.

Symptoms: The greenish yellow fungi are not always visible in harvested kernels. The toxins can only be detected in a laboratory using chemical extraction and analytical instruments.

Cultural management strategies: Irrigation will minimise the risk of pre-harvest aflatoxin. However, if the plant is allowed to stress just prior to maturity, *A. flavus* can still invade the pod.

Dig as soon as the crop is mature.

Leaving peanuts in the windrow to dry to 13% moisture increases the risk of aflatoxin because of the chance of rain re-wetting the crop. The risk is much higher if the plants were moisture-stressed before harvest. Peanuts in well-inverted windrows have a lower risk because they dry quicker.

Harvest irrigated areas separately from dryland areas. This may mean turning in the middle of a row if the irrigator does not cover the paddock. Mixing peanuts from these dry ends of rows commonly results in aflatoxin-positive loads from irrigated crops.

Clean out threshers, bins and elevators between seasons, as one contaminated nut can downgrade a whole load.

Start curing the crop within 3 h of harvest to stop further development of the aflatoxin. Harvested nuts should not be left overnight before curing, even if only part of a bin is threshed.

Low soil calcium may increase the risk of aflatoxin where soil conditions are favourable for *A. flavus* mould development.

Gypsum may reduce the risk of aflatoxin contamination. [15]

15 PCA/DPIF (2007) Managing disease. Peanut Company of Australia/Department of Primary Industries and Fisheries Queensland, http://www.pca.com.au/bmp/pdfs/4a_disease.pdf

Photo 25: *Aflatoxin: peanuts contaminated with aflatoxin will be downgraded and may be rejected.*

9.4 Soil-borne diseases

Several soil borne diseases can lead to substantial yield and quality loss. Three diseases of particular consequence are white mould, Sclerotinia blight and CBR.

Although some products are available that can lessen the effects of these diseases, the best policy is to follow a recommended rotational program (involving grass or cereal crops) and practice good cultural management. In particular, excessively aggressive inter-row cultivation should be avoided, especially where soil is pushed against the plant.

Sclerotinia blight can be particularly devastating in some areas. It is recommended that a registered fungicide spray (e.g. Rovral® at 1 L/ha) be applied as a protectant

before symptoms appear. This may be as early as when the crop is 6–8 weeks old, or when the first flower petals drop. One or two follow up fungicide applications may be required if symptoms develop. [16] Roval® is more effective at controlling *S. sclerotiorum* than *S. minor*.

MORE INFORMATION

New research investment to tackle peanut disease

New research tackles devastating peanut root rot. GRDC Media Centre.

9.4.1 Neocosmospora vasinfecta

Neocosmospora vasinfecta is a major soil-borne fungal root-rot pathogen found in all peanut-growing areas of Australia. It has caused yield losses of up to 90%.

There is a lack of information available globally regarding *N. vasinfecta* infection in peanuts, but this is being addressed through new research work being undertaken by GRDC-funded PhD student, Kylie Wenham.

The project is assessing the pathogen's form and structural characteristics, the growth and development of the fungus both *in vitro* and *in situ*, the optimal growth conditions favoured by the fungus, as well as the optimal environment for the fungus to proliferate and infect crops.

9.5 Emerging diseases

9.5.1 Peanut smut (*Thecaphora frezii*)

Peanut smut is currently the most economically important peanut disease in Argentina. During the last 10 years, this disease has caused significant decreases in yield production in Argentina, resulting in 51% losses in some locations. Currently, Argentina is the only country that has reported peanut smut in commercial crops. Both Bolivia and Brazil have reported cases of smut in wild peanuts.

T. frezii produces teliospores, which are thick walled structures that enable the fungus to overwinter in soil and crop residue. Teliospores can survive in a metabolic dormant state in the soil without the presence of live hosts. When peanut pegs penetrate the soil, their exudates disrupt telial dormancy, which promotes spore germination and initiates local infections. [17]

9.5.2 Peanut kernel shrivel

Peanut kernel shrivel (PKS) syndrome is a condition affecting peanut crops primarily in the Bundaberg growing region. Peanut kernels in pods on a plant near maturity stop filling normally and fail to reach their full size. The resulting reduced kernel size and high shell percentage reduces overall crop yield, quality/grading and price/Mt of farmer stock. Affected kernels are small and in many instances develop a shrivelled testa with light tan colour (Photo 26). There are no aboveground symptoms as leaf and stem from PKS-affected plants appear healthy with no obvious signs of nutrient deficiency or disease.

The peanut industry in the Bundaberg region has seen a steady rate of decline in crop grade since 2011, due to the increasing impact of PKS. PKS is currently costing the industry more than $2.5M per annum and growers will consider reducing peanut plantings if a solution to PKS is not initiated soon. [18]

To date, efforts to detect the cause of PKS have been unsuccessful. Initial investigations showed no evidence to indicate abiotic (including water quality and nutritional status) or biotic (including insect, nematodes, viruses and bacteria) factors. Some recent research results have suggested a pathogen (e.g. fungi) might be involved, possibly associated with a toxin or excess hormone production.

16 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

17 AM Rago, LI Cazón, JA Paredes, JPE Molina, EC Conforto, EM Bisonard, C Oddino (2017) Peanut smut: from an emerging disease to an actual threat to Argentine peanut production. Plant Disease 101, 400–408, http://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-09-16-1248-FE

18 G Wright, 2017, Peanut Company of Australia, personal communication

The University of Southern Queensland (USQ) and PCA have partnered in a GRDC-funded research collaborative project looking into the 'Extent, distribution and cause of PKS syndrome in the Bundaberg and Northern Queensland regions'.

Led by Dr Dante L. Adorada (USQ), work to identify possible biotic factors, focussing on fungi and bacteria and non-culturable microorganisms, is currently underway. The next step will be developing management strategies to minimise the incidence of PKS in commercial peanut crops.

Photo 26: *Symptoms of peanut kernel shrivel (PKS) syndrome.*

Photos: Graeme Wright