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GRDC
GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

OATS

SECTION 9

DISEASES

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

SECTION 9

Diseases

Diseases can severely affect yield and quality in oats. In some cases, diseases are controlled through simple cultural practices and good farm hygiene. One of the major practices used in the control of diseases is crop rotation.

To minimise the effect of diseases:

- Use resistant or partially resistant varieties.
- Use disease-free seed.
- Use fungicidal seed treatments to kill fungi carried on the seed coat or in the seed.
- Have a planned, in-crop fungicide regime.
- Conduct in-crop disease audits to determine the severity of the disease. This can be used as a tool to determine what crop is grown in what paddock the following year.
- Conduct in-fallow disease audits to determine the severity of the disease (e.g. yellow leaf spot and crown rot). This can also be used as a tool to determine what crop is grown in what paddock the following year.
- Send plant or stubble samples away for analysis to determine the pathogen or strain you are dealing with or the severity of the disease.
- Control summer weeds and volunteer plants that may act as a green bridge.
- Rotate crops. [1]

FAQ

Oats can be infected by diseases, including barley yellow dwarf virus (BYDV), that are transmitted by aphids. Early-sown crops are more at risk. Sow tolerant varieties or be prepared to control aphids to prevent disease transmission.

Seed dressings will offer some anti-feeding protection for your oat crop against aphids. Imidacloprid is registered for use on cereal crops as a seed dressing for the management of aphids and BYDV spread in cereal crops. For more information, go to the Australian Pesticides and Veterinary Medicines Authority website at www.apvma.gov.au.

[1] DAF Qld (2012) Wheat—diseases, physiological disorders and frost. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/wheat/diseases

Table 1: Cereal insecticide seed dressings for aphid and barley yellow dwarf virus (BYDV) control 2015 [2]

Active ingredient of insecticide and fungicide Various trade names sometimes available under these active ingredients, concentrations and formulations. See specific labels for details.	**Examples of seed treatment trade name and manufacturer**	**Rate to apply to each 100 kg###**	**Approx. cost to treat 100 kg of seed ($)##**	**Aphid feeding damage suppression (wheat aphid and corn aphid)**	**Reduces spread of BYDV**	**Grazing withholding period (weeks)**
Imidacloprid 180 g/L + tebuconazole 6.25 g/L	Hombre® – Bayer CropScience	400 mL	8.36	✓	✓	9
Imidacloprid 360 g/L + tebuconazole 12.5 g/L	Hombre® Ultra– Bayer CropScience	200 mL	8.03	✓	✓	9
Imidacloprid 180 g/L + triadimenol 56 g/L	Zorro® – Bayer CropScience	400 mL	8.62	✓	✓	9
Imidacloprid 180 g/L + flutriafol 6.25 g/L	Veteran® Plus – Crop Care	400 mL	8.42	✓	✓	9
Imidacloprid 180 g/L + flutriafol 25 g/L	Arrow® Plus – Crop Care (registered for barley only)	400 mL	8.69	✓	✓	9
Imidacloprid – 350 g/L	Gaucho® 350 – Bayer CropScience	200 mL – 400 mL	8.11–16.22	✓	✓	9
Imidacloprid – 600 g/L	Gaucho® 600 – Bayer CropScience Senator® 600 Red – Crop Care	120 mL – 240 mL	6.11–12.21	✓	✓	9

The major diseases of oats are the rust suite. Significant production losses can result from either stem rust or leaf rust. With the development of new pathotypes in some regions for stem rust, there are no remaining genetic resistances available in commercially grown varieties to fully protect crops from stem rust.

Leaf rust resistance levels in some varieties provide useful field tolerance to the disease. Monitor crops in season for the presence of these rusts. Rusts can be managed by selecting appropriate varieties for sowing and avoiding sowing later maturing varieties, or can be controlled by the use of foliar fungicides in-crop. [3]

[2] NSW DPI (2015) Winter crop variety sowing guide, Department of Primary Industries, New South Wales, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/272945/winter-crop-variety-sowing-guide-2015.pdf

[3] NSW DPI (2015) Winter crop variety sowing guide, Department of Primary Industries, New South Wales, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/272945/winter-crop-variety-sowing-guide-2015.pdf

Table 2: Guide to oat diseases [4]

Disease/Cause	Symptoms	Occurrence	Spread	Control
Foliar Diseases				
Bacterial stripe blight *Pseudomonas striafaciens* pv. *striafaciens*	Water soaked stripes on leaves, drying to tan/ red stripes, leaf death.	More severe in early maturing crops in wetter seasons.	Rain splash, insects, seed-borne.	Nil
Barley yellow dwarf *Barley yellow dwarf virus (BYDV)*	Yellowing, dwarfing of infected plants, floret blasting, leaf reddening in some varieties.	Most common near perennial grass pastures and in early sown crops.	Transmitted by aphids from infected grasses and cereals.	Resistant and tolerant varieties; controlling aphids, insecticidal seed treatments.
Leaf (Crown) rust *Puccinia coronata* f.sp. *avenae*	Orange powdery pustules on upper leaf surface.	In wet seasons; more important on the coast.	Air-borne spores from living plants.	Graze infected crops in autumn, Varieties with the best possible field resistance. Foliar fungicides.
Leaf spots Several fungi	Leaf spots, leaf death.	Usually minor.	Depends on disease.	None.
Red leather leaf *Spermospora avenae*	Long lesions with reddish borders and light centres. Leaves may look and feel leathery.	Higher rainfall, cool wet weather.	Oat stubble. Stubble and rain splash.	Avoid susceptible oat varieties and rotate crops.
Stem rust *Puccinia graminis* f.sp. *avenae*	Reddish-brown, powdery, oblong pustules with tattered edges on leaf and stem; progressive death of plant.	More important inland, from spring to summer in warm, wet weather.	Air-borne spores from living plants.	Early maturing varieties to avoid rust. Foliar fungicides.
Smuts				
Smuts *Ustilago avenae*, *U. segetum* var. *hordei*	Replacement of florets by black sooty mass.	Statewide.	Spores on or in the seed infect the seedling after sowing.	Thorough treatment of seed with appropriate fungicide.

If hay production is the end use for your crop, care must be taken to ensure a quality product is produced, in particular if the hay is headed to the lucrative export market. The table below explores which diseases are of the greatest threat to hay quality.

Table 3: Priority of disease constraints to oaten hay production in Australia (RIRDC) [5]

Highest priority	High priority	Medium priority
Septoria blotch	Barley yellow dwarf (BYDV)	Root lesion nematodes
Leaf rust	Windburn	Aphids
Stem rust	Bacterial blight diseases	Red leather leaf
Cereal cyst nematode (CCN)	Stem nematode	
Annual rygrass toxicity (ARGT)	Crown rot	
	Oat attacking strain of take-all	

[4] NSW DPI (2015) Winter crop variety sowing guide, Department of Primary Industries, New South Wales, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/272945/winter-crop-variety-sowing-guide-2015.pdf

[5] GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

9.1 Causes of cereal diseases

Cereal diseases are caused by fungi, viruses, bacteria and nematodes.

9.1.1 Fungi

Fungi and other pathogens (disease-causing organisms) often reduce grain yields by damaging green leaves, preventing them from producing the sugars and proteins needed for growth. In other cases, they block or damage the plant's internal transport mechanisms, reducing the movement of water and sugars through the plant. Yields are also reduced when the pathogen diverts the plant's energy to reproducing more of the pathogen at the expense of plant growth or grain formation.

Fungi come in a diverse variety of forms. They spread by producing one or more types of spores, which may be carried by wind, through raindrop splashes or, in the case of smuts, by mechanical movement and mixing during harvest. Some fungi survive as spores in the soil, on seed or on plant debris, such as septoria. Others survive as fine threads of growth inside plant debris or seed, and produce fresh spores in the following season. Spores are sometimes produced inside small fruiting bodies on infected plant tissue or stubble. Some diseases such as rust require continuous green host plants to survive from one season to the next.

9.1.2 Viruses

Viruses are invisible to the eye and even through a conventional microscope. Unlike other pathogens, viruses are totally dependent on the host for growth and multiplication. They cannot survive outside the plant, except in an insect or other animal that transmits the disease. They often damage plants by blocking their transport mechanisms. Barley yellow dwarf virus (BYDV) affects all of the cereals, with aphids as the vector for transmission of this disease.

9.1.3 Bacteria

Bacteria differ from fungi in that they do not form fine threads of growth, but instead multiply rapidly by continually dividing. They grow best under damp conditions and do not survive as well as fungi under dry conditions.

9.1.4 Nematodes

Nematodes are worm-like animals that cause various diseases in cereals. Most nematodes attack the plant roots or lower stems. Nematodes feeding on plants cause direct damage by reducing root area, damaging the transport mechanism, or, in the case of the seed gall nematode, by replacing the grain with galls full of nematodes. [6] Cereal cyst nematode (CCN) is one such nematode that attacks wheat. For more information see Section 8. Nematodes.

9.2 The disease triangle

Plant pathologists talk about the occurrence of disease in terms of the '*disease triangle'* (Figure 1)—an interaction of host, pathogen and environment. Alteration to any of these components of the disease triangle will influence the level of disease.

[6] H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

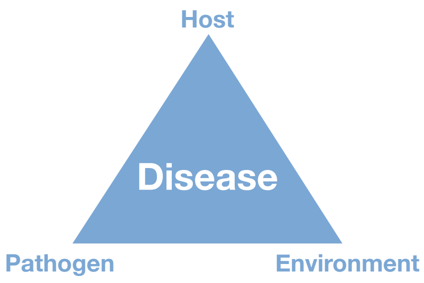

Figure 1: The disease triangle.

For disease to occur, there must be a susceptible host and a virulent pathogen, and the environment must be favourable. Following are some important examples of interactions of environmental conditions with diseases of grain crops.

- Low temperatures reduce plant vigour. Seedlings become more susceptible to *Pythium*, *Rhizoctonia* and other root and damping-off pathogens if they are emerging in soils below their optimum temperature.
- Pathogens have different optimum temperature ranges. For example, hatching in nematodes tends to occur over narrow soil temperature ranges, within a 10–25°C range and optimal at 20°C, whereas the take-all fungus *Gaeumannomyces graminis* var. *tritici* is more competitive with the soil microflora in cooler soils. This can lead to diseases being more prevalent in certain seasons or in different areas, such as wheat stem rust in warmer areas and stripe rust in cooler areas.
- Fungi such as *Pythium* and *Phytophthora*, which have swimming spores, require high levels of soil moisture in order to infect plants; hence, they are most severe in wet soils.
- Foliar fungal pathogens such as rusts require free water on leaves for infection (see Section 9.3). The rate at which most leaf diseases progress in the crop depends on the frequency and duration of rain or dew periods.
- Diseases that attack the roots or stem bases, such as crown rot, reduce the ability of plants to move water and nutrients into the developing grain. These diseases generally have more severe symptoms and larger effects on yield if plants are subject to water stress. [7]

9.3 Rusts

Rusts grow and reproduce only on living plants and must continually infect new hosts. They survive over summer by infecting wild oats and volunteer oats, and infect crops in the next season.

Seasons are at greater risk of a rust epidemic if:

- rust was present in the previous season
- summer and autumn rains allow wild or volunteer oats to grow over summer, harbouring and building up the rust (‘green bridge’)
- spring conditions are suitably wet [8]

Each factor depends on locality, so it is possible to assess rust risk in your locality.

Oat rusts have been very effective in breaking down resistance in commercially grown varieties of oats. As the pathotype of these diseases is constantly evolving, it is important that both growers and advisers are vigilant in the paddock, noting any cases of disease. Monitoring rust variability and forwarding samples to DAFWA is a crucial part of using genetic resistance to combat these diseases.

More information

NSW DPI (2015) Winter crop variety sowing guide, Department of Primary Industries, New South Wales http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/272945/winter-crop-variety-sowing-guide-2015.pdf

DAF Qld (2012) Disease management and weed control, Department of Agriculture and Fisheries, Queensland https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/oats/diseases-and-weeds

[7] UNE Agronomy of Grains Production course notes.

[8] DAFWA (2016) Oats: leaf diseases, https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C1

PBI Cobbity is home to the Australian Cereal Rust Control Program (ACRCP), established in 1973, which is funded largely by the grains industry, through the GRDC. Pathogenicity surveys are conducted on an annual basis to monitor pathogenic change in the cereal rust pathogen populations. [9]

Growers and agronomists are encouraged to submit samples for confirmation of rust identity and subsequent pathotype and virulence analyses. Samples should be sent in paper bags, not plastic to:

University of Sydney
Australian Rust Survey
Reply Paid 88076
Narellan NSW 2567

More information

Cereal rust services, Faculty of Agriculture and Environment, University of Sydney
http://sydney.edu.au/agriculture/plant_breeding_institute/cereal_rust/services.shtml

9.3.1 Stem rust (*Puccinia graminis* f. sp. *tritici*)

Figure 2: Stem rust in oats. (Photo: Robert Park)

[9] University of Sydney (2012) Pathogenicity surveys, http://sydney.edu.au/agriculture/plant_breeding_institute/cereal_rust/pathogenicity_surveys.shtml

Figure 3: *Stem rust can occur on leaves, with spores being brick red. (Photo: Terry Hahn)* [10]

Figure 4: *Stem rust in oats rupturing the stem tissue. (Photo: Bob Rees)* [11]

Stem rust is caused by the fungus *Puccinia graminis* f. sp. *tritici*. It can attack wheat, barley, rye and triticale. Oat stem rust will not attack wheat and wheat stem rust does not attack oats.[12]

Stem rust is similar in appearance to leaf rust and they can often be confused.

Stem rust can cause major yield loss in forage oat crops grown for seed or hay production. Stem rust has had the ability to cause significant economic damage (50–100% of yield). [13]

Stem rust produces reddish-brown spore masses in oval, elongated or spindle-shaped pustules on the stems and leaves, which appear about 7–10 days after infection. Unlike leaf rust, pustules erupt through both sides of the leaves. Ruptured pustules release

10 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

11 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

12 DAFWA (2016) Oats: leaf diseases, https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C1

13 DAF Qld (2015) Forage oat variety guide 2015, https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/61969/forage-oat-variety-guide.pdf

More information

DAF Qld (2015) Forage oat variety guide 2015 https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/61969/forage-oat-variety-guide.pdf

GRDC (2015) Rust in oat: new challenges and international perspectives, Ground Cover Issue 116 May–June 2015 http://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Rust-in-oat-new-challenges-and-international-perspectives

DAFWA (2016) Oats: leaf diseases https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C1

University of Sydney (2015) Rust pathotype update, Cereal Rust Report 13(2), 17 August 2015 http://sydney.edu.au/agriculture/documents/pbi/cereal_rust_report_2015_13_2.pdf

masses of stem rust spores, which are disseminated by wind and other carriers. It is darker in colour and has tended to be more of a problem in milling oats.

Stem rust develops at higher temperatures than the other oat rusts, within a range of 18–30°C. Spores require free moisture (dew, rain or irrigation) and take up to six hours to infect the plant, and pustules can be seen after 10–20 days of infection.

Inoculum must be present for the disease to develop. Practising crop hygiene by removing volunteer wheat, which forms a green bridge for the fungus through the summer, can eliminate or delay the onset of stem rust.

The disease is most common in high-rainfall areas in large bulky crops.

9.3.2 Leaf or crown rust (*Puccinia coronata* var. *avenae*)

Oat leaf rust is also known as crown rust. The word ‘crown’ refers to the shape of a type of spore produced by this fungus and is not related to the disease symptoms. It is closely related to leaf rust of wheat and barley, and has similar characteristics; however, oat, wheat and barley leaf rusts are specific strains that do not cross-infect the other cereals.

The characteristic symptom is the development of round to oblong, orange to yellow pustules, primarily on leaves but also on stems and heads, appearing about 7–10 days after infection. The powdery spore masses in the pustules are readily dislodged. The pustule areas turn black with age. [14]

This disease is most severe under mild temperatures and moist conditions (e.g. in early autumn and early spring after wet, overcast conditions). This disease will build up very quickly on susceptible varieties. It will complete its life cycle and re-infect new leaves every 2–3 weeks. [15]

Oat leaf rust is potentially a very damaging disease, reducing both grain and forage yields and forage quality and palatability. The fungus is carried over on volunteer oats and wild oats from season to season.

Control is similar to control for stem rust. Foliar fungicide registrations exist for control of this disease. When oats are grown for high-quality or export hay, early cutting should be considered before the disease builds up and causes obvious damage to leaves. [16]

Growers need to be aware that there are pathotypes of oat leaf rust present in Australia that can overcome resistance in all cultivars (not all in WA).

In early 2013, the appearance of a new pathotype (strain) of crown rust on oats from north-eastern Australia was reported that could attack the previously resistant cultivar, Drover. This left Aladdin as the only oat cultivar with resistance to this disease. Unfortunately, in late 2014, yet another pathotype of crown rust was found that can infect Aladdin, meaning that there are now no grazing oat cultivars with good levels of resistance to crown rust. Options for controlling this disease in grazing oats in north-eastern Australia are now very limited.[17] Currently these strains do not occur in Western Australia (WA), but its existence elsewhere highlights why growers need to be vigilant with biosecurity, crop monitoring and submitting suspected rust samples to DAFWA.

New research being funded by the GRDC is fast-tracking the identification and incorporation of minor gene or adult plant resistance to crown rust in Australian oat germplasm. Intensive efforts are also under way to find new sources of resistance to stem rust that can be used in the development of new cultivars.

[14] DAFWA (2016) Oats: leaf diseases, https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C2

[15] DAF Qld (2015) Forage oat variety guide 2015, https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/61969/forage-oat-variety-guide.pdf

[16] DAFWA (2016) Oats: leaf diseases, https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C2

[17] GRDC (2015) Rust in oat: new challenges and international perspectives, Ground Cover Issue 116 May–June 2015, http://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Rust-in-oat-new-challenges-and-international-perspectives

Australian oat breeders are not alone in dealing with the challenges of rust. An oat rust forum was held at the University of Minnesota in the United States in February 2015 and brought together oat breeders, rust pathologists and industry stakeholders from North America and Australia. The meeting sought to develop a strategy for a community-wide approach to manage oat rust resistance and to set clear direction for funding agencies on how this effort should be supported. [18]

Figure 5: Leaf rust (Puccinia coronata var. avenae) may first appear in crops as 'hotspots' from an initial infection. Hotspots in early spring allow leaf rusts to build up to very severe levels by the end of the season. (Photo: DAFWA)

Table 4: Tracking the breakdown of crown rust resistance in oats

Cultivar	Year of release	Virulence first detected	Seedling
Culgoa II	1991	1996	*PcMortlock, PcCulgoa*
Bettong	1992	2001	*PCBett*
Cleanleaf	1992	1995	*Pc38, Pc39, Pc52*
Barcoo	1996	2001	*Pc39, Pc61, PcBett*
Graza 68	1997	1999	*Pc68*
Moola	1998	1999	*Pc68*
Gwydin	1999	2001	*Pc56*
Warrego	1999	1998	*Pc61+*
Nugene	2000	2005	*Pc48+*
Taipan	2001	2005	*Pc48+*
Volta	2003	2008	*Pc50, Pc68*
Genie	2008	2010	*Pc48, Pc56*
Drover	2006	2012	*Pc91*
Galileo	2006	?	Not tested
Qantom	2006	2008	*Pc50*
Dawson	2009	?	Not tested
Aladdin	2001	Not yet detected	*Pc50, Pc91*

[18] GRDC (2015) Rust in oat: new challenges and international perspectives, Ground Cover Issue 116 May–June 2015, http://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Rust-in-oat-new-challenges-and-international-perspectives

Management of leaf rust

The frequency and severity of losses from leaf rust infection can be reduced by a range of management strategies.

1. Grazing management. Losses from leaf rust can be reduced by grazing or cutting rusted crops as early as possible once leaf rust is conspicuous below the top two leaves on each tiller and before the disease becomes severe. Given suitable conditions, it takes 7–14 days for a rust spore to infect and produce more spores. During this period, oat plants will normally produce several new leaves on each tiller. During active growth of the crop, the upper canopy may remain free of rust symptoms. Therefore, it is necessary to regularly inspect the crop to monitor rust occurrence. If leaf rust is obvious below the top two leaves on each stem, the crop should be grazed or cut regardless of growth stage.
2. Cultivar selection. Select cultivars with good resistance to leaf rust. Although new varieties can become susceptible to rust after commercial release.
3. Planting time. Early sown oats have a higher risk of developing rust and other leaf diseases. However delaying sowing can come at a significant trade off in yield. Growers need to weigh up the risk of leaf disease against potential yield penalty for later sowing.
4. Crop hygiene. Control volunteer oat plants and wild oats. Both leaf and stem rust survive over summer between cropping seasons on volunteer oat plants, providing a continual supply of spores for fresh rust outbreaks each year.
5. Nutrition. Maintaining good soil nutrition and ensure that the crop is supplied with adequate potassium. Cereal crops deficient in potassium can be more vulnerable to leaf disease.
6. Fungicide. A number of fungicides are registered for control of leaf rust on oats (Table 5). In recent years the cost of older fungicides has dropped significantly (e.g. $3–$6/ha). This now makes fungicides a more economic way to manage leaf diseases. Crops should be monitored from the first node onwards for leaf disease levels. When managing rust it is important to apply fungicides early, before severe crop infection occurs. Fungicide sprays should aim to protect the top three leaves (Flag, Flag-1 and Flag-2) for as long as possible. If in doubt, seek advice from your consultant or agronomist. All registered fungicides have withholding periods for grazing, hay cutting and harvest. It is critical that these withholding periods are followed.

Table 5: Commercially available foliar fungicides for control of rust disease in cereals in Australia 2015 [19]

Product name	Active ingredient	Company	Indicative cost	App rate (per ha)	App cost	Withholding period (grazing)	Registered for oats
Tilt 250SC	Propiconazole	Syngenta + Generic	$14/L	500 mL	$7/ha	7 days	Yes
Folicur 430SC	Tebuconazole	Bayer + Generic	$13/L	290 mL	$4/ha	14 days	Yes
Prosaro 420SC	Prothioconazole +Tebuconazole	Bayer	–	300 mL	–	14 days	Yes
Tilt Xtra	Propiconazole + Cyproconazole	Syngenta	$46/L	500 mL	$23/ha	21 days	No
Amistar Xtra	Azoxystrobin + Cyproconazole	Syngenta	$54/L	800 mL	$43/ha	21 days	No

19 DAF Qld (2015) Forage oat variety guide 2015, https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/61969/forage-oat-variety-guide.pdf

Figure 6: Close-up of leaf rust on leaves. (Photo: DAFWA)

Figure 7: Leaf rust in oats. (Photo: Bob Rees) [20]

20 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

A 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Figure 8: Leaf rust in oats. (Photo: Hugh Wallwork) [21]

Figure 9: Leaf rust in oats.(Photo: Hugh Wallwork) [22]

More information

GRDC (2015) Rust in oat: new challenges and international perspectives, Ground Cover Issue 116 May–June 2015 http://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Rust-in-oat-new-challenges-and-international-perspectives

GRDC (2013) Drover oats vulnerable to new crown rust pathotype, Ground Cover Issue 104 May–June 2013 http://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-104-May-June-2013/Drover-oats-vulnerable-to-new-crown-rust-pathotype

21 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

22 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

More information

Pacific Seeds (nd) Winter Forage https://www.pacificseeds.com.au/products/winter-forage.html

DAFWA (2016) Oats: leaf diseases https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C2

University of Sydney (2015) Rust pathotype update, Cereal Rust Report 13(2), 17 August 2015 http://sydney.edu.au/agriculture/documents/pbi/cereal_rust_report_2015_13_2.pdf

University of Sydney (2013) New oat crown rust pathotype with virulence for PC91, Cereal Rust Report 11(1), 8 February 2013 http://sydney.edu.au/agriculture/documents/pbi/cereal_rust_report_2013_vol_11_1.pdf

IPM (1989) Crown rust of oats, Report on Plant Diseases No. 109, Integrated Pest Management, July 1989 http://ipm.illinois.edu/diseases/series100/rpd109/

Figure 10: Black spores are produced late in the season. (Photo: Hugh Wallwork) [23]

9.4 Barley yellow dwarf virus

Symptoms of barley yellow dwarf virus (BYDV) can be confused with those caused by nutrient deficiencies, waterlogging or other plant stresses that cause yellowing, reddening and striping of leaves. Leaf symptoms differ between wheat, oats and barley. The severity depends on the age of the plant at infection, environmental conditions, the virus present and the cereal variety involved. [24]

In oats, the symptoms of BYDV infection are very striking. Most varieties develop reddening (crimson-pink) of the leaves from the tips down, which sometimes begins as blotching especially on older leaves. Young leaves often have yellow stripes. However, some varieties only develop a yellow or orange coloration. Stunting, an increase in sterile tillers or abortion of florets result in low grain yields and shrivelled grain. As for wheat and barley the effect of this virus is greatest in early-infected plants. [25]

Oats affected as seedlings may show additional symptoms of severe stunting, increased tillering and floret abortion. Infection after tillering causes a characteristic 'reddening' of later emerging leaves and tip-reddening and death of older leaves. [26]

Distribution of infection within the paddock is as for all viruses, that being patchy, but in some cases the whole crop may show symptoms.

Aphids are the vector or vehicle of transmission of the disease (see Section 7. Insects).

Use the following control methods, among others, to lessen the severity of the disease:

- Sow resistant varieties.
- Use an appropriate seed dressing that has an effect on aphids.
- Use an insecticide in-crop to prevent build-up of aphid numbers if aphid risk is high.

23 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

24 DAFWA (2015) Managing Barley yellow dwarf virus and Cereal yellow dwarf virus in cereals, https://www.agric.wa.gov.au/barley/managing-barley-yellow-dwarf-virus-and-cereal-yellow-dwarf-virus-cereals?page=0%2C1

25 DAFWA (2015) Managing Barley yellow dwarf virus and Cereal yellow dwarf virus in cereals, https://www.agric.wa.gov.au/barley/managing-barley-yellow-dwarf-virus-and-cereal-yellow-dwarf-virus-cereals?page=0%2C1

26 DAFWA (2016) Oats: leaf diseases, https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C3

Figure 11: Barley yellow dwarf virus in oats. (Photo: Hugh Wallwork) [27]

Figure 12: Barley yellow dwarf virus in oats, showing sterility (blasting) at stem base. (Photo: Terry Hahn) [28]

Figure 13: Stunting occurs when seedlings are infected. (Photo: Andrew Barr) [29]

27 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

28 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

29 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

More information

DAFWA (2015) Managing barley yellow dwarf virus and cereal yellow dwarf virus in cereals
https://www.agric.wa.gov.au/barley/managing-barley-yellow-dwarf-virus-and-cereal-yellow-dwarf-virus-cereals

DAFWA (2016) Oats: leaf diseases
https://www.agric.wa.gov.au/oats/oats-leaf-diseases?page=0%2C3

Figure 14: Reddening of oat leaves from BYDV infection. (Photo: DAFWA)

9.5 Rhizoctonia

Rhizoctonia root rot is an important disease of cereals in both the southern and western regions of the Australian grain belt. This is especially the case in the lower rainfall zones and on lighter soils. Yield losses in crops affected by bare patches can be over 50% and crops with uneven growth may lose up to 20%.

In cereals, oats are most tolerant, followed by triticale, wheat and then barley, which is the most intolerant.

The disease is caused by *Rhizoctonia solani* AG8, a fungus that grows on crop residues and soil organic matter and is adapted to dry conditions and lower fertility soils.

The fungus causes crop damage by pruning newly emerged roots (spear-tipped roots), which can occur from emergence to crop maturity.

The infection results in water and nutrient stress to the plant, as the roots have been compromised in their ability to translocate both moisture and nutrients.

Figure 15: Above-ground symptoms of crop unevenness (left) are seen when Rhizoctonia damages crown roots, even when seminal roots (right) escape the infection.

Management of rhizoctonia requires an integrated approach to reduce inoculum and control infection and impact on yield.

Rhizoctonia inoculum levels will be greatest following cereals, particularly barley. Grass-free canola is the most effective but legumes can also help reduce inoculum loading.

Disturbance below the seed at sowing promotes rapid root growth away from the rhizoctonia and disrupts hyphal networks. The ideal depth is 5–10 cm.

Fungicides applied through in-furrow liquid banding can provide useful suppression of rhizoctonia disease. Herbicides that slow root growth can exacerbate the problem.

Rhizoctonia disease is often a problem in low-fertility, sandy or calcareous soils of southern and western Australia [30]

Table 6: Management of rhizoctonia disease in cereal crops

Year 1 crop (Sept-Nov)	Summer (Dec-April)	Season break (April-May)	Year 2 crop (May-August)
Check for inoculum build-up	*Facilitate inoculum decline*	*Select appropriate crop*	*Manage infection and disease impact through management practices*
• Paddocks can often be identified in the previous spring by estimating the area of bare patches and/or zones of uneven growth during spring – verify that poor plant growth is due to *Rhizoctonia* disease	• In wet summers, early weed control will reduce inoculum. In dry summers, inoculum levels do not change • Adopt practices that prolong soil moisture in the upper layers (e.g. stubble retention and no cultivation), which helps maintain higher microbial activity • Consider soil testing for pathogen inoculum level (PreDicta B™ test in Feb-March), to identify high disease risk paddocks and if disease is not confirmed in the previous cereal crop, especially if planning to sow cereals back on cereals	• Select a non-cereal crop (e.g. canola or pulses) if you want to reduce inoculum levels • Remove autumn 'green bridge' before seeding with good weed control	• Sow early; early-sown crops have a greater chance of escaping infection • Use soil openers that disturb soil below the seed to facilitate root growth – knife points reduce disease risk compared to discs • Avoid pre-sowing SU herbicides, • Supply adequate nutrition (N, P and trace elements) to encourage healthy seedling growth • Avoid stubble incorporation at sowing to minimize N deficiency in seedlings • Consider seed dressings and banding fungicides to reduce yield loss • Remove grassy weeds early • Apply nutrient/trace elements, foliar in crop, if required

9.6 Crown rot (*Fusarium graminearum*)

Crown rot is caused primarily by the fungi *Fusarium pseudograminearum* and/or *F. culmorum*. It is hosted by all winter cereals and many grass weeds. The crown rot fungi can survive for many years as mycelia inside infected plant residues. Cereal-on-cereal cropping programs and stubble retention can increase crown rot levels.

Major yield losses occur when disease levels are high and there is moisture and/or evaporative stress during grain filling. Yield loss can be up to 90% in durum and 50% in bread wheat or barley with increased screening.

Oat crops are considered 'symptomless hosts' of crown rot that may contribute to the maintenance of inoculum.

CSIRO investigated the incidence of *Fusarium graminearum* Group 1 (infection, stem colonisation) and crown rot in three-year crop sequences of one or two years of barley, oats or mown oats, followed by wheat, compared with three years of wheat.

Seed was sown into the stubble of the previous crop and stubble production estimated for each cereal treatment. Plants of each cereal were infected by the crown rot

[30] GRDC (2016) Rhizoctonia Tips and Tactics–Western Region.

pathogen. Oats were found to be susceptible to infection but did not express symptoms of crown rot in the two years of the trial.

The overall mean incidence of infected plants increased from 12% in 1987 to 81% in 1989. The various treatments did not significantly reduce the incidence of infected wheat plants in November of the final year. The incidence of crown rot of wheat in 1989 was greatest after two prior wheat crops and lowest after one or two years of mown oats.

The three species produced a similar amount of straw by weight; however, mown oats produced significantly less. Oat straw decomposed more rapidly than that of other cereals in controlled conditions. [31]

See CSIRO: 'Effect of rotation with barley and oats on crown rot of wheat in the northern wheat belt of New South Wales' at http://www.publish.csiro.au/paper/EA9950765.htm.

9.7 Bacterial blights

Blights survive on seed and crop debris. They are spread by rain splash, leaf contact and insects, especially aphids. Moist weather conditions favour development and spread from crop debris or seed coat to seedlings and then from one leaf to the next. Symptoms often develop after frost. A period of warm, dry weather stops the spread. Heavy infection with either disease leads to withering and death of leaves, often starting from the tip. [32]

These diseases can reduce the appearance of hay and hence downgrade its value.

Using these control measures can help avoid blights:

- Avoid susceptible varieties, referring to your local state variety sowing guide for resistance ratings.
- Use seed from uninfected crops.
- Destroy infected oat stubbles.

9.7.1 Stripe blight (*Pseudomonas syringae* pv. *striafaciens*):

Bacterial stripe blight is the main blight disease in oats. It causes spots on leaves and leaf sheaths, without the halos produced by halo blight. The spots lengthen and form water-soaked patches and then brown stripes, which often have narrow yellow margins. The lesions join, forming irregular blotches. If the stripe occurs in the boot, the floret inside may appear rotten and stained. Emergent florets appear mottled brown to white and may be sterile. [33]

The bacteria multiply in huge numbers in the stripes and bacterial slime can sometimes occur on the lesions. When a lesion is cut transversely and the leaf put on a microscope slide, a faint white slime can sometimes be seen coming from the leaf veins. Bacterial ooze from veins is easily observed under a microscope. [34]

[31] KE Nelson, LW Burgess (1995) Effect of rotation with barley and oats on crown rot of wheat in the northern wheat belt of New South Wales, Australian Journal of Experimental Agriculture 35(6) 765–770, http://www.publish.csiro.au/paper/EA9950765.htm

[32] H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

[33] H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

[34] GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

Figure 16: Stripe blight (bacterial blight) in oats. (Photo: Hugh Wallwork) [35]

Figure 17: Stripe blight (bacterial blight) in oats with head sterility. (Photo: Hugh Wallwork) [36]

9.7.2 Halo blight: (*Pseudomonas syringae* pv. *coronafaciens*)

Halo blight causes light green or buff-coloured, oval-shaped spots surrounded by a pale halo with a water-soaked appearance up to 10 mm in diameter. The centre of the spots changes to a straw or brown colour, and a yellow-green halo develops in the surrounding leaf. Later the patches turn brown, join together and form irregular blotches. [37]

35 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

36 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

37 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

Figure 18: Halo blight (bacterial blight) in oats. (Photo: Bob Rees) [38]

Figure 19: Halo blight (bacterial blight) in oats, showing water-soaked halo. (Photo: Hugh Wallwork) [39]

38 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

39 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

9.8 Other diseases

9.8.1 Red leather leaf (*Spermospora avenae*)

The first recorded incidence of this disease was in Victoria in 1978. The disease is characterised by small lesions with light centres that are surrounded by a bright-red or red-brown colour that may extend along a large area of the leaf. The central green area later becomes necrotic and frequently disintegrates to leave a ragged hole surrounded by a reddish-brown border. Leaf margins and tips can die prematurely. Infected leaves can become stiff, may be slightly rolled and will assume a leathery appearance. Plants may be slightly stunted. [40]

In severe cases, whole fields can take on a brilliant red colour in winter, as reported in the Pacific north-west of the United States.

Survival of the fungus is in plant debris. The disease occurs in high-rainfall areas with high humidity. [41]

The severity of the disease is not known, although large yield losses are likely where the foliage is severely damaged.

Control measures:

- Avoid susceptible varieties in high-risk areas.
- Use fungicides that have proven to suppress the spread of this disease. [42]

Figure 20: Red leather leaf in oats. (Photo: Andrew Barr) [43]

40 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

41 GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

42 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

43 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

Figure 21: Red leather leaf in oats. (Photo: Hugh Wallwork) [44]

9.8.2 Septoria blotch (*Phaeosphaeria avenaria*)

Septoria blotch is the most common oat disease in Western Australia; it is less common in New South Wales and Queensland. It is most severe in early-sown crops in high-rainfall areas. Septoria blotch survives between growing seasons on oat stubble.

This disease may cause up to 50% yield loss and crop lodging in extreme cases but losses of around 10% are more common in high-rainfall areas. Tall or slow-maturing oats are less likely to be affected by the disease than short (dwarf) or fast-maturing varieties. [45]

The disease is caused by the fungus *Parastagonospora avenaria* f.sp. *avenaria* (synonym: *Phaeosphaeria* or *Stagonospora avenae* f.sp. *avenaria*). It is not one of the septoria diseases of wheat, which are caused by different species. [46]

The disease is also known as speckled blotch and septoria black stem. It can occur on any aboveground part of the oat plant.

It reduces yield, quality and appearance of hay. Septoria is more likely to be a problem in early-sown susceptible crops that are exposed to frequent rainfall, which disperses rain-splashed spores. [47]

Septoria blotch affects leaves, inflorescence and seed. Leaf lesions are small, dark brown to purple, and oval to elongated. They are restricted and distinct at first but may enlarge to cover most of the leaf. They enlarge to light-brown or dark-brown blotches up to 2 cm, with surrounding yellow areas. They can coalesce and kill the entire leaf.

Infections on the leaf sheath can grow onto the stem to produce greyish-brown or shiny black lesions. Severely affected tillers can lodge.

[44] H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

[45] DAFWA (2016) Oats: leaf diseases, https://www.agric.wa.gov.au/oats/oats-leaf-diseases

[46] GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

[47] DAFWA (2016) Oats: leaf diseases, https://www.agric.wa.gov.au/oats/oats-leaf-diseases

Dark-brown blotches can develop on the florets and seed. Small brown to black fruiting bodies (pycnidia) develop in lesions. Sometimes these are prominent but often are difficult to see, even with a magnifying lens. [48]

The fungus produces its sexual stage in fruiting bodies, called perithecia, on oat stubble in autumn and releases wind-borne ascospores when wetted by rain or heavy dew in autumn and winter. The ascospores can travel long distances by wind to infect young oat plants. Ascospores are probably the chief source of primary inoculum, although the epidemiology has not been studied under Australian conditions.

Infections in the crop produce a second type of fruiting body, the pycnidia, in the leaf lesions. Asexual spores called pycnidiospores ooze from pycnidia in wet weather and are spread short distances (< 1 m) by rain splash. Pycnidiospores are the secondary inoculum; their number and the number of generations of the asexual stage in the crop determine the severity of the epidemic. Frequent rain favours cycles of infection by pycnidiospores.

These are the current recommendations for control of septoria blotch:

- Sow partially resistant varieties.
- Avoid sowing early in high-rainfall areas.
- Burn or bury infested oat straw when oat crops are to be sown nearby.
- Do not sow susceptible oats continuously in the same or neighbouring paddocks.

Foliar fungicide registrations exist for control of this disease. [49]

Figure 22: Septoria blotch in oats, showing the brown blotches surrounded by a yellow area. (Photo: Bob Rees) [50]

[48] GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

[49] GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

[50] H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

Figure 23: Sepotoria blotch in oats. (Photo: Hugh Wallwork) [51]

Figure 24: Sepotoria blotch in oats, showing lesions on stems that can lead to lodging. (Photo: Andrew Barr) [52]

9.8.3 Loose smut (*Ustilago avenae*) and covered smut (*Ustilago hordei*)

Loose smut and covered smut in oats are both externally seed-borne diseases with similar symptoms, and are difficult to distinguish in the field. Both diseases are managed in the same way. After sowing, spores on the seed surface germinate and infect the emerging seedling. The fungus grows without symptoms within the plant and identification of infected plants is difficult prior to head emergence.

Affected plants may be slightly taller and heads emerge earlier than the main part of the crop. Each spikelet, including the chaff, is replaced with a spore mass that is at first covered with a fine white or grey membrane. This membrane soon bursts, releasing the spores to contaminate healthy heads and leaving a bare stalk or rachis on the infected plant. [53]

51 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

52 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

53 https://www.agric.wa.gov.au/autumn/smut-and-bunt-diseases-cereal-biology-identification-and-management?page=0,1

The disease can be spread by air-borne spores that lodge in healthy glumes, where they remain dormant until seeding or else grow into the hulls or seed coats and remain inactive until seeding.

Infection is favoured by moist conditions during flowering, with temperatures of 15–25°C. Early sowing into a warm seedbed has often been associated with smut outbreaks. [54]

Smuts have exceeded 50% incidence in susceptible varieties when no control is applied. [55]

Control measures:

- Low cost by seed treatments.
- Do not sow seed harvested from crops with obvious smut.
- Avoid growing susceptible varieties.

Figure 25: Damaged oat floret from smut infestation. (Photo: Hugh Wallwork) [56]

[54] H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

[55] GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

[56] H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

Figure 26: Smut in oats. (Photo: Hugh Wallwork)

Figure 27: Smut spores at flowering infect nearby heads. (Photo: Margaret Evans) [57]

9.8.4 Ergot (*Claviceps purpurea*)

Ergot is a fungal infection that replaces grass seeds with a fungal resting body. These can contain extremely poisonous chemicals that can kill animals.

Ergot can come from oat florets or from grass weeds in the oat crop. Ergot is more a problem for grain crops than for hay production. Because ergot kernels are similar in size to seed, they will contaminate grain harvested from crops.

57 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.

Symptoms include honeydew (sticky exudate), which develops in heads of grasses shortly after head emergence. A dark purple to black ergot develops in some florets in place of the normal seed. Ergot kernels are roughly the same shape as the seed of the host plant but are 1.5–4 times the size, usually extending prominently out of the floret.

The causal fungus survives in and on soil for several years. These kernels germinate in spring to produce a small fruiting body that releases air-borne spores (ascospores) that can infect nearby grass florets. Ryegrass seems to be particularly susceptible to ergot. [58]

More information

More Information on oat diseases, especially in hay production, can be found in:

Gordon M Murray (2007) Review of Diseases of Oats for Hay: Current and Future Management Part II: Identification and control options for the diseases of importance, A report for the Rural Industries Research and Development Corporation. RIRDC. https://rirdc.infoservices.com.au/downloads/07-122

Figure 28: Ergot in oats. (Photo: Ken Holden) [59]

58 GM Murray (2007) Review of diseases of oats for hay: current and future management, Part II: Identification and control options for the diseases of importance, Rural Industries Research and Development Corporation, Canberra, https://rirdc.infoservices.com.au/downloads/07-122

59 H Wallwork (2000) Cereal leaf and stem diseases. GRDC.