Blotches in barley

Key points

- There are 2 forms of net blotch, net form net blotch (NFNB) and spot form net blotch (SFNB). It can be difficult to distinguish between the different forms and mixed infections are common.
- Both diseases are favoured by wet weather and early sowing, and are more prevalent in higher yielding seasons with a wet spring.
- Both forms survive on infected barley stubble, however NFNB can also be seed-borne.
- High levels of NFNB or SFNB infection will remove green leaf area prematurely reducing the crop's capacity to fill grain.
- For NFNB, yield losses in susceptible varieties can range from 18–31%. For a crop yielding 3 t/ha and a price of $350/t this equates to an income loss between $189–326/ha.
- Both net blotch diseases can cause income loss due to reduced grain size and quality.
- Both NFNB and SFNB can be managed with an integrated disease management (IDM) strategy incorporating varietal selection, crop rotation, stubble management, seed treatment and fungicides.
- Ensure correct disease diagnosis before fungicide application to avoid on and off-target resistance development.
- Rotation of fungicide mode of action (MoA) group is critical to reduce resistance to fungicides.
- NFNB and SFNB pathogens have developed resistance and reduced sensitivity to Group 3 and 7 fungicides in several barley growing regions of Australia.
- Growing a high yielding, well adapted, more resistant variety while using crop rotation, provides the most economic and environmentally friendly means of disease control.

Figure 1 Spot form of barley net blotch. Photo NSW DPIRD.

Background

The barley foliar diseases, NFNB and SFNB, account for over $125 M (Murray and Brennan 2009) of annual losses in Australia and are considered 2 of the most damaging diseases in barley, along with leaf rust, crown rot, powdery mildew and barley scald.

Net blotches – the basics

There are 2 forms of net blotch affecting barley (Figure 2):

- Net form net blotch (NFNB) caused by the fungus *Pyrenophora teres* f. *teres*.
- Spot form net blotch (SFNB) caused by the fungus *Pyrenophora teres* f. *maculata*

Both forms survive on infected barley stubble, but the NFNB pathogen can also be seed-borne. It can be difficult to distinguish between the 2 forms at the early infection stage and mixed infections are common.

Figure 2 NFNB (top) compared with SFNB (bottom). Photos NSW DPIRD.

The presence and distribution of the 2 forms of the disease varies across years, mainly due to environmental conditions, inoculum loads in residual barley stubble, and the area of susceptible varieties being grown.

The NFNB pathogen is more prone to virulence changes due to its genetic diversity, giving it the ability to adapt and overcome the resistance genes in barley varieties. Virulence changes result from increased selection pressure on the pathogen by continuous barley cropping, no-till farming practices that retain infected stubble, repeated fungicide usage and widespread areas of barley grown to susceptible varieties.

It can be difficult to distinguish between the two forms of net blotch and mixed infections are common.

Net form net blotch

Symptoms

Small, round–oval dark brown spots are produced first which elongate into fine dark brown streaks along the leaf blade giving a netted appearance. Severely affected leaves yellow and wither (Figure 2 top). The disease can also affect leaf sheaths and heads when severe.

Disease cycle

NFNB infection requires moist conditions with optimal temperatures 15–20 °C, but is most rapid at 20 °C, with infection occurring after ~6 hours of moisture (Figure 3).

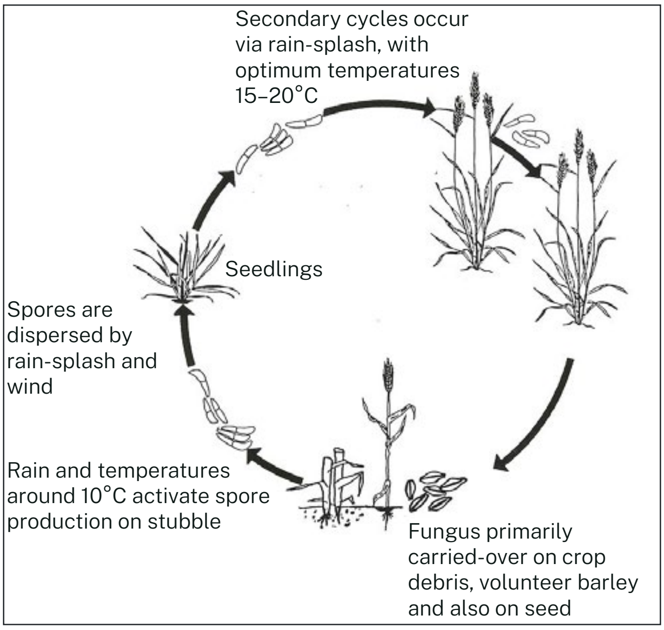

Figure 3 Barley net blotch disease cycle (GRDC 2016).

Infection can be from either airborne conidia produced by conidiophores on stubble or ascospores derived from pseudothecia (Figure 4). Primary infection occurs when conidia or ascospores land on leaf surfaces during prolonged periods of cool wet weather. Secondary conidia development occurs from 14–22 days after initial infection. Secondary infections can occur repeatedly throughout the season with favourable conditions. Conidia are produced from leaf lesions, usually starting on the lower leaves, which then infect upper leaves (Figure 5). Conidia are mostly wind-dispersed. As

Effects of both NFNB and SFNB on yield is greatest during seasons and in environments with high yield potential.

the plant senesces, the fungus colonises the stems, surviving on residual stubble (Figure 6). Carryover of NFNB in stubble is favoured by humid conditions at crop maturity. There is a positive relationship between the stubble load and ascospores produced.

Only NFNB has been proven to be seed-borne, which can result in seedling infections if seed from diseased crops is retained for sowing next season. It is advisable to use a seed treatment that will control the seed-borne stage of NFNB and to source clean planting seed if you had a high level of infection in crop in the previous season.

Figure 4 Pseudothecia erupting from infected barley stubble. Photo NSW DPIRD.

Figure 5 Spores produced from fungal fruiting bodies on stubble stems (yellow circle) causing NFNB in young barley (red circle). Photo NSW DPIRD.

Figure 6 Barley stubble with NFNB pseudothecia. Photo NSW DPIRD.

Spot form net blotch

Symptoms

The disease initially appears as small, dark brown round-oval spots or blotches up to 10 mm long on the leaves that become more straight-sided as they enlarge. Larger blotches are often surrounded by a yellow margin, particularly towards the leaf tip and lesions will often join (coalesce) into each other (Figure 7). On susceptible adult plants, lesions are generally oblong with chlorotic margins. These often coalesce to kill large leaf portions reducing photosynthetic area, with severely infected leaves senescing prematurely (Figure 8). These spots do not elongate to the net-like pattern of NFNB.

The disease is favoured by cool, moist temperatures (8–25 °C) with infection occurring after ~10 hours of moisture. Repeated cycles of infection occur throughout the growing season in favourable conditions.

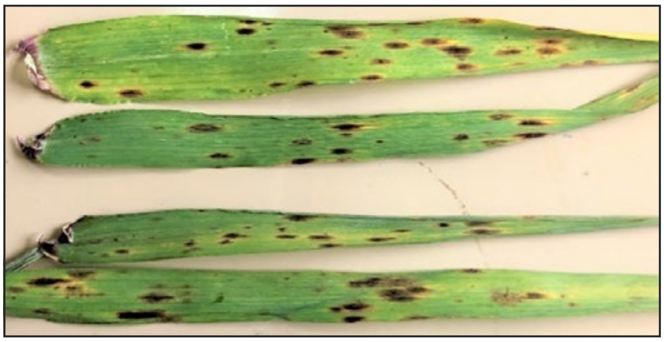

Figure 7 SFNB on a barley leaf showing blotches surrounded by yellow margins. Photo NSW DPIRD.

Figure 8 Severe SFNB on adult barley plants. Photo QDPI.

Methods of transmission

- Both NFNB and SFNB spread firstly by either conidia or ascospores from stubble and secondly by conidia produced from lesions on the plant
- NFNB is also known to be seed-borne.

Effects on yield and quality

Effects on yield for both NFNB and SFNB are greatest during seasons with high yield potential.

Yield losses from NFNB generally range between 10–20%, but losses >30 % have been reported in susceptible varieties. NFNB most commonly causes losses during seasons with a yield potential >5 t/ha, coupled with wet conditions during spring. Grain size and quality can also be reduced.

Yield losses resulting from SFNB are generally <10%, but in severe outbreaks can exceed 40% (GRDC 2016). Losses due to SFNB generally occur when infection severity is greater than 10% on the top 4 leaves at grain fill stage (Jayasena et al. 2002). When severe, SFNB can also cause significant reductions in grain plumpness. Increases in screenings and reduction in retention and grain weight can also occur.

Downgrading of barley destined for malt grade can also result from the presence of the blotch diseases due to their effect on grain size quality parameters.

Net blotch control options

Top 6 net blotch control options

1. Grow resistant varieties.
2. Do not keep planting seed from infected crops.
3. Do not plant barley into barley stubble from previous season, rotate with non-host crops.
4. Reduce stubble loads.
5. Use seed dressing for early crop protection.
6. Rotate foliar fungicide mode of action (MoA) groups to reduce fungicide resistance.

Varietal selection

Growers should avoid growing varieties rated susceptible (S) to very susceptible (VS) in high-risk situations, such as paddocks with barley residue from the previous 2 seasons. Grow varieties with at least an MS (moderately susceptible) rating. Varieties rated MS or better to blotches have significantly less grain yield and quality loss than susceptible varieties and assist in reducing inoculum levels across the local area.

Growing the same variety continuously will lead to an increase in the presence of pathotypes virulent on that particular variety and put increased pressure on effective resistance genes.

Find the latest varietal resistance ratings for your region at NVT Disease Ratings | NVT (grdc.com.au).

Avoid growing varieties rated susceptible (S) to very susceptible (VS) to net blotch in high-risk situations.

Crop rotation to avoid infected barley stubble

Rotation with non-host crops is one of the most effective tools growers can use to limit net blotches and other stubble-borne barley diseases. Non-host crops such as canola and pulses provide a disease break, and in the case of pulses, add to soil nitrogen reserves. Crop rotation plans use time and distance to reduce disease carry-over.

Avoid growing barley in successive years in the same paddock as most inoculum survives in the stubble. Crops located close to infected stubble will receive more inoculum than those situated further away from infected stubble. Disease levels can rise rapidly across districts when susceptible barley varieties are sown into infected barley stubble and seasonal conditions promote disease development.

NFNB and SFNB can survive on infected barley stubble for up to 3 years, or as long as the stubble is present on the soil surface. Stubble breakdown and inoculum production might be prolonged during seasons with dry summer conditions, which slow the breakdown process.

Reducing stubble residues (e.g. by cultivation) might help increase the speed of stubble breakdown and reduce the time the paddock remains at high risk. The negatives of stubble reduction such as erosion and reduced water retention should be carefully considered before burning or cultivating a paddock.

Seed dressings

There are a number of seed dressings available to help control seed-borne NFNB infection. A table of these can be found in the *NSW Winter crop variety sowing guide 2025*. Note that some treatments only control the seed-borne infection and will not provide protection against infection from ascospores coming from infected stubble.

The fungicide seed treatment fluxapyroxad (Systiva®) provides useful levels of control against seed and stubble-borne infections of both blotches. It is a Group 7 fungicide from the SDHI class, which is vulnerable to resistance development, already detected in areas of South Australia and Western Australia.

Growers should be aware that the fungicide flutriafol, commonly applied as a fertiliser treatment, is not an effective control for either of the net blotch diseases.

Fungicide applications are more effective when applied before net blotch diseases become established.

Foliar fungicides

Fungicide applications are more effective when applied before net blotch diseases become established. This requires regular monitoring and accurate diagnosis to ensure crops can receive fungicide application at the first sign of disease symptoms. More frequent crop inspections will be needed when conditions are favourable for the disease and repeat fungicide applications might be necessary.

Foliar fungicides should aim to protect the key leaf 'solar panels' present during grain filling – namely; the flag leaf sheath, the flag leaf (f), flag−1 (f−1), and f−2.

Typically, foliar fungicides to reduce net blotch diseases are applied between the beginning of stem elongation (GS31) and full flag leaf emergence (GS39). In situations with high disease pressure, a single application of foliar fungicide might be insufficient to limit loss of grain yield and quality, and a second application might be needed. Application of foliar fungicide up until head emergence (GS59) might be economical but will provide less benefit than if applied before flag emergence (GRDC 2016).

To reduce the risk of fungicide resistance:

- avoid applying a foliar application from the same fungicide group in the same season
- rotate and vary fungicide active constituents and mode of action (MoA) groups
- select more resistant varieties
- rotate crops (avoid back to back barley where possible)
- consider stubble management
- ensure correct disease diagnosis before fungicide application.

Withholding periods, maximum residue limits (MRLs) and other label restrictions must be taken into account when deciding on product choice and timing of application. Always rotate fungicide MoA groups and active constituents to reduce the risk of fungicide resistance developing in the pathogen population.

Fungicide resistance in barley pathogens

Fungicide resistance or reduced sensitivity has been detected in both NFNB and SFNB in some regions of Australia, particularly to the fungicide Groups 3 and 7. Dual resistance/reduced sensitivity (reduced sensitivity to the Group 3 fungicide tebuconazole and resistance to the Group 7 fungicide fluxapyroxad) has been detected in isolates from the production regions in southern Australia. Currently the status of fungicide resistance in NSW is unclear, but DNA monitoring detected Group 3 (DMI) resistance in NFNB in Queensland in 2022.

Interactions between the fungal pathogen, barley variety genetics and fungicide actives are complex, and can result in the rapid development of resistance in some pathogen populations. The NFNB pathogen appears to be generating resistance to fungicides more rapidly than the SFNB pathogen, which might be related to the widespread use of very susceptible varieties. Research to understand these interactions is on-going.

For more information

- Fungicide resistance in barley | GRDC
- Fungicide resistance | AFREN

What else could it be?

Physiological leaf spotting

Physiological leaf spotting often occurs in barley and can be easily mistaken for disease or herbicide damage (Figure 9). It is not thought to affect yield.

Barley varieties vary in susceptibility to spot formation and the type of spot formed. Abiotic factors such as nutrient deficiencies or weather can cause these spots.

Figure 9 Physiological leaf spotting (left) compared with SFNB (centre and right). Photo NSW DPIRD.

Barley scald

Barley scald (Figure 10) is a common foliar disease in southern NSW barley crops with the majority of current varieties being rated as susceptible (S). The fungus, *Rhynchosporium commune*, survives from one season to the next on barley stubble and on barley grass.

Figure 10 Barley scald. Photo NSW DPIRD.

Ramularia leaf spot

Ramularia leaf spot (RLS) is an emerging barley disease caused by the fungus *Ramularia collo-cygni*. The epidemiology of this disease in Australia is not well understood, although initial NSW DPIRD research shows that all current commercial cultivars are susceptible (S). Symptoms are very similar to SFNB and physiological spotting, however the lesions have a squarer appearance and are restricted by leaf veins (Figure 11). Ramularia lesions are also found on stems and leaf sheaths. Symptoms do not usually develop until after flowering.

Figure 11 Ramularia leaf spot. Photo NSW DPIRD.

New research

The GRDC investment 'Integrated management strategies for Net Form Net Blotch in low, medium, and high rainfall zones' (DAQ2304-008RTX) aims to develop and deliver cost effective integrated disease management (IDM) strategies for NFNB across rainfall zones of the Northern and Southern GRDC regions. At the conclusion of the project, growers will have access to best practice IDM strategies for NFNB specific to their rainfall zone and farming systems, including return on investment of fungicide options (e.g. Blanch et al. 2024), thereby assisting decision making to reduce yield and quality losses.

Outcomes will be delivered through an extension strategy to drive grower adoption. Other partners in the GRDC investment lead by QDPI include Agriculture Victoria (Ag Vic), South Australian Research and Development Institute (SARDI), NSW

Department of Primary Industries and Regional Development (NSW DPIRD), University of Southern Queensland (UniSQ) and Field Applied Research (FAR Australia).

References and further reading

Understand how fungicide resistance develops | AFREN

Barley. Fungicides – current field performance | AFREN

Blanch S, Moore N, Moss A and Chen K (2024) Effect of fungicide combination and timing on net form net blotch in barley – Grafton 2023. NSW DPIRD

GRDC National Variety Trials (2024) Disease resistance ratings on-line

GRDC (2000) Wheat & Barley Leaf Symptoms: The Back Pocket Guide.

GRDC (2016) Barley: Section 9 Diseases. GRDC Grownotes™ Southern

GRDC (2021) Fungicide resistance in barley. Factsheet

GRDC (2021) Fungicide resistance management in Australian grain crops. Guide

GRDC (2023) 'Program 5 – Integrated management strategies for Net Form Net Blotch in low, medium, and high rainfall zones.' Project investment description GRDC website

GRDC (2024) Integrated management strategies for net form net blotch, Nick Poole, FAR Australia. GRDC podcast March 2024

Jayasena KW, Loughman R and Majewski J (2002) Evaluation of fungicides in control of spot-type net blotch on barley. *Crop Protection* 21 (1) 63–69. https://www.sciencedirect.com/science/article/abs/pii/S0261219401001181

Murray GM and Brennan JP (2009) The current and potential costs from diseases of barley in Australia. Report to GRDC

Winter crop variety sowing guide 2025 | NSW DPIRD

Net blotches of barley. | Agriculture Victoria

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If you require diagnostic help, please contact the plant pathologist from your local state research organisation.

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