Blotches in barley

Key points

- There are two 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, but NFNB can 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 $340/t this equals an income loss between $180–$316/ha.
- Both net blotch diseases can cause income loss due to reduced yield and grain quality as a result of reduced grain size.
- Both SFNB and NFNB can be effectively controlled with an integrated disease management (IDM) strategy incorporating varietal selection, crop rotation, stubble management, seed treatment and fungicides.
- Ensure correct disease diagnosis prior to fungicide application to avoid on and off target resistance development.
- NFNB and SFNB have developed resistance and reduced sensitivity to Group 3 and 7 fungicides in some barley growing regions of Australia.
- Growing a high yielding, well adapted, more resistant variety while utilising crop rotation, provides the most economic and environmentally friendly means of disease control.

Figure 1 Spot form of net blotch on barley. Photo NSW DPI.

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 two of the most damaging diseases in barley, along with leaf rust, crown rot, powdery mildew and barley scald.

Net blotches – the basics

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

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

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

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

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

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

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continuous barley cropping, no-till farming practices, repeated fungicide usage and widespread areas of barley grown to homogeneous varieties.

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 occasionally infect heads.

Infection of NFNB requires moist conditions with optimal temperatures 15–25°C, but is most rapid at 25°C, with infection occurring after ~6 hours of moisture (Figure 3). Primary inoculum is derived from airborne spores (ascospores), which are produced by pseudothecia on stubble residue from a previous barley crop (Figure 4 and Figure 6) and are ejected short distances by rain-splash or wind up to 40 cm onto the newly emerging barley plants (Figure 5).

Disease cycle

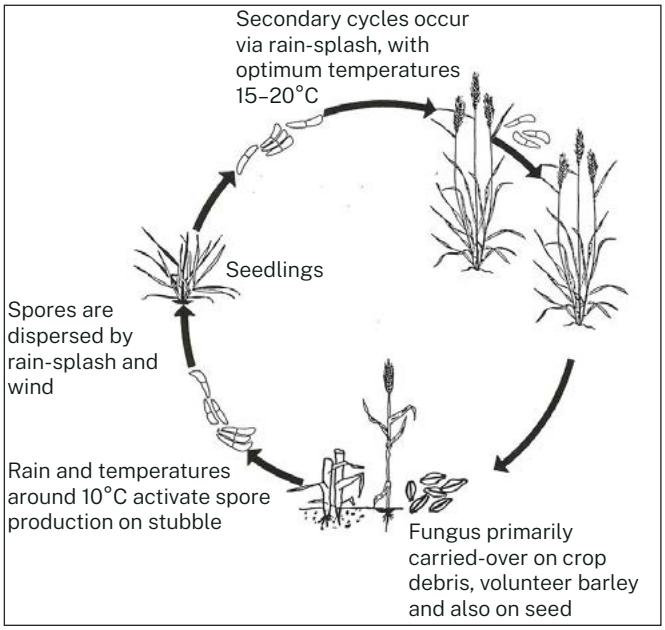

Figure 3 Barley net blotch disease cycle (GRDC 2016).

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

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

Secondary infections can occur repeatedly with favourable conditions throughout the season and with conidia being produced from leaf lesions. These lesions usually start on the lower leaves, which then infect the upper leaves during periods of free moisture. Conidia can be wind-dispersed and therefore can travel considerable distances. The spread of infection decreases with distance from the inoculum source. As the barley plant begins to senesce, the fungus colonises the stem of the plant. After harvest, it survives on the residual stubble and it will begin to produce ascospores when cool, moist conditions are present (Figure 6). There is a positive relationship between the stubble load and ascospores produced. Carryover of NFNB in stubble is favoured by humid conditions at crop maturity.

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

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.

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, with severely infected leaves senescing prematurely and reducing photosynthetic area (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.

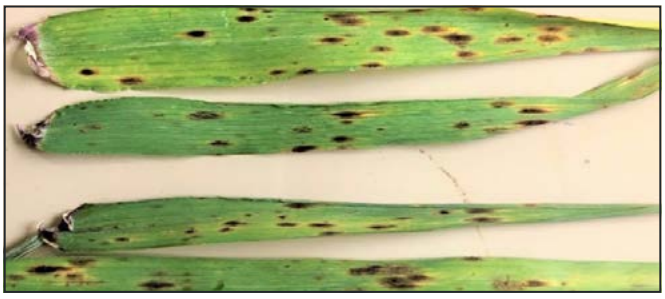

Figure 7 SFNB on a barley leaf showing blotches surrounded by yellow margins. Photo NSW DPI.

Figure 8 Severe SFNB on barley plants. Photo Queensland Department of Agriculture & Fisheries.

Methods of transmission

- Both NFNB and SFNB spread firstly by airborne 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 SFNB and NFNB 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 quality can also be affected.

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 KW 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

- Grow resistant varieties.
- Do not keep planting seed from infected crops.
- Crop rotation.
- Reduce stubble load
- Seed dressings.
- Foliar fungicides.

Varietal selection

Growers should avoid growing varieties rated susceptible (S) to very susceptible (VS) in high-risk situations, such as paddocks with barley residue

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

from the previous two seasons. Opt to grow varieties with at least an MS (moderately susceptible) rating. Varieties rated MS or better to SFNB 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.

For the latest varietal resistance ratings for your region, head to NVT Disease Ratings | NVT (grdc.com.au).

Crop rotation

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

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 will be higher in crops in districts where barley crops are grown in close rotation.

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 may be prolonged during seasons with dry summer conditions.

Reducing stubble residues may help increase the speed of stubble breakdown and reducing the time that the paddock remains at high risk. The negatives of stubble reduction such as erosion and reduced water retention should be 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 NSW Winter crop variety sowing guide 2023. Note that this treatment only controls the

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

seed-borne infection and will not provide protection against infection from ascospores coming from infected stubble.

The fungicide seed treatment Systiva® (fluxapyroxad) 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.

Foliar fungicides

Fungicide applications are more effective when applied before net blotch diseases become established. This requires regular monitoring to ensure crops can receive a fungicide application at the first sign of disease or growth stage for the first fungicide timing is reached. More frequent crop inspections will be needed when conditions are favourable for the disease and repeat fungicide applications may be necessary.

Foliar fungicides should be aimed at protecting 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 help control net blotches are applied between the beginning of stem elongation (Zadoks Growth Stage 31) and full flag leaf emergence (GS39). A single application of foliar fungicide may be insufficient to limit loss of grain yield and quality in severe cases, and a second application may be needed. Application of foliar fungicide up until head emergence (GS59) may be economical but will provide less benefit than if applied prior to flag emergence (GRDC 2016).

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

Withholding periods, maximum residue limits (MRL's) and other label restrictions must be taken into account when deciding on product choice and timing of application. Always rotate fungicide 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 SFNB and NFNB in some regions of Australia, in particular to the fungicide Groups 3 and 7 (Table 1). 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 Yorke Peninsula, SA.

Currently the status of fungicide resistance in NSW is unclear, but DNA monitoring in 2022 detected Group 3 (DMI) resistance in NFNB in Queensland.

To avoid 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 prior to fungicide application.

For more information

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

Table 1 Fungicide resistance status of net blotch in Australian barley.

		Current field performance					
State		**NSW**	**Qld**	**SA**	**Tas**	**Vic**	**WA**
Group 3 (DMI) e.g., propiconazole, tebuconazole	NFNB	✓	✓*	✓	✓	✓	✗
	SFNB	✓	✓	+/–	✓	+/–	✗
Group 7 (SDHI) e.g., fluxapyroxad	NFNB	✓	✓	R	✓	✓	✓
	SFNB	✓	✓	✓	✓	✓	R

✓ Still effective
✓* Some resistance detected in Qld in 2022. Further research needs to be undertaken
+/– Some active compounds compromised
✗ Reduced sensitivity or resistance
R Resistance to most or all active compounds – avoid entirely if possible

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.

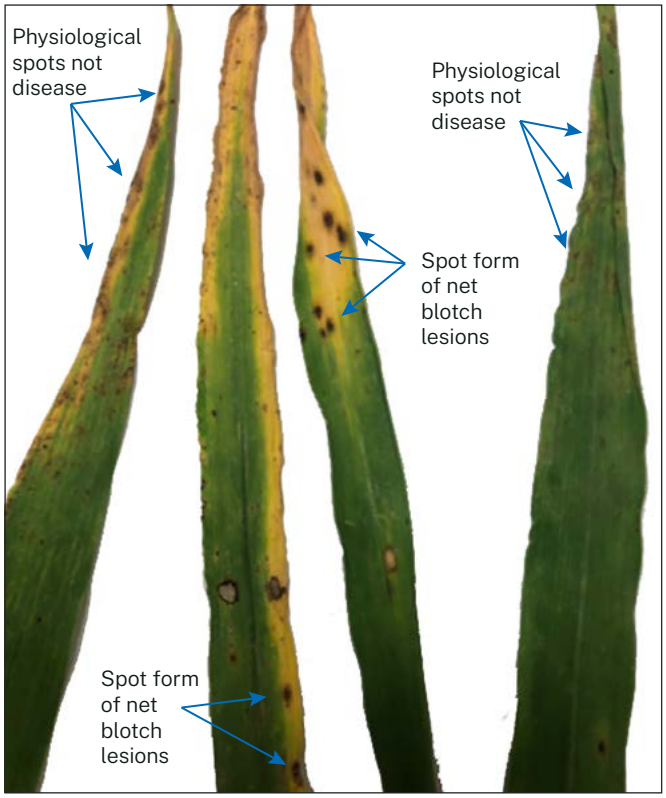

Figure 9 Physiological leaf spotting (left) compared with SFNB (centre and right). Photo NSW DPI.

Barley scald

Barley scald 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 DPI.

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 DPI 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. 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 DPI.

New research

A new 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, 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 DAF include: Agriculture Victoria, South Australian Research and Development Institute (SARDI), NSW DPI, University of Southern Queensland (UniSQ) and Field Applied Research (FAR Australia).

References and further reading

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

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

GRDC How do I manage crop diseases in a stubble-retained system. GRDC website

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

Agriculture Victoria Net blotches of barley. website

Contact details

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

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