Key Points:

- ⇒ Know the level of inoculum / disease risk
- ⇒ Crop varietal selection - avoid susceptible and very susceptible varieties where the disease risk is high
- ⇒ Use of break or non-susceptible crops will assist in reducing disease risk
- ⇒ Well planned fungicide program will be required for some diseases

Disease Management in Retained Stubble Systems

Background

With a change in management systems and the retention of stubble, additional challenges often arise. Diseases that had historically been controlled by cultivation or through the removal of stubble from the surface increase in their prevalence and risk of causing yield loss in a retained stubble system. There are also 'new' diseases such as eyespot that have appeared in stubble retained systems that had previously only been seen overseas, challenging the system, crop varieties and rotational management.

These diseases are placing increased pressure on existing crop varieties, with disease mutations and subsequent breakdowns in plant resistance being observed across the South-East. Fungicides (applied at seeding and/or post-emergent) can assist in control but should always be used in an integrated program where varieties with higher plant resistance levels are utilised to ensure longevity of these fungicides in the system.

The stubble borne diseases that are most common in the South-East and on KI affect wheat, barley, canola and faba and broad beans. If not managed correctly, these diseases can result in large crop losses and some also have the potential to affect grain quality and the ability to deliver a marketable product (particularly in the case of beans). There are four main factors that determine the development of each disease; pathogen levels, crop/variety that you select, on-farm management practices and the environment. While the environment is a factor that is out of our control, we can improve our understanding and the level of risk that some of the soil-borne pathogens pose through PreDicta™ B[1] sampling, and use this information to inform decisions around on-farm practices and crop or varietal selection to reduce the impact of soil-borne diseases.

The use of a break crop that is not only unaffected by the specific disease, but that also doesn't act as a host for the disease is often the most effective way to manage diseases (particularly with cereal on cereal rotations). Distance between infected crops – although not always practical can also assist.

Introduction

This guideline has been developed for the MacKillop Farm Management Group (MFMG) as part of the project "Maintaining Profitable Farming Systems with Retained Stubble in the South-East and KI regions", funded by the Grains Research and Development Corporation (GRDC) as part of the Stubble Initiative.

The Stubble Initiative involves farming systems groups in South Australia, Victoria, southern and central New South Wales and Tasmania, collaborating with research organisations and agribusiness to address challenges associated with stubble retention, including weeds, pests, disease, nutrition and the physical aspects of managing stubble.

Soilborne Diseases

Crown Rot

Crown rot is a stubble borne disease of all winter cereals caused by *Fusarium pseudograminearum* – a soil borne fungi that can grow and survive inside both living and dead host material; particularly cereal stubble. Symptoms often appear as white heads prior to harvest. Grain yields can be reduced by up to 90 % in durum wheat crops and up to 50 % in bread wheats, and grain quality may also be affected[2].

The disease risk from crown rot is higher where infected stubble persists and where it has been mulched or cultivated close to sowing as the disease inoculum is being placed into the emerging root zone of the next crop. The level of inoculum produced is greater in bulky cereal crops.

For effective control, control of the cereal stubble during the break crop is imperative. Grazing will also help to remove the stubble/break it down. Total removal through burning is only partially effective, as even though it removes the stubble from the surface, the crown is often still present in the paddock with the ability for the disease to survive.

To assist with disease control, select varieties with an increased level of resistance. Other management options include sowing early to avoid heat and drought stress at the end of the season.

Figure 1. Crown rot in wheat. Healthy tillers (left) and severe basal or stem browning (right)
(Source: https://grdc.com.au/__data/assets/pdf_file/0021/210918/grdc-crown-rot-fact-sheet-southern-and-western-regions.pdf.pdf)

Take-All

The Take-all fungus grows on a living host but can over-summer on dead roots and crowns. If no host is present, then the disease declines very quickly, especially in moist soil.

Wet winter/spring favours fungal establishment. Crops most likely to be affected if they have had a soft season and then a hard finish to the season (wet season to anthesis and then moisture stress).

Take-all can be effectively controlled with one break crop (Break Crop Guideline[3]). If cereal on cereal rotations, using barley as the second crop can reduce yield loss due to take-all infection by 50%[2].

Rhizoctonia

Although Rhizoctonia isn't a stubble-borne disease, it has become more prevalent due to the change in practices and reduced cultivation in retained stubble systems.

It is more likely to be an issue in the Upper South-East (particularly in dry summers with little microbial activity) or on low fertility soils. Higher carbon systems that increase / promote microbial activity generally assist with the suppression of rhizoctonia.

Rhizoctonia Solani AG-8 is a fungi that forms a hyphal network in the top 0-5cms of the soil. This hyphal network is sensitive to soil disturbance and so cultivation and/or soil disturbance below the seed can have a large impact on reducing disease incidence. If soil levels are high, then the use of a fungicide may be effective (particularly if the outlook for winter rainfall is positive)[2].

Foliar Diseases

Yellow Leaf Spot

Yellow leaf spot (YLS) is caused by the fungus *Pyrenophoroa tritici-repentis.* The fungus can infect all bread wheat, durum and triticale varieties and can survive on the stubble for up to two years. Barley – although not affected by YLS can host the pathogen and generate inoculum for the following season.

Early infection is often caused by inoculum within the paddock, however later infection can occur from spores blown in later in the growing season from other nearby paddocks.

Varietal selection can play a large role in reducing the impacts of yellow leaf spot, as can rotational management, with a one-year rotation out of wheat being highly effective in reducing disease incidence; particularly in higher rainfall environments.

Eyespot

Eyespot is caused by the fungus *Oculimacula yallundae* which infects the lower stem of wheat plants causing eye shaped lesions and frequent lodging of plants. Eyespot has increased in incidence across the region in recent years. It is thought that an increase in retained stubble systems has resulted in localised build-up of soil inoculum and what may once have been individual plants within a paddock have become large patches[4].

Eyespot is a 'hidden disease' with symptoms not being seen until close to harvest when it is too late to implement management strategies. Yield losses from this disease occur as a direct result of the stem lesions and, secondarily, from plants lodging, often in all directions, due to weakened stem bases which can make it difficult or impossible to harvest affected plants. Yield loss may be directly reduced by up to 30% in susceptible varieties. Losses through crop lodging and harvest issues are in addition to this.

Management of Eyespot

⇒ Know your level of risk

Know the risk of yield loss from eyespot before sowing a cereal - inspect stem bases (lodging does not always occur) in a previous cereal crop or take soil samples pre-sowing and submit them to PreDicta B for analysis.

⇒ Varietal selection

In paddocks where there is a history of eyespot, varietal selection is very important. Both the eyespot rating and also the straw strength (and therefore susceptibility to lodging) will be important in determining the most suitable variety for your situation.

Screening of varieties (2015-2017) has determined the provisional ratings for eyespot (Table 1). This data is continually being reviewed as part of the National Variety Trial disease screening program.

Main Season Wheat			
Trojan	MS	Cutlass	S
Darwin	MSS	Grenade CL+	S
Emu Rock	MSS	Harper	S
Pascal	MSS	Hatchett CL+	S
Scepter	MSS	Havoc	S
Zircon	MSS	Mace	S
Arrow	S	Scout	S
Beckom	S	Shield	S
Chief CL+	S	Tenfour	S
Cobra	S	Tungsten	S
Corack	S	Wyalkatchem	S
Cosmick	S		

Long Season Wheat	
Beaufort	MRMS
Forrest	MS
Gazelle	MS
Bolac	MSS
Impala	MSS
Manning	MS
Orion	S
Wedgetail	S

Durum Wheat	
Hyperno	MS
Saintly	MS
Aurora	MSS

Barley	
Fathom	MR-MS
Oxford	MR-MS
Hindmarsh	MRMS-S
La Trobe	MRMS-S
Rosalind	MS
Compass	MS
Scope	MS
Spartacus	MS
Planet	S

Triticale	
Fusion	MS

At Cummins these varieties rank as MRMS and at other sites they rank as S

Based on one data set only

Table 1. Provisional ratings for Eyespot[4] (Courtesy Dr. M. Evans, SARDI)

⇒ Time of sowing
In high risk paddocks (where eyespot has been seen previously or is suspected), avoid sowing early. A delay in the time of sowing will assist in reducing the time that the disease has to develop, reducing the potential damage.

⇒ Fungicide management
Fungicide control can assist in yield increases (particularly in susceptible varieties). This is shown in Table 2 where Mace (S) and Trojan (MS) were both sprayed at GS30 with a fungicide for eyespot control resulting in an 32% yield increase in the susceptible variety.

Table 2. Effect of varietal resistance on yield, Tarlee 2016[4]

	Yield (t/ha)		
Variety	Untreated	Treated	% yield increase
Mace	3.8	5	32
Trojan	6	6.4	7

Findings from 2016 and 2017 at both Tarlee and Kangaroo Inn suggest that variety susceptibility rating and timing of fungicide application can also have an impact on carryover of inoculum into the next season. Figure 2 shows the reduction in eyespot inoculum (when compared to the untreated plots) with a fungicide application at GS30-31. Revenue T2 was sprayed at GS21-22 (early tillering) and again at GS30.

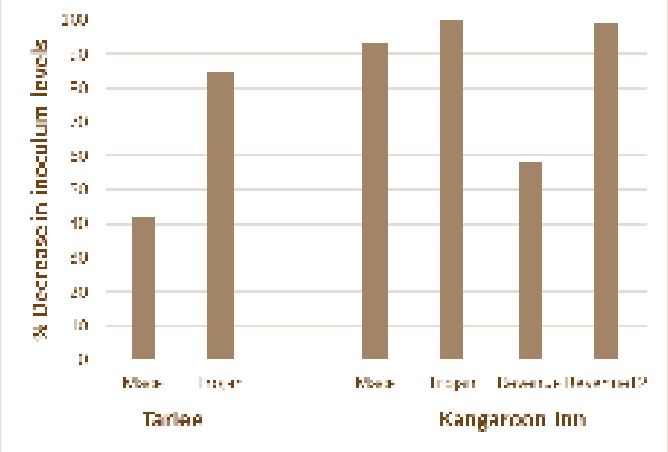

Figure 2. Decrease in inoculum levels post-harvest with an in-crop fungicide, Kangaroo Inn[4]

⇒ Break crops
The use of break crops can be very effective in reducing the level of soil inoculum, however more than one year of break crop is often required with the inoculum surviving in stubble for two years or more. The number of break crops will depend on the soil inoculum levels which can be measured through the Predicta™ B Diagnostic Service and degree of breakdown of stubbles.

⇒ Stubble removal
Stubble removal through burning can also assist in reducing inoculum, **but will not eliminate** the disease completely. Stubble removal followed by a break crop may assist in getting inoculum levels down to low and acceptable levels, particularly where coupled with other management practices.

Figure 3. Lodging in a Mace wheat crop on the Eyre Peninsula (Source. M.Evans, SARDI)

PreDicta™ B

PreDicta™ B is a DNA based soil testing service which allows growers to identify soil-borne disease risks prior to sowing. The test enables growers to identify the pathogens that are posing the greatest risk on their farm and allows them to monitor changes in the disease populations over time and under varying seasonal conditions. This allows better informed decisions to be made around crop rotations, varietal selection and overall paddock management, reducing the risk of crop loss due to these soil-borne pathogens.

Septoria

Septoria is a stubble borne disease, however it is very challenging to monitor and manage as the spores can travel large distances via wind and aren't just related to within paddock or within farm management. Sowing into infected stubble will increase the chance of infection, however infection can still occur when sowing into break crops with no cereal stubble residue present as it may be infected from an external spore shower.

Delaying sowing can reduce the risk of infection as the spore shower may have occurred prior to crop emergence. If the crop has emerged when the spore shower occurs, then infection is more likely. Once the crop is infected, then the disease travels from the lower leaves up the plant through rainfall events (splash-borne).

Varietal selection is one of the key management tools, with various fungicide strategies also promoted depending on the variety, location and severity of infection. The largest challenge is that Septoria has a 4 week latent period, and therefore once evidence of the disease is observed, it is often too late. Protecting the upper canopy to ensure maximum green leaf area during grain fill is something to consider – particularly in longer growing season environments.

Net Form Net Blotch (NFNB), Spot Form Net Blotch (SFNB)

Net Blotch in barley is caused by the fungus *Purenophoroa teres*. There are two forms, the spot form (SFNB) and the net form (NFNB). Initial crop infection generally comes from infected stubble which the pathogen can survive on for up to three years. The stubble will continue to produce spores until it has all broken down. The NFNB can also be seed-borne if humid conditions exist in an infected crop during maturity.

Both forms of net blotch can be effectively managed using a combination of varietal selection, crop rotation and fungicide management. Management during the fallow period to reduce stubble residues may also assist in increasing the speed of breakdown on the stubble reducing the time that the paddock remains as high risk for net blotch.

In higher rainfall environments where more than one fungicide may be required, it is important to ensure that a sound fungicide program is in place with different actives being rotated. This also applies if using SDHI seed treatments.

Stubble borne diseases in Beans

Chocolate spot (caused by *Botrityis fabae* and *Botrytis cinerea*) and Ascochyta leaf and pod spot (caused by the fungus *Ascochyta fabae)* are both diseases that can carry over from one season to the next on bean stubble, infected seed and volunteer plants. The disease spores also have the ability to be wind-borne and chocolate spot in particularly can move long distances.

Factors that help reduce stubble load and volunteers such as grazing or stubble reduction during the fallow period will help in reducing the disease carryover as well as crop rotations where volunteer plants are controlled.

Even with good fallow management, varietal selection and crop rotations, a sound fungicide program should be developed and followed to protect the crop during the growing season.

The three critical periods for disease control in beans are [5]

⇒ 5-8 weeks post crop-emergence
⇒ During flowering
⇒ End of flowering / pod-fill

The number of fungicide applications required will depend on the level of disease infection, seasonal conditions and crop grain yield potential.

Both chocolate spot and ascochyta (if not managed properly) can go on to infect the seed. This can lead to discolouration and staining of the seed resulting in an unmarketable product.

Further information available at

http://www.pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/idm-strategies

Blackleg in Canola

Blackleg survives on canola stubble, producing fruiting bodies that contain large quantities of airborne spores that have the ability to travel several kilometres.

As canola rotations have tightened in some areas, the importance of managing blackleg to maintain longevity of the crop in the rotation is required.

Varietal selection

Trials conducted on KI in 2014 showed the importance of varietal selection in managing the disease. Knowing your blackleg resistance rating and ensuring you are choosing a variety with adequate blackleg resistance for your environment is very important. Monitor crops pre-harvest (or after windrowing) to establish level of stem infection, and if numbers of infected stems are starting to increase, you are starting to see a yield decline (or if you have grown the same cultivar for more than three seasons), choose a cultivar from a different resistance group.

More information can be found in the GRDC Blackleg Management Guide[7]

Fungicide control

Fungicide control should always be used in conjunction with varietal selection. Relying on fungicides alone poses a high risk of fungicide resistance developing.

Fungicide trials conducted on KI in 2014 (Figure 4) established that even though there were no yield responses to fungicides (potentially as the overall disease pressure/ burden was quite low), the use of fungicides reduced the measured levels of stem infection and levels of inoculum being carried forward (when compared with the untreated control), decreasing the risk for subsequent canola crops.

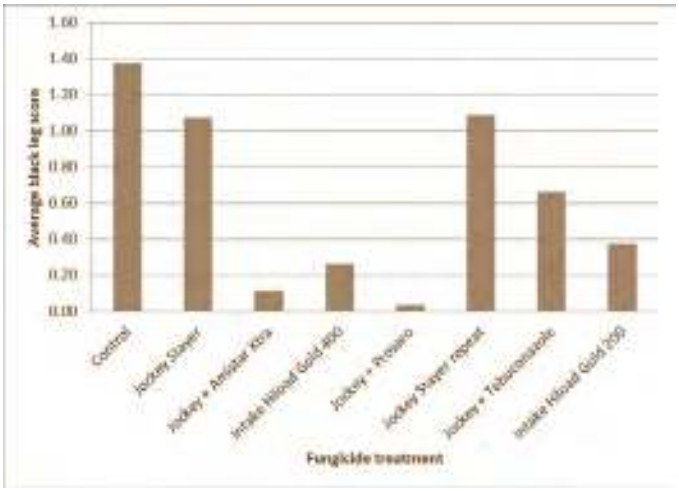

Figure 4. Effect of fungicide on blackleg infection, Kangaroo Island, 2014.

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References

[1]http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

[2]Broadacre Soilborne Disease Manual, 2016

[3]Role of break crops in Retained Stubble Systems MFMG

[4]DAS00139 "Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in South Australia", SARDI

[5]http://www.pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/idm-strategies

[6]https://grdc.com.au/GRDC-FS-BlacklegManagementGuide

Further Information

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