Final Technical Report

Surveys and associated diagnostics of the incidence and severity of diseases of cereals and pulses in the Southern Region (South Australia).

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Abstract

This project was conducted as part of ongoing disease surveillance to monitor changes in pathogen populations including their incidence and severity in association with changes in farming practice. These findings inform industry of disease risks and RD&E investment priorities for the future. With increased world trade and international scrutiny of trade barriers, there has been an increase in requirements to provide certified pest area freedom status. Random stratified surveys were conducted across the South Australian grain growing regions in spring of 2020. The incidence and severity of several endemic diseases of cereals (wheat, barley) and pulses (chickpea, lentil, faba bean, field pea) was recorded, along with incidence and severity of five high priority plant diseases. Overall a low level of disease severity of endemic disease was found likely owing to the dry climatic conditions in June and July as well as use of in-crop fungicides by growers. None of the high priority plant diseases targeted in the survey were detected. This project contributes to understanding the frequency and distribution of endemic diseases observed in 2020 as well as demonstrating area freedom of selected high priority exotic grain diseases for South Australia.

Executive Summary

The objectives of this project were to conduct a structured survey of cereal and pulse crops in South Australia (SA) to quantify disease prevalence and distribution of endemic leaf diseases and to detect and record notifiable exotic diseases of high priority. This project permitted the monitoring of disease epidemics including the distribution of pathogens and severity of disease expression. This information will guide priorities for continued research and to ensure that breeding efforts are targeted at priority and/or changing pathogen populations. Integrated disease management decisions can also be enhanced by gathering associated farming systems information to help determine the success of current recommended strategies. Importantly, the project also supports claims to export markets that SA cereal and pulse grain is free from notifiable high priority exotic plant pests.

A survey of 100 crops of cereals (n=60) and pulses (n=40) was conducted in spring 2020 across the five main growing regions in SA: Eyre Peninsula (EP), Yorke Peninsula (YP), lower-mid-upper North (L-M-U N), Mallee, and upper-lower South East (U-L SE). Crop numbers per region were based on the area sown in 2019 of each crop type per region. To select paddocks, a comprehensive list of agronomists and independent consultants was compiled then a stratified random sampling approach was applied. Additional data were collected including GPS coordinates of paddock, sowing date, crop type and variety for the 2020 season, as well as three-year paddock history of crop and cultivar. Fungicide application products and timing for the 2020 season was also sought to assist in interpreting the disease data.

100 plants were sampled per paddock and transferred to the laboratory for disease rating. Biosecurity protocols for both person and vehicle were followed to ensure no transfer of pests, weeds or diseases from one paddock to the next. Each sample (100 plants per crop) was assessed for disease incidence (presence/absence) of the major endemic diseases per crop type and of five selected high priority exotic plant diseases. Disease severity of each of the leaf diseases was assessed using either percent leaf area diseased for the upper two leaves in cereals, or percent whole plant area diseased for pulse crops.

Overall, the level of visual foliar disease identified was generally low in both cereal and pulse crops with disease expression at levels unlikely to cause significant yield loss. This low level of disease was likely due to the contribution of fungicide applications, where most crops received at least one or two foliar fungicide applications, along with the dry climatic conditions in June and July. For cereal samples, 90 percent of samples examined had visual symptoms of one to five fungal pathogens on upper leaves and/or heads. For pulses, at least one foliar disease was observed in 73 per cent of the samples. None of the targeted high priority notifiable exotic diseases were detected.

In wheat, Septoria tritici blotch was found in 53 per cent of samples. Yellow leaf spot, powdery mildew, stripe rust and leaf rust were present in 15 per cent or fewer samples. Stripe rust was at levels likely to cause significant yield loss in two paddocks surveyed from the South East, where the disease was difficult to manage in the 2020 season. In barley, the widespread incidence of net form net blotch (43 per cent) is a concern given the potential for severe damage and increasing fungicide resistance. Spot form net blotch was found in 74 per cent of samples and sowing susceptible varieties should be avoided in future seasons.

For pulses, ascochyta blight in the chickpea, faba bean and lentil paddocks surveyed was very low, including some completely free of disease. However in field pea, all plants in all paddocks showed ascochyta blight (syn. blackspot) symptoms varying from low to high level of disease. Low levels of downy mildew were also detected in some paddocks however reports of this disease were widespread earlier in the season. No bacterial blight on field pea was found during the survey although reports of this disease were received during the season. Chocolate spot was found only in the four faba bean paddocks in the South East, with moderately high levels of disease in two paddocks associated with mistimed fungicide sprays. Disease levels in these two paddocks would have affected grain yield and or quality. Further research on timing of fungicide application for chocolate spot control would be of great benefit the industry.

Industry benefits from this project through the disease management priorities and guidelines that will be informed by the recently collected information. This will assist growers and researchers to stay

abreast of developing issues and guide the year-to-year tactical response as well as longer term strategic needs of industry. Additionally, the surveys provided the opportunity to improve survey protocols and upskill staff in disease identification, with a particular emphasis on the identification of exotic diseases. Importantly, the high priority pest (absence of exotic disease) data collected in this survey will be delivered to BiosecuritySA as a record of exotic disease monitoring showing that none of the five exotic diseases targeted in this project were found in SA.

As this information is of great benefit to industry and for Australian grain trade, it is recommended that structured surveys of broadacre grain disease in future seasons continue especially as the 2020 season for most regions was characterised by a drier winter period and low levels of disease. Due to the intensive nature of sampling (particularly travel time), surveying for root diseases using molecular techniques would add great value to the survey data set as plant samples are already collected and scored back at the laboratory. A more strategic approach targeting more paddocks of fewer crop types in any one survey year would ensure a more comprehensive data set is collected; one that is more representative of each region and state. A suggested approach is increased sampling conducted on the crops with the high priority plant pest of most concern or interest to South Australia and Australia more broadly. Furthermore, it is recommended that future surveys are not constrained to just the spring period where some diseases may not be expressed; for example, cercospora leaf spot of faba bean typically initiates in early-mid winter but may not be observable by spring. Whilst state biosecurity restrictions and trespass laws prevent ad-hoc surveys of growers paddocks without permission, the flexibility to survey additional paddocks en route to other paddocks or field trials would greatly increase the data set available to contribute to area freedom and understanding of regional disease epidemics.

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Background

To protect the South Australian grain industry, cereal and pulse crops need to be regularly monitored for disease. Objective monitoring of grain crops for both endemic and exotic foliar disease can be reliably done through proactive, structured disease surveillance that visually quantifies foliar disease prevalence and distribution in South Australia. Such a survey also assists with identifying any new or emerging disease issues by collecting independent evidence to support anecdotal information that suggest changes are occurring or issues are evolving. This includes but is not limited to fungicide resistance, pathotypes and pathogen population shifts, disease distribution and severity of disease expression as well as facilitating the collection of isolates and samples for this identification and testing. Structured disease surveys conducted on an annual (or regular) basis also provides regular reliable and current information that supports claims to export markets that South Australian cereal and pulse grain is free from notifiable high priority exotic grain diseases. Surveillance for both endemic and exotic cereal and pulse disease also helps to guide priorities for continued research and for ensuring breeding efforts are targeted at priority and/or changing pathogen populations as well as longer term strategic needs of industry. Disease surveillance data collected on a regular (annual) basis over many years can also inform integrated disease management (IDM) decisions and determine the success of recommended strategies. By liaising with growers and advisors for access to paddocks for surveillance, relationships with industry can be maintained and expanded to provide a better understanding of changes in farming systems so that the implications for disease management can be examined. This has the complementary benefit to industry by ensuring growers and advisors are aware of and prepared for managing existing and new diseases within and between cropping seasons.

Project objectives

The objectives of this project were to conduct a structured survey of cereal and pulse crops in South Australia (SA) to quantify disease prevalence and distribution of endemic leaf diseases and detect and record notifiable exotic diseases of high priority. This project also allowed the collection of independent evidence to support or refute anecdotal information that suggest pathogen population changes are occurring or issues are evolving. This information will guide priorities for continued research and ensure that breeding efforts are targeted at priority and/or changing pathogen populations. Integrated disease management decisions will also be enhanced by gathering associated farming systems information to help determine the success of current recommended strategies. However it will be essential for surveys to be undertaken in future seasons to understand the prevalence of disease in seasons with lower or higher rainfall than that observed in 2020. It will also be essential to expand the number of pulse crops surveyed as the current project was restricted to only ten paddocks of each pulse crop type. For example, all the lentil crops surveyed came from the Yorke Peninsula as it is the major, but not the only, region of lentil production in SA. Similarly, faba beans were not surveyed on the lower Eyre Peninsula. Focusing structured surveys on crops with high priority plant pests of concern could assist with collecting a more comprehensive data set from an increased number of paddocks and or from other regions. Due to budget constraints, root diseases were not assessed in this survey but SARDI has the capacity and capability to do so in future appropriately funded projects. Importantly, the project supports claims to export markets that SA cereal and pulse grain is free from five of the notifiable high priority exotic plant pests.

Methodology

A total of 100 crops of cereals (n=60) and pulses (n=40) were selected for survey during the spring period across the five main growing regions in SA: Eyre Peninsula, Yorke Peninsula, lower-mid-upper North, Mallee and upper-lower South East. Crop numbers per region were based on the area sown of each crop type per region. As pulse crops are sown in smaller areas than cereal crops, approximately ten crops for each of the four pulse crop types (chickpea, field pea, faba bean and lentil) were surveyed. The remaining 60 crops were divided in a 2:1 ratio between wheat and barley to represent the highest frequency of these crops across the five regions. For the Eyre Peninsula, this equated to 12 wheat, four barley, and four field pea crops (Table 1).

Table 1: Number of crops per crop type and region surveyed

	Crop types and numbers for consolidated Regions					
Regions	**Wheat**	**Barley**	**Field pea**	**Faba bean**	**Lentil**	**Chickpea**
Eyre Peninsula	12	4	4			
Mallee	8	4				
North (lower-mid-upper)	8	4	6	5		5
South East	6	4		4		
Yorke Peninsula	6	4			10	6
TOTAL per crop type	**40**	**20**	**10**	**9**	**10**	**11**

To select paddocks, a comprehensive list of agronomists and independent consultants was first compiled and then a stratified random sampling approach applied (see Appendix A – Stratified paddock selection method). Additional data was collected from these advisors including property owner contact details, GPS coordinates of paddock, sowing date, crop type and variety for 2020 season, as well as three-year paddock history of crop and cultivar (this data is stored at SARDI on the network drive as specified in the project IP Register). Fungicide application products and timing for the 2020 season was also sought. Paddocks sampled were mapped using Google Earth.

Paddocks were sampled at flowering to mid grain filling for cereals and at early pod development for pulses. A paddock sample consisted of 100 plants collected along a single transect (most pulses) or four transects (cereals and some pulses). Transects started a minimum of 50 m away from the fence line with a whole plant collected approximately every 10 m. Biosecurity protocols were followed to ensure no transfer of pests, weeds or diseases from one paddock to the next (see Appendix B – Biosecurity protocol). Most importantly, vehicles were not taken into paddocks and boots were disinfected between each paddock. Plants were transferred to the laboratory for disease rating.

Presence/absence of major endemic and priority exotic diseases (Table 2) and disease severity on the whole plant was assessed visually. For pulses, percent whole plant area diseased was recorded and for cereals (where disease expression was high enough), the 1-9 scoring scale used for assessing variety resistance was used (score 5 is likely to cause some yield loss). Data was analysed using Microsoft Excel.

Table 2: Endemic and high priority exotic foliar diseases selected for visual assessment in different crop types in South Australia in the 2020 foliar disease survey.

Crop Type	Diseases Assessed
Wheat	Septoria tritici blotch, powdery mildew, stripe rust, stem rust, leaf rust, yellow leaf spot, wheat stem rust UG99[e]
Barley	Net form net blotch, spot form net blotch, powdery mildew, scald, leaf rust, barley stripe rust[e]
Field pea	ascochyta blight (syn. blackspot), downy mildew, bacterial blight, botrytis grey mould, sclerotinia
Faba bean	ascochyta blight, chocolate spot, cercospora leaf spot, sclerotinia, rust, downy mildew[e]
Lentil	ascochyta blight, botrytis grey mould, sclerotinia, anthracnose[e], rust[e]
Chickpea	ascochyta blight, botrytis grey mould, sclerotinia

[e] = high priority exotic disease

Location

The locations of the 39 bread wheat, 23 barley, 11 chickpea, nine faba bean, ten field pea and ten lentil paddocks surveyed for foliar disease in South Australia in 2020 are shown in Figure 1. The details of these paddocks are stored at SARDI on a network drive as specified in the project IP Register.

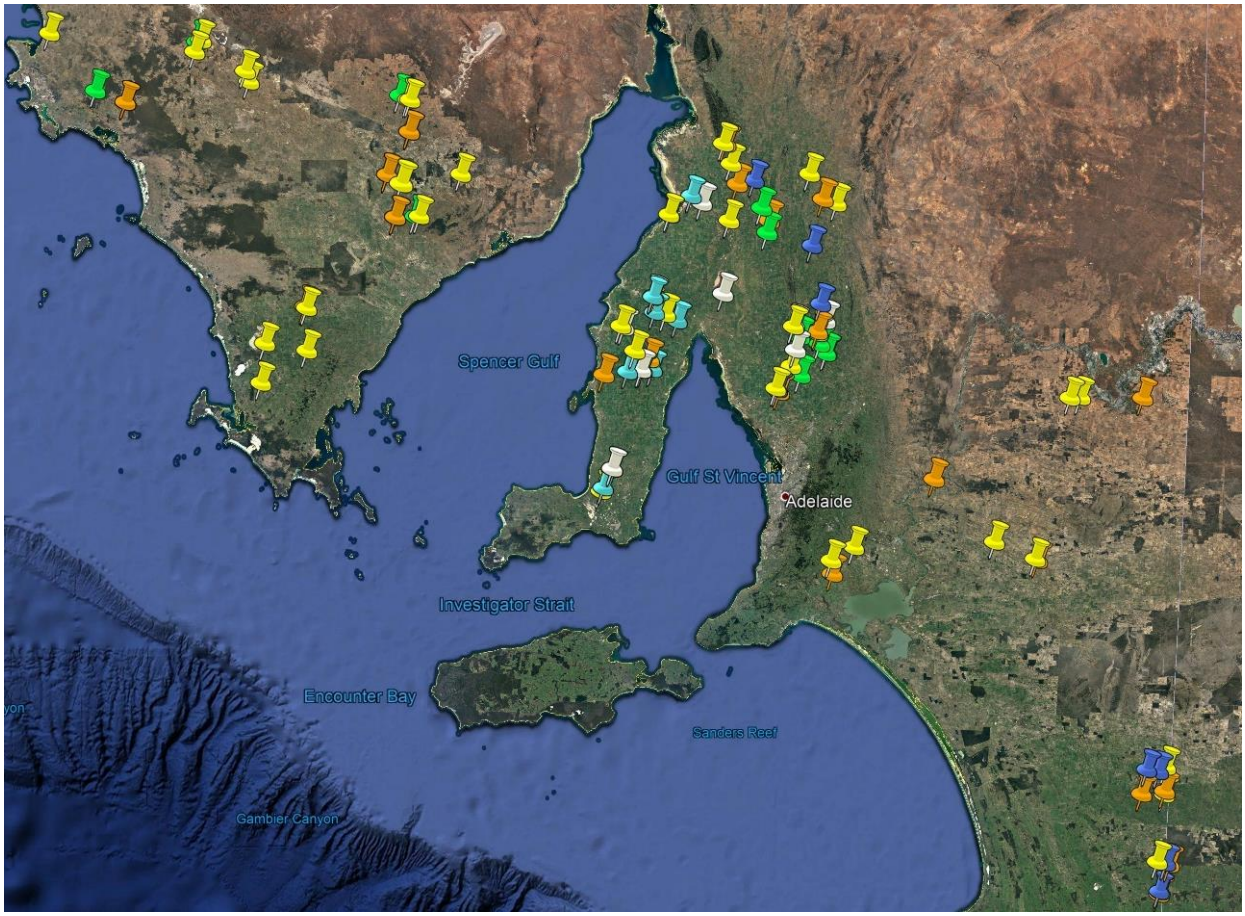

Figure 1. Location of bread wheat (yellow pins), barley (orange pins), chickpea (white pins), faba bean (dark blue pins), field pea (green pins) and lentil (pale blue pins) crops inspected for selected endemic and exotic leaf diseases in South Australia in 2020.

If the research results are applicable to a specific GRDC region/s (e.g. North/South/West) or Agro - Ecological Zone/s please indicate which in the table below:

Research	Benefiting GRDC Region (can select up to three regions)	Benefiting GRDC Agro-Ecological Zone (see link: http://www.grdc.com.au/About-Us/GRDC-Agroecological-Zones) for guidance about AE-Zone locations	
Experiment Title: Surveys of cereal and pulse diseases in South Australia	Southern Region Choose an item.	☐ Qld Central ☐ NSW NE/Qld SE ☐ NSW Vic Slopes ☐ Tas Grain ☒ SA Mid north-Lower Yorke Eyre ☐ WA Northern ☐ WA Eastern ☐ WA Mallee	☐ NSW Central ☐ NSW NW/Qld SW ☐ Vic High Rainfall ☒ SA Vic Mallee ☒ SA Vic Bordertown-Wimmera ☐ WA Central ☐ WA Sandplain

Results

Cereal crops surveyed

Sixty two South Australian cereal paddocks (39 wheat; 23 barley) representing all regions across the state were surveyed in spring between 15 September and 27 October 2020. One hundred plants per paddock were sampled and assessed for selected endemic and high priority exotic foliar diseases (Table 2 above). Agronomic information collected for each paddock was complete, with the following exceptions: the variety sown and the three-year paddock history was not available for three wheat and two barley paddocks; fungicide information was not available for five wheat and two barley paddocks. All cereal paddock data is stored at SARDI on a network drive as specified in the project IP Register.

Wheat paddocks were sown between 28 April and 17 May except for one Mallee wheat crop sown on 25 June 2020. Barley paddocks were sown between 23 April and 26 May 2020. Sowing windows were similar within regions across the state. The most common main bread wheat variety sown was Scepter, with Compass and Spartacus being the most common barley varieties. Apart from two crops, all wheat and barley seed was treated with fungicide prior to sowing. Only three cereal crops had in-furrow fungicide applied at sowing and two had fungicide-amended fertiliser applied. Cereals dominated rotations in lower rainfall areas with pasture and vetch being common breaks from cereal. In medium and high rainfall areas, cereals still generally dominated rotations, but there was much more diversity in breaks from cereal including canola, pasture for seed, and a range of pulse crops. More detailed regional information can be found in summary tables in Appendix C - Cereal Report.

No visual symptoms of the high priority exotic foliar diseases barley stripe rust or wheat stem rust UG99 were observed. No visual expression of endemic foliar diseases was observed in 23% of wheat and 13% of barley samples whilst in all other samples, visual symptoms of one to five diseases were found on the upper leaves and/or heads of plants. Septoria tritici blotch was observed in 53%, yellow leaf spot in in 15%, powdery mildew in 13%, stripe rust in 8% and leaf rust in 8% of wheat samples. Spot form net blotch was found in 74%, net form net blotch in 43%, scald in 39%, and leaf rust in 22% of barley samples. Disease levels were low in most crops, but there were six barley crops (three spot form net blotch; two scald; one net form net blotch) and four wheat crops (two stripe rust; two powdery mildew) where foliar disease levels would have caused significant yield loss. In many of these instances, the significant disease expression occurred despite fungicide application and/or use of varieties with some resistance to the disease. A detailed description of foliar disease observed in wheat and barley samples can be found in Appendix C - Cereal Report.

For cereals, in-crop fungicides were generally used less in low rainfall areas (zero to one application) than in higher rainfall areas (one to more than two applications). In total, 34 fungicide applications were made to the 34 wheat paddocks for which fungicide data were supplied and of these applications, 68% included epoxiconazole, 21% included prothioconazole, 18% included a strobiluran and 3% included propiconazole. In total, 24 fungicide applications were made to the 21 barley paddocks for which fungicide data were supplied and of these applications, 54% included propiconazole and 37% included a strobiluran.

Pulse crops surveyed

40 South Australian pulse paddocks (11 chickpea, nine faba bean, ten field pea and ten lentil) representing all regions across the state were surveyed in spring between 8 September and 28 October 2020. 100 plants per paddock were sampled and assessed for endemic and exotic foliar disease. Agronomic information including crop type and variety for the 2020 season was collected for all paddocks surveyed. Additional data including 2020 sowing date, application of fungicide products in 2020 as well as a three-year crop history was sought for all paddocks surveyed and received for 37 of 40 of pulse paddocks. All pulse paddock data is stored at SARDI on a network drive as specified in the project IP Register.

All pulse paddocks in 2020 were sown between 14 April and 15 June with some smaller sowing windows for individual crops and regions (refer Appendix D – Pulse Report) A range of cultivars were sown with no single cultivar of any pulse crop being dominant in any region in the survey. Rhizobial inoculant at sowing was employed in only six pulse paddocks (two field pea, one faba bean and three

chickpea) whist seed was treated with fungicide prior to sowing for 15 paddocks (three field pea, four lentil and eight chickpea). Barley and wheat (durum and bread) dominated the three-year rotational history of these 2020 pulse paddocks. There were a few instances of the same pulse crop having been sown in the previous three years: three chickpea paddocks had chickpea in their rotation (and one paddock had three chickpeas sown between 2017 and 2020; three lentil crops had lentil in their rotation; three faba bean paddocks had faba bean in their rotation; and one field pea paddock had field pea in their rotation.

At least one foliar disease was observed in 73% of the samples. No disease was observed in 60% of lentil paddocks and 27% of chickpea paddocks. No sclerotinia in any pulse sample, cercospora leaf spot in faba bean or bacterial blight in field pea were recorded in this survey. None of the five high priority plant pests targeted in this survey were detected in the paddocks surveyed. Disease severity and incidence of ascochyta blight in the chickpea, faba bean and lentil paddocks was very low, including some completely free of disease. However in field pea, all plants in all paddocks showed ascochyta blight (syn. blackspot) symptoms varying from a low to high level of disease severity. Low levels of downy mildew were detected in some field pea paddocks however no bacterial blight was found during the survey although reports of this disease were received during the season. Chocolate spot was found only in the four faba bean paddocks surveyed in the south east, with moderately high disease levels in two paddocks associated with mistimed fungicide sprays. A detailed description of foliar disease observed in each pulse crop type can be found in Appendix D – Pulse Report.

Most crops received at least one foliar fungicide application (18 of 40 paddocks) with many receiving two applications (10 of 40). Seven paddocks received three or more fungicide sprays whilst only three paddocks did not receive a fungicide spray in 2020. In-season fungicide application was not available for two paddocks.

Discussion of Results

Cereal disease survey

Disease expression in the spring 2020 survey of 62 cereal paddocks was generally low and unlikely to cause significant yield losses. Exceptions to this were seen in four wheat crops and six barley crops where disease was present at medium to high levels and would have caused significant yield loss. Use of variety resistance combined with in-crop fungicide application was not sufficient to manage stripe rust on two of the four wheat crops assessed in the South East. This is consistent with industry reports that stripe rust is difficult to manage in crops in that region and demonstrates the importance of disease surveillance surveys in understanding industry issues with disease management. Although net form net blotch (a serious disease of barley) and spot form net blotch (less likely to cause yield losses) were present at high levels in only one and three crops surveyed respectively, both of these barley diseases were widespread across the state in 2020. This means that inoculum loads will be high and variety resistance, crop monitoring and timely in-crop fungicide application will all be important to avoid yield losses when growing barley in 2021. This example provides a clear demonstration that objective disease surveillance surveys are a useful tool for predicting cereal foliar disease issues for the next growing season.

There is now heavy reliance on fungicides to manage foliar cereal diseases. In the crops surveyed, there were 34 fungicide applications to 34 wheat crops (zero to two per crop) and 24 applications to 21 barley crops (zero to three per crop). Additionally, the majority of in-crop fungicide applications included epoxiconazole (wheat) or propiconazole (barley). Rotation of fungicide groups was employed in some but not all instances where more than one in-crop fungicide was applied. Despite the rotation of fungicide groups, this level of fungicide use places significant pressure on the foliar disease pathogens and suggests that resistance to fungicides is likely to develop quickly in current farming systems.

The survey found no evidence of two exotic cereal diseases (wheat stem rust UG99 and barley stripe rust) which were selected in this project as part of the five high priority plant pests targeted for proof of area freedom. This bolsters South Australia's area freedom status from these exotic cereal diseases and this data will be delivered to BiosecuritySA as a record of exotic disease monitoring.

Pulse disease survey

Overall, disease expression observed in the spring 2020 survey of 40 pulse paddocks was generally at low levels unlikely to cause significant yield loss. This is most likely due to the dry conditions in June and July for most regions as well as most pulse crops receiving only one or two foliar fungicide applications. The agronomic data also indicates that the majority of pulse growers included in this survey are adhering to the integrated disease management recommendation of observing three years between a pulse crop of the same type (Appendix D – Pulse Report). This rotation practice assists with reducing pathogen inoculum levels for the following season(s) and can contribute to reduced risk of disease in seasons where the climate (eg higher rainfall) is conducive to disease epidemics.

The survey did not find evidence of three exotic pulse diseases (anthracnose of lentil, rust of lentil, downy mildew of faba bean) which were selected in this project as part of the five high priority plant pests targeted for proof of area freedom. This bolsters South Australia's area freedom status from these exotic pulse diseases and this data will be delivered to BiosecuritySA as a record of exotic disease monitoring.

The endemic and exotic disease results for pulse crops however must be considered with some caution as the total number of pulse paddocks surveyed was very small (n=40) and the survey timing was restricted to a six to eight week period in spring. Furthermore, not all crop types were surveyed in all regions (for example, lentils were surveyed only on the Yorke Peninsula) thus it is not possible to generalise results across all South Australian regions without oversimplifying the disease levels or epidemics observed. For instance, downy mildew in field peas was observed at a very low severity in the paddocks surveyed in spring 2020 however severe downy mildew had been reported widely across the state in seedling crops early in the season. Similarly, no bacterial blight was observed in field peas in the survey however this disease was seen at low levels in other paddocks not captured by the survey on the Eyre Peninsula in spring.

Conclusion

This project surveyed for endemic and high priority exotic foliar plant diseases in cereals and pulses in South Australia in spring 2020. Overall a low level of endemic disease was observed in the paddocks surveyed however the 2020 season had lower than average rainfall in June and July which would have limited the development and spread of some disease. For pulse crops, it is difficult to generalise the results from the spring 2020 survey more broadly to the whole of South Australia, or the southern region as a whole, as the number of paddocks surveyed was small and not all pulse crop types were surveyed in all regions. For cereals, the relatively small number of paddocks surveyed has caused some issues with interpreting results, particularly at a regional level. However this project contributes to demonstrating area freedom of the five selected National Priority Plant Pests of high priority exotic grain diseases for South Australia as none of the five targeted notifiable exotic plant pathogens were detected.

Capturing the agronomic data of each paddock provided insight into farming practices in 2020. In this survey of pulse crops, the three-year crop rotation choices are dominated by wheat and barley. For pulses, there is a broad sowing window from mid-April to mid-June and the range of cultivars sown are not dominated by any one particular cultivar in any one region. It was reassuring, especially in a year where June and July were drier than average, that the number of in-crop fungicide sprays applied during the growing season was limited to only one or two sprays for the majority of paddocks. The data on crop rotation, varied cultivar selections and minimal in-crop fungicide sprays indicates that the vast majority of growers are observing these same recommended disease management practices that assist with reducing the risk of foliar disease epidemics in pulses.

Capturing agronomic data also provided insight into farming practices in paddocks sown to cereals in 2020. There was a small sowing window (mid April to late May) across the state for wheat and barley, indicating the importance of early sowing in current farming systems and underscoring the need for frost risk management using variety maturity. The dominance of Scepter as the bread wheat variety of choice across the state raises concerns for the effects this might have on increasing inoculum levels of powdery mildew and septoria tritici blotch as Scepter is rated susceptible-very susceptible and susceptible, respectively. Unexpectedly, rotation information showed that in the Mallee, fallow is included in some paddocks and that cutting crops for hay rather than growing crops for grain is not economic due to severe frosts. One grower involved in the survey is assessing whether multiple varieties with different maturities sown as a mix might provide a frost mitigation strategy that allows cereal grain crops to be grown

Future research on disease surveillance would benefit from increasing the number of paddocks surveyed. For pulses, this could be done either by increasing the total number of paddocks inspected, by targeting surveillance activities to specific region(s) (i.e lentils in the Yorke Peninsula; faba beans in the south east), or by more intensively sampling from crop types of particular concern (i.e. those that host high priority plant pests). For cereals, this would best be done by increasing the total number of paddocks inspected. Surveillance would also be greatly enhanced by the use of existing molecular diagnostic tests as well as by development and implementation of new molecular diagnostic tests for both foliar and root pathogens in cereals and pulses.

Implications

This single year survey conducted in spring 2020 of 100 cereal and pulse crops in South Australia has contributed to demonstrating area freedom of five selected National Priority Plant Pests of high priority exotic grain diseases. This means that South Australian growers, advisors, grain traders and exporters can be confident that grain grown and sold from South Australia is free of the exotic plant pathogens wheat stem rust UG99, barley stripe rust, lentil anthracnose, lentil rust and faba bean downy mildew. This survey also revealed that the majority of pulse growers are observing the recommended integrated disease management practices of rotating crops, diversifying cultivar selections, and applying minimal in-crop fungicide sprays. Based on this survey, South Australian grain growers continue to produce high quality disease-free grain for domestic and export markets.

Recommendations

Ongoing disease surveillance across the South Australian grain growing season is required for continued monitoring for high priority plant pests both for provision of exotic absence data to biosecurity, industry and trade partners, as well as ongoing active monitoring of endemic cereal and pulse diseases. It would be sensible to consider aligning surveillance activities across the southern region as a whole. Surveys need to be conducted across multiple years in order to capture disease observations and agronomic management practices in seasons that have more or less rainfall than that received in 2020. It is recommended that future surveys are focused on grain crop types that host exotic pathogens of concern so that resources can be dedicated more intensively. Surveying more paddocks would improve the data set available for making generalisations across crop types and regions. Observational disease data would be enhanced by the inclusion of molecular DNA tests that are more comprehensive than foliar disease assessments because DNA techniques can capture pathogen presence whilst disease is asymptomatic. It is recommended that future surveys include the development and implementation of improved molecular diagnostic techniques for identifying both shoot and root pathogens.

Appendix A.
Stratified paddock selection method

1. Use the crop types and numbers as defined in the Disease Surveillance project (see Table below) as the basis for paddock selection.

Regions	Wheat	Barley	Lentil	Faba bean	Field pea	Chickpea
Eyre Peninsula	12	4			4	
Mallee	8	4				
North	8	4		5	6	5
South East	6	4		5		
Yorke Peninsula	6	4	10			5
TOTAL as in project contract	**40**	**20**	**10**	**10**	**10**	**10**

2. Break each Region into sub-regions based on agro-climatic differences and allocate crop types and numbers to each sub-region in such a way as to meet Regional crop requirements for the survey. This was done to ensure adequate geographic and agronomic coverage of the state. The Mallee was not divided into sub-regions as it is relatively homogeneous.

Regions		Number of crops - disease surveillance SA 2020					
		Wheat	Barley	Lentil	Faba bean	Field pea	Chickpea
Eyre Peninsula	Lower	4	1				
Eyre Peninsula	Mid	4	2			2	
Eyre Peninsula	Upper	4	1			2	
Mallee		8	4				
North	Lower	2	1		2	3	2
North	Mid	3	2		3	3	3
North	Upper	3	1				
South East	Lower	2	1		1		
South East	Mid	2	1		2		
South East	Upper	2	2		2		
Yorke Peninsula	Lower	2	1	3			2
Yorke Peninsula	Mid	2	2	4			2
Yorke Peninsula	Upper	2	1	3			1
TOTAL		**40**	**20**	**10**	**10**	**10**	**10**

3. Collect, combine and collate contacts from a number of sources in an "All contacts" sheet in the “co-operator selection” Excel file.
4. Assign a sub-region (as given in the Table above) to each contact based on their postal address (although they may have clients in other Regions).
5. Place all farming system groups to one end of the list - all are selected for inclusion
6. Sort remaining contacts into sub-region order (if no sub-region assigned, exclude from the remaining procedure).
7. Assign a random number to each contact within a sub-region.
8. Select co-operators at random (using random numbers to select each one) from within each sub-region to achieve paddock numbers (might ask for >1 paddock from a co-operator to make up crop numbers). If too many potential crops provided by co-

operators, select the ones easiest to access or best suited for sampling (e.g. susceptible variety).

9. Record the selected potential co-operators in a “Selected co-operators” sheet in the “co-operator selection” Excel file.
10. Develop an e-mail (e-mail 1 – see end of this file) for sending to farming systems groups and send to all on Monday 3rd August, requesting response by Thursday 6th and noting they will be contacted by phone on Friday or Monday.
11. Develop an e-mail (e-mail 1 – see end of this file) for sending to agronomists/advisors - including that farming systems groups in their area have also been asked to contribute paddocks.
12. Send e-mail 1 to potential agronomist/advisor co-operators on Thursday 7th August, requesting response by Wednesday 12th - using Word mail merge to send automatically to all with their name inserted automatically (uses Excel spreadsheet for details and mail merge) .
13. Record responses (positive or negative; date of receipt; comments) or non-responses from each potential participant in the “Selected co-operators” sheet in the “co-operator selection” Excel file.
14. Develop e-mail 2 (see end of this file for e-mail 2) for sending to those interested in being involved so they can see what is expected.
15. Send e-mail 2 - basic template tailored for each individual and sent separately.
16. Develop Excel template for sending to co-operators for recording grower and paddock information (see end of this file for copy of template).
17. Call and discuss survey and requirements with co-operators.
18. Send e-mail 3 - basic template tailored for each individual and sent separately; including Excel information entry template.
19. Record date of responses and the paddock information provided.
20. Prompt co-operators as needed to ensure all information is provided.
21. Access extra paddocks (and information for those paddocks) from co-operators as needed to ensure crop targets for the survey are met.
22. Continue contact with co-operators to ascertain optimum timing for paddock sampling.

Disease Surveillance – email 1, outline for potential co-operators

Advisors and Agronomists

Please Respond: Disease surveillance in cereal and pulse crops 2020 – an opportunity for you

Hi xxx,

This is to let you know about the GRDC funded leaf disease surveillance we are undertaking in commercial cereal and pulse crops this year and to ask whether you would like to be involved in the survey.

Please RSVP by Wednesday 12th August – just send a reply saying interested, not interested or might be interested.
I will follow up with you by phone after Wednesday, but don't hesitate to call me if you wish to discuss this further before then.

GRDC disease surveillance project
GRDC is funding a pilot program this year so we can develop a long-term, structured surveillance protocol that will provide a data set for South Australia that demonstrates we survey cereal and pulse crops for endemic and exotic diseases.

What we would expect of you:

- Select up to 4 paddocks (representing wheat, barley and one or more pulse types). This is not about selecting the best or worst paddocks, just paddocks typical of the area.
- Provide us with contact details for the grower(s); paddock locations; variety; sowing date; 2018 and 2019 paddock history; fungicide (including seed dressing) applications in the crop.

What you can expect from us:

- Contact with the co-operating grower(s) to ensure they understand what and how we will work with them to assess crops.
- Adherence to biosecurity and COVID-19 protocols.
- Confidentiality in terms of results from individual paddocks and properties.
- Contact with you and the grower(s) at least 48 hours prior to sampling and again on the day of sampling (usually by text - to ensure no paddock operations will be/are being undertaken on the sampling day).
- Provision of 2 types of reports to you by February 2021 – one for the grower(s) paddock(s) and one with the region and state survey results.

Sampling protocol we will use:

- 100 paddocks across SA - 40 wheat; 20 barley; 10 lentil; 10 faba bean; 10 field pea; 10 chickpea.
- Localities - Eyre Peninsula; Yorke Peninsula; Lower/Mid/Upper North; Mallee; South East.
- Assessment of presence/absence and severity of selected endemic and exotic diseases.
- 100 plants dug up from along a transect and taken to the lab for assessment.

Looking forward to hearing from you. Marg.

end of email

Farmer groups

Please Respond: Disease surveillance in cereal and pulse crops 2020 – an opportunity for you

Hi all,

This is to let you know about the GRDC funded leaf disease survey we are undertaking in commercial cereal and pulse crops this year and to ask whether your farming systems group would like to be involved in the survey.

If you choose to be involved, then you may wish to: nominate paddocks yourself; work with an advisor/agronomist to nominate paddocks; or to provide us with contact details for the advisor/agronomist you want to select paddocks for you. If you choose not to be involved, we will keep you informed of results for your region and for the state.

Whichever choice you make, we would appreciate being able to include the region/state surveillance results in your trial results books or to discuss the project at your field days.

RSVP Thursday 6th August using the voting buttons above. I will follow up with you by phone on Friday 7th or Monday 10th, but don't hesitate to call me if you wish to discuss this further.

GRDC disease surveillance project
To develop a long-term, structured surveillance protocol and data set for South Australia, GRDC is funding a pilot program this year.

What we would expect of you:

- Select up to 4 paddocks (representing wheat, barley and one or more pulse types)
- Provide us with contact details for the grower(s)/advisor(s); paddock locations; variety; sowing date; 2018 and 2019 paddock history; fungicide (including seed dressing) applications in the crop.

What you can expect from us:

- Contact with the advisor/agronomist/grower(s) of your choice to ensure they understand what and how we will work with them to assess crops.
- Adherence to biosecurity and COVID-19 protocols.
- Confidentiality in terms of results from individual paddocks and properties.
- Contact with growers/advisors/you at least 48 hours prior to sampling and again on the day of sampling (usually by text, to ensure no paddock operations will be/are being undertaken on the sampling day).
- Be available for field walks or "getting the crop in" discussions.
- Provide 2 types of reports by February 2021 – one to the grower(s) for their paddock(s) and one to you with the region and state results.

Sampling protocol we will use:

- 100 paddocks across SA - 40 wheat; 20 barley; 10 lentil; 10 faba bean; 10 field pea; 10 chickpea.
- Localities - Eyre Peninsula; Yorke Peninsula; Lower/Mid/Upper North; Mallee; South East.
- Assessment of presence/absence and severity of selected endemic and exotic diseases.
- 100 plants dug up from along a transect and taken to the lab for assessment.

Looking forward to hearing from you. Marg.

end of email

Disease Surveillance – e-mail 2, information for co-operators

Note – this e-mail is tailored for each person, changing the yellow-highlighted info as needed.

Subject for email: Disease surveillance survey - more info

Hi Marty,

Some more specific information for you about the survey. Do you have a preference for a day/time for me to call you to discuss further?

Details of Regions and crops being targeted across SA (Table) and diseases we will assess on the plants we collect (list) are at the end of this e-mail.

I would appreciate you nominating the following crops from the general area of the Mid Eyre Peninsula:

- 1 wheat
- 1 barley
- 1 field pea
- 1 chickpea

Crops can be selected from one or multiple properties and the paddocks/crops should be typical of the area. The information needed for each paddock is as follows:

- Name and contact details for the grower
- Paddock locations (GPS and/or map)
- Crop type and variety
- Sowing date
- Fungicide applications (including seed dressing) in the 2020 crop
- Paddock history (including variety) for 2018 and 2019 - and for 2017 if possible.

Cheers. Marg.

Table. Region and crop type targets for the disease surveillance survey

Regions		Number of crops - disease surveillance SA 2020					
		Wheat	Barley	Lentil	Faba bean	Field pea	Chickpea
Eyre Peninsula	Lower	4	1				
Eyre Peninsula	Mid	4	2			2	
Eyre Peninsula	Upper	4	1			2	
Mallee		8	4				
North	Lower	2	1		2	3	2
North	Mid	3	2		3	3	3
North	Upper	3	1				
South East	Lower	2	1		1		
South East	Mid	2	1		2		
South East	Upper	2	2		2		
Yorke Peninsula	Lower	2	1	3			2
Yorke Peninsula	Mid	2	2	4			2
Yorke Peninsula	Upper	2	1	3			1
TOTAL		**40**	**20**	**10**	**10**	**10**	**10**

Diseases we will be checking for in the plant samples we collect and assess:

Endemic

- Wheat - powdery mildew, stem rust, leaf rust, stripe rust, septoria, yellow leaf spot, flag smut, loose smut.
- Barley - powdery mildew, stem rust, leaf rust, net form net blotch, spot form net blotch, scald, covered smut, loose smut.
- Lentil - ascochyta blight, botrytis grey mould, sclerotinia.
- Faba bean - ascochyta blight, chocolate spot, sclerotinia, cercospora leaf spot, rust.
- Field pea - Ascochyta blight (Syn.Blackspot), botrytis grey mould, sclerotinia, downy mildew, powdery mildew, bacterial blight.
- Chickpea - ascochyta blight, botrytis grey mould, sclerotinia.

Exotic

- Stem rust UG99 (wheat); stripe rust (barley); anthracnose and rust (lentil); downy mildew (faba bean).

end of email

Disease Surveillance – e-mail 3, collecting paddock information

Note – this e-mail is tailored for each person, changing the yellow-highlighted info as needed.

Subject for email: Disease surveillance survey – recording property owner and paddock info

Hi Brianna,

As discussed, could you please nominate the following crops from the general area of the Mid North:

- 1 wheat
- 1 barley
- 1 field pea
- 1 faba bean

Paddocks should be accessible from a public road so that we can avoid driving on farm tracks or into paddocks and spreading weed seeds etc. between areas and properties when we sample.

I've attached an Excel spreadsheet for you to use when recording grower contact and paddock details. I'd appreciate getting that information as soon as you can manage it – I need to assess what paddocks we have so that I can plan our trips to do the sampling.

We plan to start collecting samples around the second week in September, starting with Upper EP, and finishing in the SE in late October or early November.

Before we sample your nominated paddocks we'll be in touch with you and the property owners so you know what vehicle and people will be there and to ensure our planned sampling day does not coincide with any pesticide applications.

We will try to provide individual property reports to you and the property owners before the end of November 2020 and will provide you with a report for the state in early 2021.

Call me any time if you have any questions or comments.

Cheers. Marg.

Dr Margaret Evans | Senior Research Scientist | Crop Sciences

South Australian Research and Development Institute - SARDI | Government of South Australia

Gate 2b Hartley Grove Urrbrae SA 5064 | GPO Box 397 Adelaide SA 5001 | DX 66756

Mb: 0427 604 168 | **P:** (08) 8429 2225 | **E**: marg.evans@sa.gov.au

Service I Professionalism I Trust I Respect I Collaboration & Engagement I Honesty & Integrity I Courage & Tenacity I Sustainability

end of email

Example of the Excel recording sheet for survey paddocks, SA 2020

Property owner	
Phone	
E-mail	
Paddock Name	
Nearest town	
GPS Location of paddock	
2020 Crop type	
2020 Crop variety	
2020 Sowing date	
2020 Seed dressing	
2020 Fungicides + dates	
2019 Crop+variety/pasture	
2018 Crop+variety/pasture	
2017 Crop+variety/pasture	

Appendix B.
Biosecurity protocol

Effective cleaning (personnel, equipment and vehicle) prior to departure from a property is 90% of the biosecurity job.

Do not take vehicles into properties or paddocks – select paddocks accessible from public roadways. Entering on the main driveway to the house is acceptable, but avoid driving in shed/machinery movement areas. This means that the vehicle will not need to be cleaned and washed between each paddock.

Where possible use a dedicated vehicle (not used by anyone else) during the survey period. Use a dual cab ute (or similar) to ensure no equipment or samples are placed on carpet or in the passenger compartment. If quarantine-style decontamination is necessary, it will be simplest to undertake and most effective in the load bed of a dual cab ute (or similar).

Basic biosecurity protocol where no exotic pests are suspected.

1. When selecting paddocks discuss the following with the property owner and their advisor:
   - Any biosecurity protocols pertaining to the property.
   - The possible presence of weed/disease/insect pests in the location being visited or on the roadside by that location.
   - The steps being taken during the disease surveillance survey to ensure there is no transfer of pests between properties and paddocks.
   - Determine the best way to communicate with them prior to (may require a phone call) and on the day (text is probably best) of any property visit.
2. At least 24 hours prior to each visit contact the property owner to ensure there are no WHS issues (e.g. the crop just having been sprayed with fungicide) or unexpected biosecurity (e.g. a new weed) or other issues on the property.
3. Prior to starting a field trip inspect tyres, the vehicle interior and soles of boots for weed seeds and soil. Clean as needed.
4. When parking on a public roadway, select a parking area for the vehicle that is well off the road and clear of plant or other material that may cause contamination.
5. Don disposable boot protectors prior to exiting the vehicle. While preparing for sampling, ensure all equipment remains in the vehicle and is not placed on the ground.
6. Once samples have been collected, **effective cleaning (personnel, equipment and vehicle) prior to departure is 90% of the biosecurity job.** Prior to entering the vehicle or placing samples/equipment in the vehicles:
   - If needed, use sanitising wipes to wipe down bags holding samples. Place bags into plastic boxes within the vehicle load bed.
   - Inspect vehicle tyres, under-wheel arches, radiator grill and interior (particularly the floor mats) for weed seeds etc. Clean as needed.
   - Using a handheld brush, brush off clothing and hats.
   - Wash and disinfect brushes.
   - Wash hands thoroughly with soap and water.
   - Sit in the vehicle with feet out of the door, remove boot protectors and place in a plastic bag. Seal the plastic bag.
   - If not using boot protectors or if boot protectors have been compromised, thoroughly clean boots and then step into a disinfecting foot bath. A sealable container with approved disinfection solution and foam rubber in the bottom (to stop liquid slopping during travel) and large enough to step into could be used for this purpose as well as for disinfecting brushes etc.
   - Use hand sanitiser.
7. On completing a field trip:
   a. Remove bags with samples from the load bed. Clean boxes that held the samples and the load bed if needed. Spray load bed and boxes with 70% alcohol/methylated spirits.
   b. If the next field trip is in the same region, inspect vehicle tyres, under-wheel arches, radiator grill and interior (particularly the floor mats). Clean as needed.
   c. If moving to another region for the next field trip or if the vehicle is dirty - vacuum the interior and take the vehicle through a car wash that includes under-vehicle washing.
   d. Thoroughly wash/disinfect all clothing, boots and equipment used during sampling.
   e. Handle and dispose of plant, soil and other material collected during the field trip in a way that ensures there will be no transfer of pests to other properties.

To clean vehicles and equipment effectively, use a detergent and degreaser and pay particular attention to tyres, radiator grills, wheel arches, sump guards, floor mats and under carriages where seeds and dirt can lodge. If using high pressure air or water to clean vehicles and equipment, make sure soil and plant material isn't blown/washed into machinery movement areas, roads, sheds, crops, waterways etc.

Where it is suspected an exotic pest might be present in a paddock

In addition to adhering to the basic protocol as set out above, the following must be undertaken:

1. Prior to leaving the vehicle, don disposable coveralls, gloves and boot protectors.
2. Before entering the vehicle to leave the property, active personnel and vehicle disinfection methods must be implemented as described in farm biosecurity fact sheets.
3. As soon as possible after leaving the property and prior to entering any other property, the vehicle must be thoroughly washed and disinfected inside and out.
4. On arrival back at worksite all PPE and other materials should be disposed of in quarantine/biohazard bins or disinfected/autoclaved.

If you suspect or find an exotic plant pest

1. Contact Ross Meffin Chief Plant Health Manager (DPIR Biosecurity; mobile 0418 817 186) for advice and do not touch, move or transport affected plant material without advice from DPIR.
2. Notify Chief Scientist and relevant expert Senior Pathologists in SARDI Crop Sciences.
3. Photograph symptoms/pests.
4. Record GPS location.
5. Restrict the movement of people and equipment near the affected area.
6. Wash hands, clothes and boots that have been in contact with affected plant material or soil.
7. Report to the Exotic Plant Pest hotline.

EXOTIC PLANT PEST HOTLINE **1800 084 881**

Biosecurity kit – checklist

To be carried by those doing the sampling:

- Camera/mobile phone
- GPS/mobile phone

In the back of the vehicle:

- 10 L of water (preferably in 2 x 5 L containers for ease of handling)
- 2 x oblong buckets for use when disinfecting boots etc.
- Sealed container with approved disinfection solution and foam rubber in the bottom (to stop liquid slopping during travel) and large enough to step into for disinfecting boots etc.
- 3 long wooden pegs to mark any suspect areas
- Spade

Plastic box with tight-fitting lid containing:

- Stiff brushes, scraper, screwdriver for vehicle and tyre cleaning
- Dustpan and brush
- Rubber gloves
- Disposable overalls
- Disposable boot protectors
- Detergent
- Soap and paper towel for handwashing
- Disinfectant
- Spray bottle of 70% alcohol/methylated spirits
- Hand sanitiser
- Disinfectant wipes
- Farm Biosecurity double sided info sheet (*see attached*)
- Small box containing:
    - Clipboard with checklist
    - Folder with MSDS for the hand sanitiser, disinfectant, methylated spirits etc
    - Folder with exotic pests ID sheets; fact sheets, including “Grains Farm Biosecurity Program”; “NVT Exotic Plant Pests - Surveillance Pack 2010” by Judy Bellati etc.; names and contact details for those who need to be notified immediately if an exotic is suspected.
    - Secateurs/scissors
    - Flagging tape
    - Strong plastic bags (including heavy duty, large rubbish bags)
    - Paper and Ziplock bags
    - Sample jars and vials
    - Pens, pencils and rubber bands
    - parafilm
    - Stapler and staples

Appendix C.
Cereal report of paddocks surveyed in 2020 – agronomic and disease descriptions

Executive Summary

- 62 commercial cereal crops (39 wheat; 23 barley) representing all regions across the state were assessed for leaf diseases in 2020, with 100 plants from each paddock being inspected visually.
- Many regions, particularly Upper Eyre Peninsula and the Mallee, had good sowing rains then very dry conditions until early/mid grain filling. The South East had consistently good rainfall.
- Relationships between SARDI and Industry were strengthened during this project, as 23 advisors, five grower groups and 49 growers contributed paddocks and information for inclusion in the survey.
- No visual symptoms of the high priority exotic leaf diseases barley stripe rust or wheat stem rust UG99 were observed.
- No visual expression of foliar diseases was observed in 23% of wheat and 13% of barley samples. In 77% of wheat and 91% of barley samples, visual symptoms of one to five fungal pathogens were found on the upper leaves and/or heads of plants.
- Disease expression was generally at levels unlikely to cause significant yield loss, probably due to the dry seasonal conditions combined with most crops having had at least one foliar fungicide application and with many having two to three applications.
- In wheat, septoria tritici blotch was found at low levels in 53% of samples. Yellow leaf spot, powdery mildew, stripe rust and leaf rust were present in 15% or fewer samples.
- Stripe rust was at levels likely to cause significant yield loss in samples from two wheat crops in the South East, where this disease is proving difficult to manage.
- In barley, spot form net blotch (SFNB) was found in 74% of samples, net form net blotch (NFNB) in 43% of samples, scald in 39%, and leaf rust in 22% of samples.
- SFNB was the dominant barley disease, particularly in low rainfall areas and susceptible varieties should be avoided in 2021, as inoculum levels will be high.
- The widespread incidence of NFNB (43% of samples) is a concern given the potential for significant yield loss due to this disease and its increasing resistance to fungicide seed treatment.
- No powdery mildew was detected on barley samples and this suggests the Western Australian pathotype has not yet reached SA.
- In addition to disease and fungicide information this survey has provided interesting agronomic information. For example, fallow is still being used in rotations in the Mallee and multiple wheat varieties with different maturities are being sown mixed together in one paddock as a frost-avoidance strategy to allow grain crops rather than hay crops to be grown in very frost-prone paddocks.

Methodology

The number of crops sampled in each region was based on the area sown of each crop type. Using this as a guide, a comprehensive list of agronomists and independent consultants was compiled. A stratified random sampling approach was then applied when inviting participation in the survey. Paddock information was collected, including property owner contact details, GPS coordinates, sowing date, 2020 crop type and variety, 2020 fungicide applications (products and timing), and a three-year paddock history.

Paddocks were sampled at flowering to mid grain filling. A paddock sample consisted of 100 plants collected along four transects. Transects started a minimum of 50 m away from the fence line with a whole plant collected approximately every 10 m. Plants were transferred back to the laboratory for disease rating.

Biosecurity protocols were followed to ensure no transfer of pests, weeds or diseases from one paddock to the next. Most importantly, vehicles were not taken into paddocks and boots were disinfected between each paddock.

Presence/absence of major endemic and priority exotic diseases (Table 1) and disease severity on the whole plant was assessed visually. Incidence only was recorded where disease expression was very low, but where disease expression was high enough, the 1-9 scoring scale used for assessing variety resistance was used (score 5 is likely to cause some yield loss).

Table 1. Endemic and exotic diseases selected for assessment in cereal crops in South Australia in 2020.

Crop Type	Diseases Assessed
Wheat	Septoria tritici blotch, powdery mildew, stripe rust, stem rust, leaf rust, yellow leaf spot (YLS), wheat stem rust UG99 [e]
Barley	Net form net blotch (NFNB), spot form net blotch (SFNB), powdery mildew, scald, leaf rust, barley stripe rust [e]

[e] = high priority exotic disease

Wheat

39 wheat paddocks selected by advisors and growers were surveyed in five main regions (Table 2) across South Australia (Figure 1) in the period 15 September to 27 October 2020. The sowing window across the state was early and surprisingly narrow (28 April to 17 May), with the exception of one Mallee crop sown on 25 June. There was no obvious trend for earlier sowing in the lower rainfall areas or the more westerly regions of the state (Table 2). This reflects the importance placed on early sowing in current farming systems.

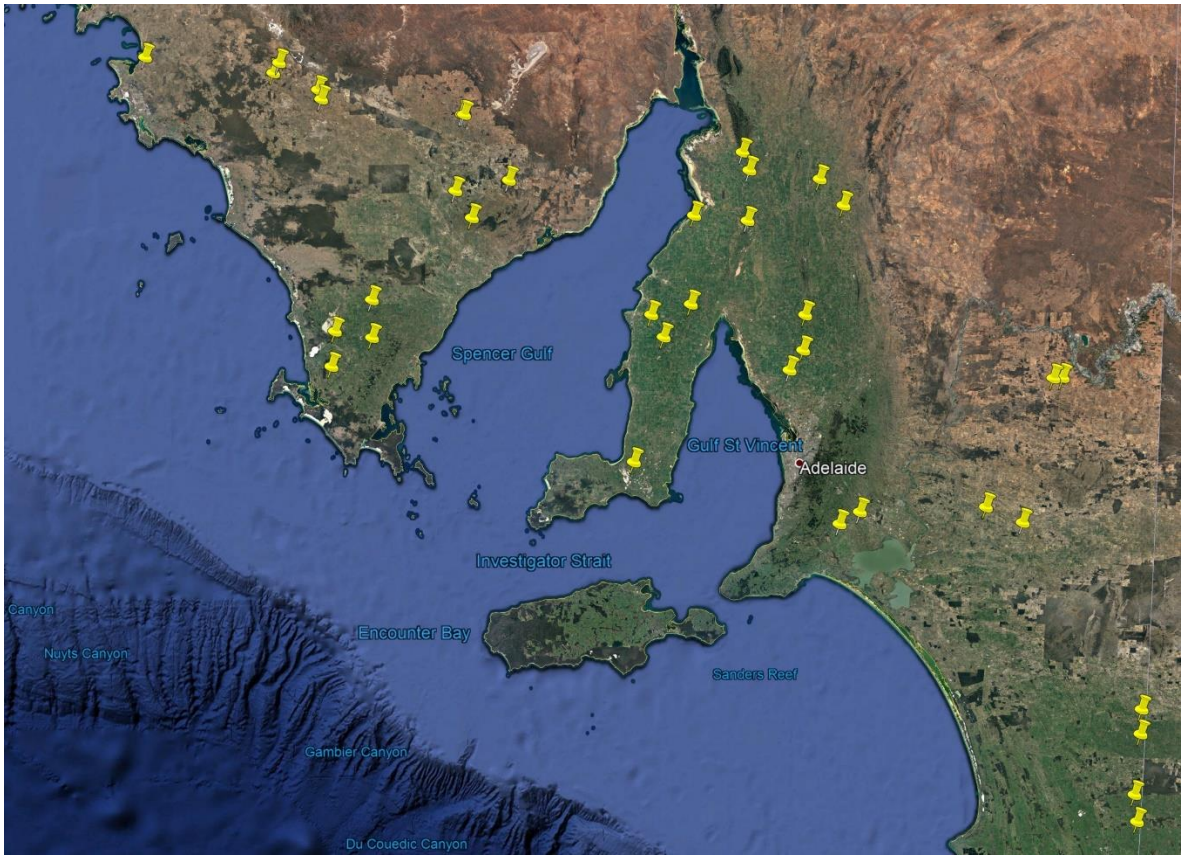

Figure 1. Location of wheat crops (yellow pins) surveyed for leaf diseases in 2020.

Scepter was the most commonly grown variety (21 crops – 54%), with nine other varieties being represented in one to three paddocks across the state (Table 2). It is normal for one bread wheat variety to dominate, but this can contribute to leaf disease issues for other wheat crops if the dominant variety is susceptible or very susceptible to one or more major leaf diseases and increases inoculum levels across the state (e.g. Scepter is SVS to powdery mildew and S to septoria – Table 4). As this can result in greater reliance on fungicides to manage leaf diseases, it can also contribute more rapid development of fungicide resistance.

Cereals dominated rotations in lower rainfall areas with pasture and vetch being common breaks from cereal (Table 2). In the Mallee, some paddocks included fallow in the rotation and on one property hay was used as an alternative to cereals for grain due to frost causing large grain losses. On this property they are trialling a mixture of wheat varieties with different maturities as a frost mitigation strategy. This may present some challenges for disease management as the varieties will have different levels of susceptibility to diseases and with different maturities may require different timing of fungicide applications.

Fungicide seed treatment (Table 2) was applied to all but two crops (one on Upper Eyre Peninsula, one in the South East). At sowing, fungicide was applied in-furrow to only two crops and on fertiliser to two crops, mostly like for control of take-all as this root disease is a problem in the Upper North where the fungicide-amended fertiliser was used.

In-crop fungicide application information was not provided for five paddocks, so 34 paddocks are used for calculating % application information (Table 2). In-crop fungicides were used less in low rainfall areas (zero to one application) than in higher rainfall areas (one to two applications) which reflects need to control the increase in disease development that can occur with foliar diseases driven by rainfall. In total, 34 fungicide applications were made to

the 34 paddocks surveyed and of these applications, 68% included epoxiconazole, 21% included prothioconazole, 18% included a strobiluran and 3% included propiconazole. The widespread reliance on epoxiconazole is a concern in relation to development of fungicide resistance in leaf diseases. Where more than one fungicide application was used, rotation of fungicide groups was employed in some but not all instances.

The high priority exotic disease wheat stem rust UG99 was not detected. Nine paddock samples (23%) did not show visual symptoms of any foliar disease: six from low rainfall areas (Upper Eyre Peninsula, Upper North, Mallee) and three from medium rainfall areas (Lower Eyre Peninsula, Lower North). Septoria tritici blotch was found in 53%, yellow leaf spot in 15%, powdery mildew in 13%, stripe rust in 8% and leaf rust in 8% of samples.

Stripe rust was identified in two paddocks from the South East at levels high enough to cause yield loss. Both crops were cv Trojan which is susceptible to the new 198 pathotype found in SA for the first time in 2020. These crops had flag leaves and heads affected by this disease despite having had one or two foliar fungicide applications. This is consistent with industry reports that stripe rust is difficult to manage in crops in the South East.

Powdery mildew (PM) was found at levels likely to cause some yield loss in one crop on Lower Eyre Peninsula and one crop on Yorke Peninsula. In both instances, approximately 20% of plants were affected with PM occurring on heads, flag leaves, and flag leaves minus one. The highest disease expression of PM was observed on the edges of the affected crops, where double sowing occurred with rows at right angles resulting in increased plant density and decreased air flow along rows. This highlights the importance of walking well into a crop before assessing the level of foliar disease present.

Table 2. Summary of the agronomy of South Australian wheat paddocks assessed in the visual foliar disease survey 2020.

Region	n[1]	Sowing date	Fungicides applied (% paddocks)						Varieties in 2020	Paddock use 2019 2018 2017[4]
			At sowing		In crop					
			Seed	Other	0	1	2	>2		
Eyre Peninsula										
Upper	10	Apr 28-May 20	90	10[2]	50	20	0	0	Scepter (7); Trojan; Chief	WPP; WLuB; WVB; WLW; PWP (2); VBW; COW; WWP
Lower	4	May 5-16	100	0	0	0	75	0	Scepter; Wyalkatchem; Cobra; Arrow	WWL; CFbW; CBW; CLuW
Mallee										
	6	May 7-Jun 25	67	17[3]	50	17	0	0	Scepter (4); Grenade; mixture for frost management	HoHoB; HbvBW; FBW; WFB; CFpW; LuWC
North										
Upper	5	May 5-9	100	67[3]	67	33	0	0	Scepter (3)	FpBW; FbBW; LBW
Lower	4	Apr 28-May 12	100	0	0	75	25	0	Scepter (2); Razor; Sherriff	CBW; WFbB; LBW; WWL
Yorke Peninsula										
	6	May 2-26	100	17[2]	0	33	67	0	Scepter (5); Sherriff	FbWO; PPW; C??; C??
South East										
	4	May 10-17	75	0	0	75	25	0	Scepter; Trojan (2); Mace	LWL; CLW; LCFb; Fb(burnt in fire)BW; LiWL; LBW

[1] Number of paddocks sampled – all agronomic information not always available for all paddocks

[2] Fungicide in-furrow at sowing

[3] Fungicide amended fertilizer

[4] ? unknown paddock use; B barley; C canola; Cp chickpea; F fallow, chemical; Fb faba bean; Fp field pea; D durum wheat; Hb hay barley; Ho hay oats; Hv hay vetch; L lentils; Li linseed; Lu lupins; O oats; P pasture (medic; balansa or subclover); V vetch; W bread wheat.

Table 3. Disease incidence (% of paddocks and average % of plants affected) in South Australian wheat crops visually assessed during the foliar disease survey 2020.

			Septoria		Stripe rust		Leaf rust		Powdery mildew		Yellow leaf spot		Crown rot		Russian wheat aphid	
Region	**n**	**Sample date**	Paddock	Plant	Paddock	Plant	Paddock	Plant	Paddock	Plant	Paddock	Plant	Paddock	Plant	Paddock	Plant
Eyre Peninsula																
Upper	10	Sep 15-17	0	0	0	0	10	<1	0	0	60	8	60	5	0	0
Lower	4	Oct 16	75	7	0	0	25	2	50	5	0	0	40	6	0	0
Mallee																
	6	Sep 24-25	67	7	17	<1	17	<1	0	0	0	0	25	3	100	15
North																
Upper	5	Sep 18-30	80	31	0	0	0	0	0	0	0	0	100	<1	100	28
Lower	4	Sep 8-Oct 14	50	18	0	0	0	0	0	0	0	0	25	14	75	<1
Yorke Peninsula																
	6	Oct 1-13	100	19	0	0	0	0	50	7	0	0	33	7	17	2
South East																
	4	Oct 27	75	17	50*	37	0	0	0	0	0	0	75	8	0	0

* One paddock with high levels of disease.

Table 4. Susceptibility of commercial wheat varieties assessed for disease during the foliar disease survey 2020.

Variety	Septoria tritici blotch	Stripe rust	Leaf rust	Powdery mildew	Yellow leaf spot	Crown rot
Arrow	S	S	SVS	SVS	MRMS	S
Chief	MS	S	MR	SVS	MRMS	MSS
Cobra	MS	MSS	MR	MSS	MRMS	S
Grenade	S	MRMS	S	MSS	S	S
Mace	S	SVS	MSS	MSS	MRMS	S
Razor	SVS	MS	S	MSS	MSS	S
Scepter	S	MSS	MSS	SVS	MRMS	S
Sherriff	S	MSS	SVS	SVS	MRMS	S
Trojan	MS	MR	MR	S	MSS	MS
Wyallkatchem	S	S	S	SVS	MR	S

Barley

23 barley paddocks selected by advisors and growers were surveyed in five main regions (Table 5) across South Australia (Figure 2) in the period 15 September to 27 October 2020. The sowing window across the state was early and quite narrow - 23 April to 26 May (Table 5). There was no obvious trend for earlier sowing in the lower rainfall areas or the more westerly regions of the state (Table 5). This reflects the importance placed on early sowing in current farming systems.

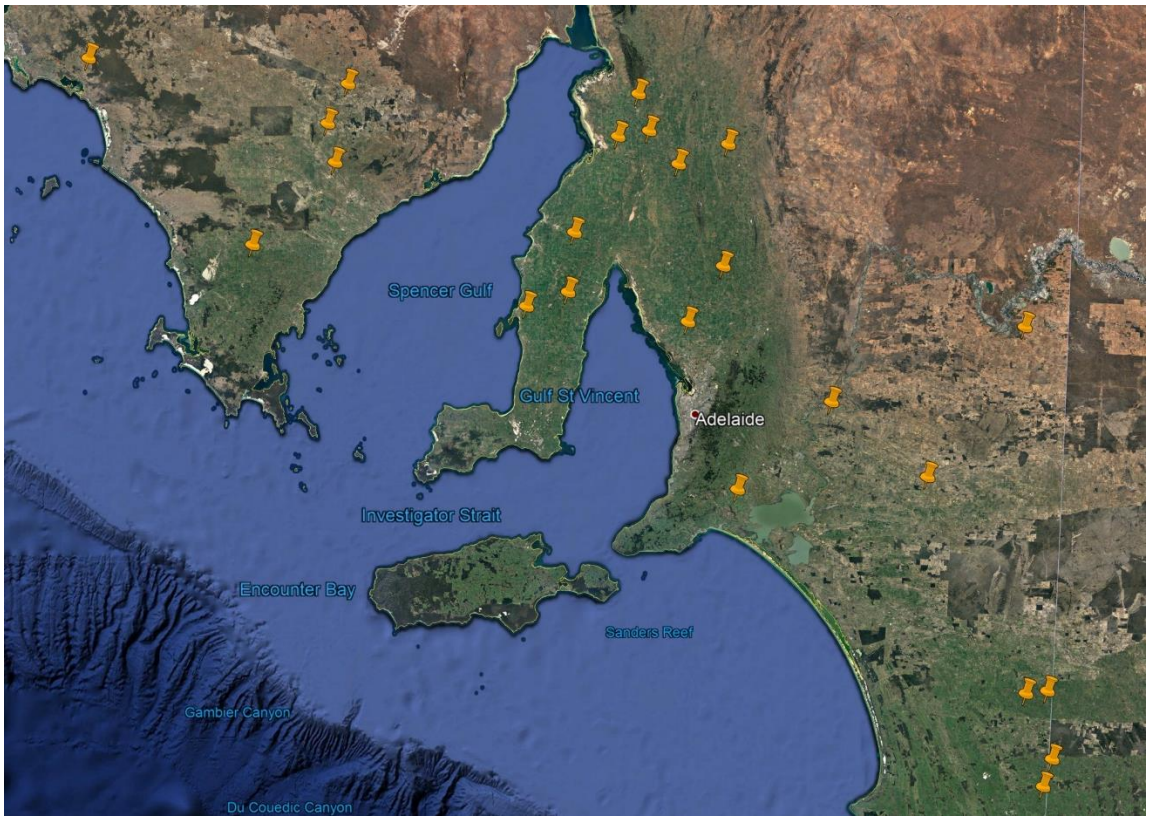

Figure 1. Location of barley crops (orange pins) surveyed for foliar diseases in 2020.

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The most commonly grown varieties were Compass (nine crops – 39%) and Spartacus (four crops – 17%) with six other varieties being represented in one to two paddocks each across the state (Table 5). This is in contrast to wheat where one variety dominated. For barley grown in South Australia, the range of varieties grown ensures a wider range of disease resistance (Table 7) meaning a lower likelihood that the disease susceptibility of one variety will result in a build-up of inoculum to infect other varieties. In lower rainfall areas, cereal dominated rotations (Table 5).

Fungicide seed treatment (Table 5) was applied to all crops except for three paddocks on the Upper Eyre Peninsula and one in the South East. Six crops (29%) had fluxapyroxad applied as a seed treatment. Anecdotal evidence indicates that less crops employed this seed treatment than previous years due to increasing issues with resistance of NFNB to this active ingredient. Tracking the use of this seed treatment in future disease surveys is recommended. None of the three crops in either the Lower North or South East regions where NFNB was recorded expressed NFNB symptoms. Fungicide was applied at sowing in-furrow to only one crop (Table 5).

In-crop fungicide application information was provided 21 of 23 paddocks and used for calculating % application information. In-crop fungicides were generally used less in low rainfall areas (zero to one application) than in higher rainfall areas (one to more than two applications; Table 5). In total, 24 fungicide applications were made to the 21 paddocks for which fungicide information was supplied. Of these applications, 54% included propiconazole and 37% included a strobiluran and reveals a different spectrum of active ingredients applied in barley crops in 2020 than that applied to wheat crops previously described. Where more than one fungicide application was used, rotation of fungicide groups was employed in some but not all instances.

The high priority exotic disease barley stripe rust was not detected. Three paddock samples (13%) did not show visual foliar symptoms of any disease: two from the low rainfall areas Upper North and Mallee, and one from the medium rainfall area of the Lower North. SFNB was found in 74%, NFNB in 43%, scald in 39%, and leaf rust in 22% of samples. No PM was detected on barley samples in the 2020 survey. This may mean that the Western Australian powdery mildew pathotype has not yet reached SA.

NFNB was widespread despite dry conditions in 2020 not being conducive to this disease. This prevalence of NFNB is a serious concern given the potential for severe damage and the increasing resistance to fungicide seed treatment. In the drier winter conditions of 2020, SFNB was at levels likely to cause significant yield loss in only one paddock and that was in the high rainfall zone of the South East. The variety in this paddock (RGT Planet) is rated SVS for NFNB in that region and did not have an in-crop fungicide applied.

SFNB was widespread particularly in the lower rainfall areas due to dry conditions during the middle of the growing season. Two crops in the Mallee and one on Upper Eyre Peninsula had levels of SFNB likely to cause some yield loss; this was despite reasonable varietal resistance (Compass - MR-MSS) in one paddock and application of a fungicide in-crop to less resistant varieties (Scope – MS-S; Spartacus - S) in the other two paddocks. Although SFNB does not usually cause significant yield losses it does have the potential to do so if seasonal conditions are favourable. As SFNB inoculum levels will be high going into 2021, industry will need to be reminded to avoid susceptible varieties in areas where SFNB was prevalent in 2020.

Scald was not widespread but was present at damaging levels in two crops in the high rainfall region of the South East. In one of these paddocks, down with an MS-SVS variety (Compass) scald was a problem despite two in-crop fungicide applications, whilst in the

other paddock an R-VS variety (RGT Planet) without an in-crop fungicide application did not adequately manage scald. This reinforces the importance of monitoring crops regularly for foliar diseases even when more disease resistant varieties are being grown.

Table 5. Summary of the agronomy of South Australian barley paddocks assessed in the visual foliar disease survey 2020.

Region	n[1]	Sowing date	Fungicides applied (% paddocks)						Varieties in 2020	Paddock use 2019 2018 2017[4]
			At sowing		In crop					
			Seed	Other	0	1	2	>2		
Eyre Peninsula										
Upper	4	May 12	25	25[2]	25	25	0	0	Compass; Spartacus	WPaB; WLW; WPaW
Lower	1	May 2-10	100	0	0	100	0	0	Compass	WLW
Mallee										
	4	Apr 23-May 20	100	0	25	75	0	0	Compass (2); Spartacus; Scope	HbHtvHbv; VBC; WPaB; WCB
North										
Upper	3	May 6-14	100	0	33	33	33	0	Spartacus (2); La Trobe	WFpB; WLB; OBW
Lower	3	May 5-13	100	0	0	0	100	0	Compass (2); Leabrook	BLO; BWC; WWC
Yorke Peninsula										
	4	April 19-May 26	100	0	25	0	50	25	Compass (2); Fathom; Maximus	BFbW; PaBPa; LWL; WLW
South East										
	4	May 12-15	75	0	50	25	25	0	Compass; Spartacus; Planet (2)	WCPa; WPaW; Ho??; Pa??

[1] Number of paddocks sampled – all agronomic information not always available for all paddocks

[2] Fungicide in-furrow at sowing

[3] ? unknown paddock use; B barley; C canola; Cp chickpea; F fallow, chemical; Fb faba bean; Fp field pea; D durum wheat; Hb hay barley; Ho hay oats; Hv hay vetch; L lentils; Li linseed; Lu lupins; O oats; P pasture (medic; balansa or subclover); T triticale; V vetch; W bread wheat.

Table 6. Disease incidence (% of paddocks and average % of plants affected) in South Australian barley crops visually assessed during the foliar disease survey 2020.

Region	n	Sample date	Spot form net blotch		Net form net blotch		Scald		Leaf rust		Powdery mildew		Russian wheat aphid	
			Paddock	Plant	Paddock	Plant	Paddock	Plant	Paddock	Plant	Paddock	Plant	Paddock	Plant
Eyre Peninsula														
Upper	4	Sep 15-17	100	91	0	0	50	23	0	0	0	0	0	0
Lower	1	Oct 16	100	4	0	0	100	4	100	50	0	0	0	0
Mallee														
	4	Sep 24-25	50	49	50	13	75	19	25	4	0	0	50	
North														
Upper	3	Sep 18-30	33	27	33	33	33	2	0	0	0	0	0	0
Lower	3	Sep 23-Oct 14	67	13	33	1	0	0	0	0	0	0	0	0
Yorke Peninsula														
	4	Oct 1-13	100	51	33	25	0	0	33	25	0	0	0	0
South East														
	4	Oct 27	100	34	50	35	100	59	75	23	0	0	0	0

Table 7. Susceptibility of commercial barley varieties assessed for leaf diseases during the foliar disease survey 2020.

Variety	Spot form net blotch	Net form net blotch	Scald	Leaf rust	Powdery mildew
Compass	MR-MSS	MR-MSS	MS-SVS	SVS	MRMS-S
Fathom	RMR	MS-VS	R-MS	MRMS-S	MRMS
La Trobe	MSS	MR-MSS	R-VS	MRMS-S	MR-SVS
Leabrook	MS	MR/S	MS/SVS	MS/SVS	MRMS
Maximus	MRMS	RMR-MRMS	R-MRMS	MS-S	MR-S
Planet	S	MRMS-SVS	R-S	MR-MS	R
Scope	MS-S	MR	MS-S	MS-SVS	RMR
Spartacus	S	MRMS-S	R-VS	MR-S	MR-SVS

Appendix D.
Pulse report of paddocks surveyed in 2020 – agronomic and disease descriptions

Executive Summary

- In 2020, 40 commercial pulse crop paddocks (11 chickpea, nine faba bean, ten field pea and ten lentil) were surveyed and sampled across South Australia. Plant samples were visually inspected for disease.
- Plants (100 per paddock) representing all regions across the state were inspected
- Relationships between SARDI and Industry were strengthened, as 23 advisors, five grower groups and 49 growers contributed paddocks and information for inclusion in the survey.
- Many regions, particularly Upper Eyre Peninsula and the Mallee, had good sowing rains then very dry conditions until early/mid grain filling. The South East had consistently good rainfall. However disease levels were generally low most likely due to fungicide applications and the dry June and July.
- At least one foliar disease was observed in 73% of the samples
- No sclerotinia nor exotic diseases were detected.
- Ascochyta blight (AB) in the chickpea, faba bean and lentil paddocks was very low, including some completely free of disease. However in field pea, all plants in all paddocks showed AB (syn. blackspot) symptoms varying from a low to high level of disease.
- Low levels of downy mildew were detected in some field pea paddocks and no bacterial blight was found during the survey although reports of both diseases were received from industry during the season.
- Chocolate spot (CS) was found only in the four faba bean paddocks in the south east, with moderately high disease levels in two paddocks associated with mistimed fungicide sprays. Disease levels in these two paddocks would have affected grain yield and or quality. Further research on timing of fungicide application for CS control would benefit the industry.
- Disease expression was generally at levels unlikely to cause significant yield loss, probably due to most crops having had at least one foliar fungicide application, with many having two or three applications.
- No disease was observed in 60% of lentil paddocks and 27% of chickpea paddocks.

Methodology

Described in detail in the Methodology section of main Final Technical report. All paddock passport and agronomic data is stored at SARDI in network folder: G:\SARDI Grains Pathology Projects\GRDC UA-2007-006 Disease surveillance

Briefly, pulse crops (n=100) were sampled in spring during mid flowering to early grain filling. Presence/absence of major endemic and priority exotic diseases (Table 1) and disease severity was visually assessed with percent whole plant area diseased recorded.

Table 1. Endemic and exotic diseases selected for assessment in pulse crops in South Australia in 2020.

Crop Type	Diseases Assessed
Chickpea	ascochyta blight, botrytis grey mould, sclerotinia
Lentil	ascochyta blight, botrytis grey mould, sclerotinia, anthracnose[e], rust[e]
Faba bean	ascochyta blight, chocolate spot, cercospora leaf spot, sclerotinia, rust, downy mildew[e]
Field pea	ascochyta blight (syn. blackspot), downy mildew, bacterial blight, botrytis grey mould, sclerotinia

[e] = high priority exotic disease

Chickpea

Eleven chickpea paddocks were surveyed for disease in spring 2020 between 9 September and 15 October on the Yorke Peninsula and in the Mid North of South Australia (Figure 1). Agronomic information was received and collated for ten of 11 chickpea paddocks surveyed (Table 2a). There was a wide sowing window on the Yorke Peninsula with paddocks sown between 11 May and 22 June whilst paddocks in the Mid North were sown between 11th and 28th May. PBA Monarch was the main cultivar sown in the paddocks surveyed (six of 11), Genesis090 was sown to four paddocks, and Kalkee and CICA 1521 (released as CBA Captain) to one paddock each. In eight out of ten paddocks, chickpea seed was treated with fungicide which is recommended as the first line of defence against AB in germinating and developing seedlings. Only three of ten paddocks used rhizobial inoculant at sowing.

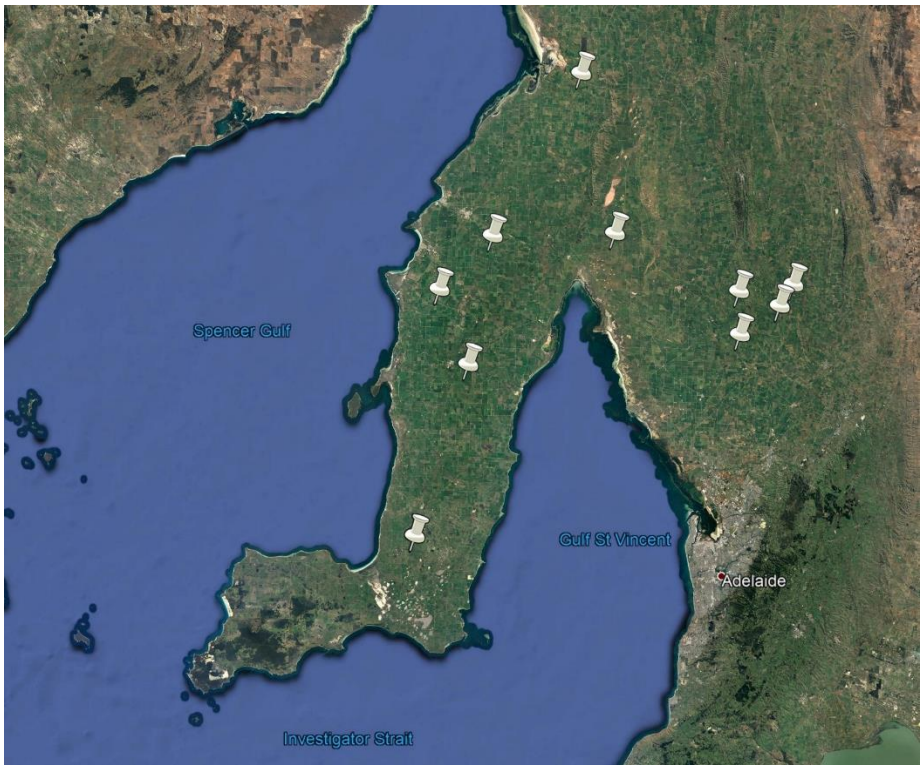

Figure 1: Map showing location of chickpea paddocks (white pins) surveyed for disease in spring 2020.

Table 2a. Summary of the agronomy of South Australian chickpea paddocks assessed in the visual foliar disease survey 2020.

Region	n[1]	Sowing date	Inoculant at sowing	Fungicides applied (no. paddocks)					Varieties in 2020	Paddock use 2019 2018 2017[2]
				Seed treatment	In crop					
					0	1	2	>2		
North										
Mid	5	11 May – 28 May	3	3	0	0	1	3	PBA Monarch, Genesis090	BWW, BWW, WDC, BWC
Yorke Peninsula										
	6	11 May – 22 June	0	5	0	2	2	2	Genesis090, Kalkee, PBA Monarch, CICA1521	BWCp, BWCp, WWL, CpWCp, WLiL, BWW

[1] Number of paddocks sampled – all agronomic information not available for one paddock from Mid North

[2] B barley; C canola; Cp chickpea; D durum wheat; L lentils; Li linseed; W bread wheat.

The average severity and incidence of foliar disease observed in chickpea paddocks surveyed in South Australia was very low (Table 2b). In the 11 chickpea paddocks surveyed, 55% of crops were infected with AB but at very low severity (2% or less) and the number of plants per crop with AB lesions (i.e. disease incidence per crop) ranged between 1-44%. Botrytis grey mould (BGM) was identified in only one crop, which was on the Yorke Peninsula, but severity was almost zero (0.002%) and the disease incidence was also very low (1%). There was no sclerotinia detected in surveyed chickpea paddocks.

Table 2b: Average severity (% whole plant disease) and incidence (plants per crop) of diseases in South Australian chickpea paddocks assessed in the visual foliar disease survey 2020.

Region	n	Sample date	Ascochyta blight		Botrytis grey mould	
			severity	incidence	severity	incidence
Mid North	5	23 Sept – 14 Oct	0.39	9.00	0.00	0.00
Yorke Peninsula	6	1 Oct – 14 Oct	0.17	8.00	0.00	0.17
State	11	23 Sept – 14 Oct	0.27	8.45	0.00	0.09

Note: No sclerotinia detected in this survey; data not shown.

The number of fungicide sprays applied per paddock prior to survey sampling ranged from one to five with almost half the paddocks surveyed receiving three or more fungicide applications (Table 2a). Three paddocks in the Mid North applied additional sprays after the survey sampling was conducted. The products applied on multiple occasions (chlorothalonil, AviatorXPro®) are recommended for management of AB. Only three paddocks surveyed had

a history of chickpeas in their rotation. One paddock had sown chickpeas three times between 2017 and 2020 which is contrary to the recommended best practice of three-year rotations between chickpea crops for management of AB. It is difficult to draw conclusions about the need for the fungicide applications reported due to the small number of paddocks surveyed, and in a season characterised by a dry winter as disease levels were very low in all paddocks surveyed. Pre-sowing inoculum levels were also not reported in this survey which may have influenced decision making. It is possible that these paddocks were perceived at higher risk of AB perhaps due to chickpea stubble in neighbouring paddocks (where infested stubble can act as a source of inoculum) however this information was not captured as part of this survey. One advisor disclosed that growers were risk-averse to allowing AB to develop in chickpea crops and preferred to apply prophylactic fungicide sprays. This was the case where hot spots of AB developed in crops in 2018 and 2019 that did not receive timely fungicide applications and resulted in loss of yield potential. In these instances, the decision was made that once a fungicide spray was applied in the 2020 season, then follow up sprays would occur every two to three weeks ahead of a rainfront as a preventative spray.

Lentil

Ten lentil paddocks were surveyed for disease in spring 2020 between 1 October and 14 October on the Yorke Peninsula (Figure 2) and agronomic information was received and collated for all ten paddocks (Table 3a). These paddocks were all sown between 27 April and 15 June without rhizobial inoculant. Seed in four of the paddocks were dressed with P-Pickel T® fungicide. PBA Hurricane XT was the main cultivar sown in the paddocks surveyed (six of ten) with PBA Hallmark XT sown to three paddocks and Jumbo2 sown to one paddock. The rapid adoption of lentil XT cultivars with Group B imidazolinone tolerance has become commonplace on the Yorke Peninsula due to the improved ability for growers to control in-crop broadleaf weeds.

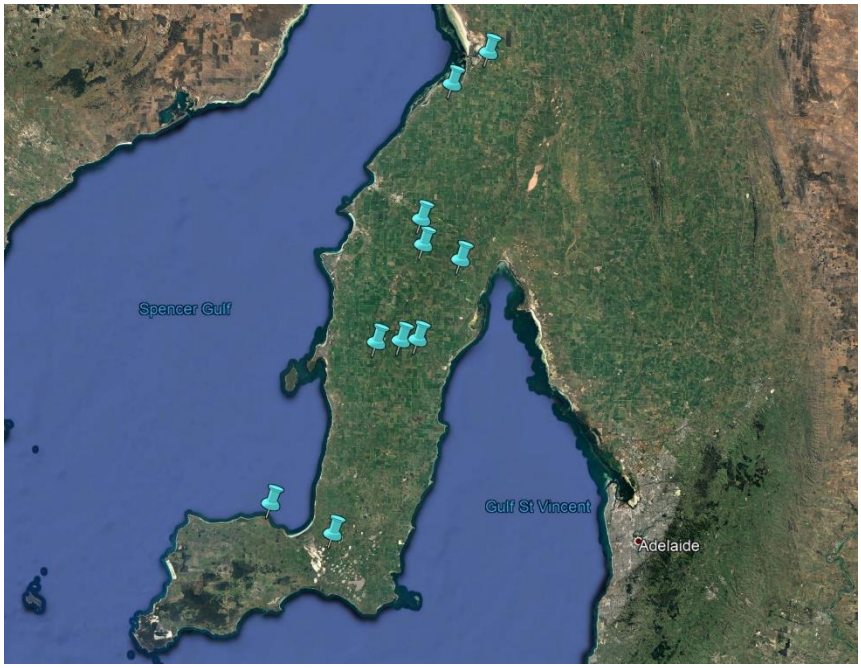

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Figure 2: Map showing location of lentil paddocks (pale blue pins) surveyed for disease in spring 2020.

Table 3a. Summary of the agronomy of South Australian lentil paddocks assessed in the visual foliar disease survey 2020.

Region	n[1]	Sowing date	Inoculant at sowing	Fungicides applied (no. paddocks)					Varieties in 2020	Paddock use 2019 2018 2017[2]
				Seed treatment	In crop					
					0	1	2	>2		
Yorke Peninsula										
	10	27 April – 15 June	0	4	0	9	1	0	PBA Hurricane XT, PBA Hallmark XT, Jumbo2	BWV, WLW,WLB,WWFb, BW?, WCpW, WLW, WLiL, WCpW, BWCp

[1] Number of paddocks sampled.

[2] ? unknown paddock use; B barley; Cp chickpea; Fb faba bean; L lentils; Li linseed; V vetch; W bread wheat.

The average severity and incidence of foliar disease observed in lentil paddocks surveyed in South Australia was very low (Table 3b). In this survey, it was observed that 30% of crops were infected with AB but at a very low severity (less than 1% whole plant area diseased) and the disease incidence per crop was also very low (ranging from 3-4%). Two crops showed BGM symptoms at a very low severity (range 4.3-5.7% in the two crops), although disease incidence was high at 83-88% in those two crops. There was no sclerotinia detected in the lentil crops surveyed and the exotic diseases, anthracnose and rust, were also not detected.

Table 3b: Average severity (% whole plant disease) and incidence (plants per crop) of endemic diseases in South Australian lentil paddocks assessed in the visual foliar disease survey 2020.

Region	n	Sample date	Ascochyta blight		Botrytis grey mould	
			severity	incidence	severity	incidence
Yorke Peninsula	10	1 Oct – 14 Oct	<0.01	0.78	0.48	9.78

Note: No sclerotinia and exotic diseases were detected in the survey; data not shown.

Nine of ten paddocks in the survey received only a single fungicide application (Table 3a) applied at canopy closure. In eight of these paddocks this application included two fungicide products, the active constituents being chlorothalonil and carbendazim. Both the products and the timing of application are recommended for the control of AB and BGM respectively in lentil crops (GRDC Grow Notes – South). Another disease management recommendation is to observe three-year rotations between lentil crops in the same paddock and six of ten paddocks surveyed did not report a lentil crop in the same paddock since 2017. This may have contributed to the low levels of disease observed in this survey.

Faba bean

Nine faba bean paddocks (five from the south east, four from the lower/mid north; Figure 3) were surveyed in South Australia in spring between 8 September and 28 October 2020 and agronomic information was received and collated for all paddocks except one from the mid north (Table 4a). Paddocks were sown between 25 April and 14th May with no fungicide seed treatment. Only one paddock from the Mid North was sown with peat inoculant. The two main cultivars sown were PBA Samira and PBA Bendoc (three paddocks each) with one paddock sown to PBA Marne in the lower north and one paddock in the south east sown to the old variety Fiesta.

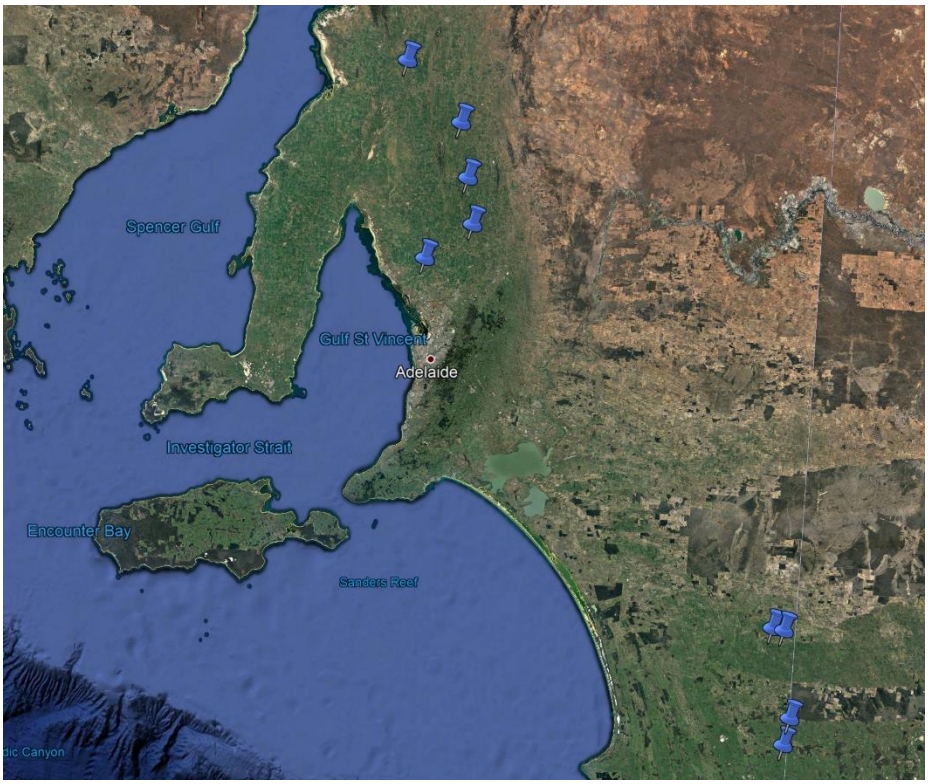

Figure 3: Map showing location of faba bean paddocks (blue pins) surveyed for disease in spring 2020.

Table 4a. Summary of the agronomy of South Australian faba bean paddocks assessed in the visual foliar disease survey 2020.

Region	n[1]	Sowing date	Inoculant at sowing	Fungicides applied (no. paddocks)					Varieties in 2020	Paddock use 2019 2018 2017[2]
				Seed treatment	In crop					
					0	1	2	>2		
North										
Lower	1	5 May	0	0	0	0	1	0	PBA Marne	BWW
Mid	4	14 Apr – 6 May	1	0	0	2	1	0	PBA Bendoc, PBA Samira	BWC, WCHo, WDC.

South East										
	4	25 Apr – 10 May	0	0	0	2	1	1	Fiesta, PBA Bendoc, PBA Samira	PWFb, WFbW, WVB, WWFb.

[1] Number of paddocks sampled – all agronomic information not available for one paddock from Mid North.

[2] B barley; C canola; D durum wheat, Fb faba bean; Ho hay oats; V vetch; W bread wheat.

The average severity and incidence of foliar disease observed in faba bean paddocks surveyed in South Australia in 2020 was very low (Table 4b). In the nine faba bean paddocks surveyed, 56% of crops were infected with AB but at very low severity (2% or less) and the disease incidence in those affected crops was also low, ranging from 3-12%. Forty-four per cent of crops were infected with CS, ranging in severity between 0.6 to 53.9%, and disease incidence was high at 49-100% in those crops. All surveyed crops in the South East region were infected with CS with disease severity in two of those four crops being high (45 to 54% whole plant disease). No cercospora leaf spot was detected probably due to the timing of survey being later in the season than when this disease is typically observed. No sclerotinia or rust was detected in this survey. The exotic faba bean disease, downy mildew, was also not observed.

Table 4b: Average severity (% whole plant disease) and incidence (plants per crop) of diseases in South Australian faba bean paddocks assessed in the visual foliar disease survey 2020.

Region	n	Sample date	Ascochyta blight		Chocolate spot	
			severity	incidence	severity	incidence
Mid North	5	8 Sep – 12 Oct	0.10	6.40	0.00	0.00
South East	4	27 Oct – 28 Oct	0.00	0.00	25.22	81.00
State	9	8 Sep – 28 Oct	0.06	3.56	11.21	36.00

Note: no cercospora, sclerotinia, rust or the exotic disease, downy mildew, were detected; data not shown.

A similar pattern of the number of fungicide sprays were applied in both the Lower/Mid North and the South East regions where a single spray was applied in two crops in each, whilst two sprays were applied in one crop each in the Lower North, Mid North and South East (Table 4a). Only one crop in the South East received three sprays which was sown to the older cultivar Fiesta and this was one of the paddocks that had a high level (45% whole plant disease severity) of CS. This cultivar is rated susceptible (S) to both AB and CS. In three of the four paddocks surveyed in the South East, faba beans had been grown in the rotation in the last 3 years.

Field pea

Ten field pea paddocks were surveyed for disease in spring 2020 between 9 September and 15 October on the Eyre Peninsula and Lower/Mid North of South Australia (Figure 4). Agronomic information was available for nine of these paddocks surveyed (Table 5a). Seed was sown between 29 April and 25 May. Only one paddock each on the Eyre Peninsula and in the Mid North sowed seed with applied rhizobial inoculant. For seed treatment prior to sowing, only three paddocks surveyed employed P-Pickle T fungicide: one on the Eyre Peninsula, two in the mid North. The two main cultivars sown in the surveyed paddocks were Gunyah (three of ten) and PBA Wharton (four of ten) with one paddock each of PBA Butler, Kaspa and Oura.

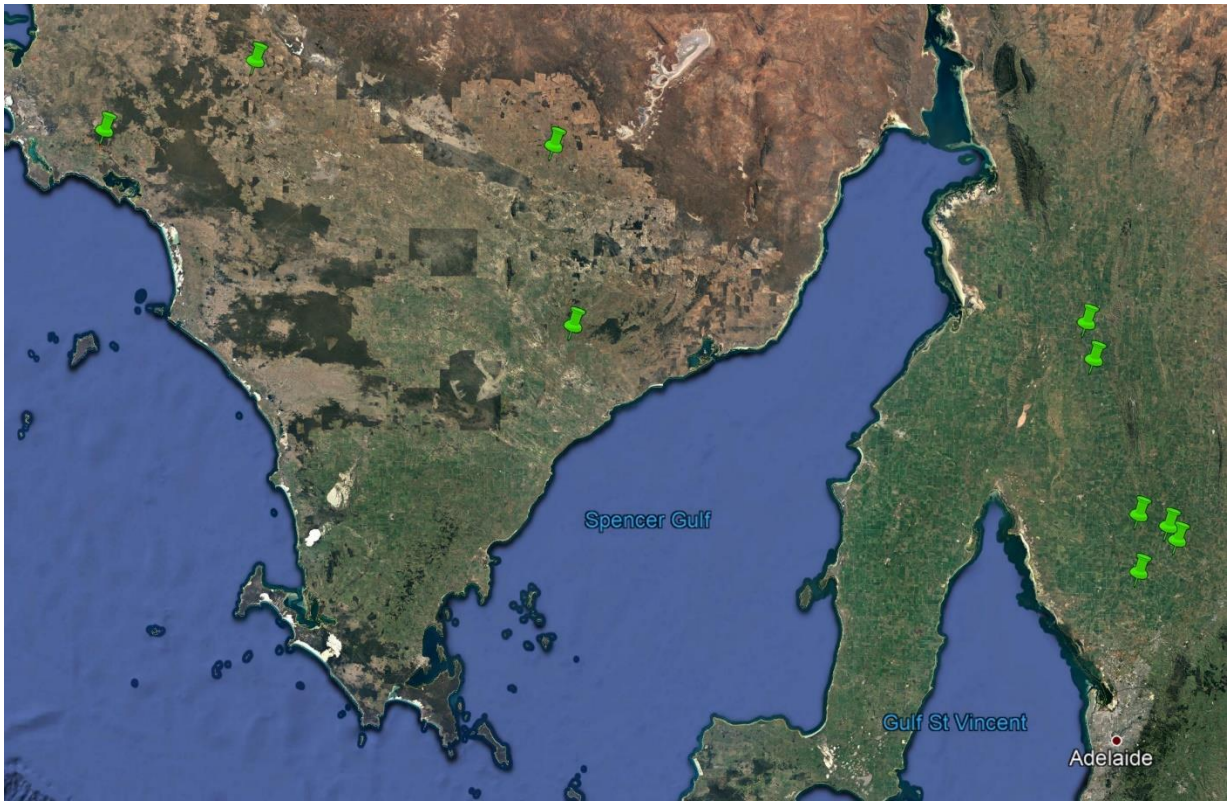

Figure 4: Map showing location of field pea paddocks (green pins) surveyed for disease in spring 2020.

Table 5a. Summary of the agronomy of South Australian field pea paddocks assessed in the visual foliar disease survey 2020.

Region	n[1]	Sowing date	Inoculant at sowing	Fungicides applied (no. paddocks)					Varieties in 2020	Paddock use 2019 2018 2017[2]
				Seed treatment	In crop					
					0	1	2	>2		
Eyre Peninsula										
Upper	4	29 Apr – 18 May	1	1	2	2	0	0	Gunyah, PBA Butler, Kaspa	BBW, BWP, BWV.
North										

Lower	1	21 May	0	0	0	0	0	1	PBA Wharton	BWC
Mid	5	15 May-25 May	1	2	1	2	2	0	PBA Wharton, Oura, Gunyah	BHoW,BDFb, BWL, BWW, BWV&Fp.

[1] Number of paddocks sampled – all agronomic information not always available for all paddocks

[2] B barley; C canola; D durum wheat, Fb faba bean; Fp field pea; Ho hay oats; L lentils; P pasture; V vetch; W bread wheat.

The average severity and incidence of downy mildew observed in field pea paddocks surveyed in South Australia was very low whereas as AB (syn. Blackspot) was moderate to high (Table 5b). In the ten field pea paddocks surveyed, 100% of crops were infected with AB with whole plant severity ranging between 15-58%. Severe downy mildew had been reported widely across the state in seedling crops early in the season, and in the survey, four of ten crops were infected but at a very low severity (0.02-1.6%) with 1-50% disease incidence. Warm spring conditions likely restrained downy mildew. No bacterial blight, botrytis grey mould or sclerotinia were detected in these crops.

Table 5b: Average severity (% whole plant disease) and incidence (plants per crop) of diseases in South Australian field pea paddocks assessed in the visual foliar disease surveillance survey 2020.

Region	n	Sample date	Ascochyta blight		Downy mildew	
			severity	incidence	severity	incidence
Mid North	6	9 Sep – 15 Oct	41.25	100	0.38	10.50
Eyre Peninsula	4	15 Sept – 17 Sept	25.98	10	0.19	0.75
State	10	9 Sep – 15 Oct	35.14	100	0.30	6.60

Note: no bacterial blight, botrytis grey mould or sclerotinia were detected, data not shown.

The four paddocks on the Eyre Peninsula applied either no (n=2) or one (n=2) fungicide spray prior to sampling for the disease survey (Table 5a). Paddocks in the Mid North applied either nil, one or two fungicides sprays whereas the single paddock surveyed in the Lower North applied three sprays. Due to the small sample size of surveyed paddocks it is difficult to draw conclusions about how the varied number of fungicide sprays relate to the disease levels observed. Of interest, the paddock with the second highest severity of AB received no fungicides either at sowing or in-crop and was at higher risk that other paddocks surveyed due to having been sown to field peas in 2017. Pre-sowing inoculum levels were not reported in this survey which may have influenced growers' decision making and it is possible that some paddocks were perceived at higher risk of AB. Fungicide sprays for control of AB on field pea are only economically advantageous where the yield potential is greater than 1.5 tonne per hectare.

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Glossary and Acronyms

SA	South Australia
SE	South East
YP	Yorke Peninsula
MN	Mid North
LN	Lower North
UN	Upper North
LEP	Lower Eyre Peninsula
UEP	Upper Eyre Peninsula
AB	Ascochyta Blight
BGM	Botrytis Grey Mould
CS	Chocolate Spot
SFNB	Spot form net blotch
NFNB	Net form net blotch

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Is there any reason why this report cannot be communicated on social media?

a. The data identifying paddocks, owners, operators and or advisors should remain private and not be communicated on social media. Regional or whole state results can be shared.

If no, please provide the following:

1. Who is the target audience for this content? (e.g., growers, adviser, researchers, policy makers, etc.)
   a. *Growers, advisors, trade partners,*
2. At what time of year is this content most relevant to the target audience?
   a. *During the cropping season, from May – November.*

3. On which of GRDC's social media accounts would you like this content posted? Please provide text (2-3 sentences for Facebook and LinkedIn and 140 characters for Twitter), images, graphs, or charts that support the content. Where applicable, please include any relevant Twitter handles (usernames) for project staff.
   a. *Results of disease survey of cereal and pulses in South Australia in 2020 found generally low levels of disease likely due to a dry winter and fungicide applications @Sara_N_Blake @SA_PIRSA @theGRDC #SARDIscience*
   b. *A survey of 100 cereal and pulse paddocks in South Australia in 2020 found no high priority plant pests targeted for identification in the survey project. @Sara_N_Blake @SA_PIRSA #SARDIscience #biosecurity*