Rhizoctonia management strategies – effects on soil pathogen concentrations
Paddock demonstration at Buckleboo, Upper Eyre Peninsula, 2021-2022

A report for the GRDC Project FLR1912-003RTX - Soilborne pathogen identification and management strategies for winter cereals

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Key messages

- Results from this demonstration have fostered discussion during Buckleboo Farm Improvement Group crop walks (with 40-50 attendees each year) and suggest that disease interactions might affect inoculum carryover (further investigation might be warranted).

- At the start of 2021, the target disease, rhizoctonia root rot, was present at medium to high risk levels, as were crown rot, take-all and common root.

- In-crop observations of uneven growth during early spring in 2021 were consistent with rhizoctonia causing substantial loss of crown roots.

- No visual improvements in evenness of cereal crop growth or of grain yield were apparent where cereal seed was treated with EverGol® Prime fungicide pre-sowing.

- There appeared to be a general decrease in inoculum in cereal plots from the start of 2021 to the start of 2022 for rhizoctonia root rot, take-all and common root rot. This was possibly due to high rainfall over summer and/or to different operators taking samples at the start of 2021 and the start of 2022.

- Over the demonstration period (2021-2023), there appeared to be a general decrease in inoculum or inoculum levels remained low/below detection. Again, possibly due to high rainfall over summer and/or to different operators taking samples at the start of each year.

- The vetch treatment (brown manured to kill a barley grass infestation) appeared to be most effective at reducing inoculum concentrations of rhizoctonia root rot, take-all, crown rot and common root rot. High summer rainfall is likely to have contributed to these reductions, particularly for rhizoctonia and take-all.

- Trends in the results appear to show that EverGol® Prime seed treatment increased rhizoctonia root rot inoculum and decreased inoculum of take-all, crown rot and white grain disorder. These results are unexpected and difficult to explain. The direct effect of EverGol® Prime should be to reduce rhizoctonia root rot inoculum and there should not be any direct effect on inoculum of take-all, crown rot or white grain disorder. Further research might be justified to clarify this situation.

- The presence of white grain disorder at the demonstration site suggests this disease might still have potential to cause issues on Upper Eyre Peninsula if seasonal conditions are conducive to expression.

- Comments on what worked well and what might have been done differently for this demonstration as well as suggestions for alternative approaches to demonstration work are given at the start of this report.

- PREDICTA® B soil analysis continues to be a useful demonstration, research and broad-acre disease management tool.

What worked well:
- Local work addressing a local problem.
- The collaborative approach that included growers; grower groups; local management of the site (AIR EP; Minnipa Agricultural Centre); pathologists etc.
- Extension of information from the site via inclusion of the site in the Crop Walk for the Buckleboo Farm Improvement Group.
- Having access to expertise at the Crop Walk event (Marg Evans had prepared washed root samples showing disease symptoms present at the site for people to inspect and presented on the project overall) dramatically increased the value of the event for farmers – questions could be asked and answered on the spot.

What we <u>would</u> do differently next time:
- If using PREDICTA B as an inoculum assessment tool:
  - Before starting, determine a sampling protocol that is most likely to detect the changes of interest. That might mean deciding that sampling is done at random and without adding stubble at all times of sampling. This will be simplest to do consistently over the whole period, particularly if there are one or more non-cereal treatments. Otherwise there will be difficulties about deciding whether to sample on the cereal rows from pre-treatment or post-treatment (and old cereal rows will be very difficult to find after a non-cereal) and about deciding which cereal stubble to add to the sample and how to identify whether it is cereal stubble from the correct year.
  - Have the same person take all soil samples so that different samplers do not influence treatment effects or changes in inoculum levels over time.
  - Take soil samples from each plot pre-treatment (could be done after crop emergence) to identify variability and underlying trends in inoculum concentrations across the site
- Assess root health and/or expression of disease symptoms on roots and stem bases (depending on diseases present/being examined) in late winter/early spring in the year of treatment. This would be a simple protocol that needs to be budgeted for in the project.

What we <u>might</u> do differently next time - points to be considered by GRDC
Large plot demonstrations where treatments are applied using commercial equipment give growers an opportunity to assess new and existing management options in local broadacre cropping systems under local growing conditions on local soils.

This approach means that treatments are applied with machinery of the same weight and size and at the same speeds that would be used in commercial farming systems. The large plots (rather than small plots in replicated trials) give a better understanding of the real spatial variability of responses to treatments at the paddock level. The large plots also let growers to walk in the plots and inspect and pull up/dig up plants without compromising information from small plot replicated trials.

However, there are some problems with this approach, including:
- The lack of replication means that yield and other results often cannot be interpreted - there is also some risk growers will draw incorrect (visual) conclusions and come away with.
- Sowing and harvesting the demonstration plots inevitably clashes with the busiest time of year for the co-operator and their equipment and this can mean timing of operations for the demonstration plots are not optimal.
- Ensuring the plots, when required, are avoided during normal paddock operations can be difficult, as can locating the plots in the year of and the years post treatment.

- If any treatments cause issues in the paddock (e.g. increased weed seed burden), this can be difficult for the co-operator to manage in subsequent years as the plots usually take up a significant proportion of the paddock.
- The plots are very large and looking at or assessing the whole site (or individual plots) is time-consuming and difficult.

Possible alternatives to current approaches to large plot demonstrations:
- Don't do rigorous assessment of plots, but use them as opportunities for:
  - ❖ Extending management strategies, information etc. from replicated trials. Discuss how to implement management options at a paddock level and whether treatments would be easy to implement locally without causing issues. If this option included facilitated, semi-structured discussions (based around planned questions) it would lend itself to site "case studies" using photographs taken and ideas etc recorded during discussions.
  - ❖ Hands-on field-based capacity building activities e.g. root health and sowing depth inspection; assessing yield at early grain filling. These activities could be offered to growers, agronomists, advisors, technical and research staff etc. It might even be possible to do minimalist sampling for each plot as part of the training opportunities offered.
- Place medium size plots at the end of existing trials, with the plots running the length of all bays in the trial and being about 40-60 m long. Sow, treat, harvest and manage with small-plot equipment. Small-plot equipment is lighter than commercial gear, but speed of movement should be similar as there is no need to go slow to provide small-plot by small-plot treatments. This would be more convenient for the co-operator and allow more timely operations. Plots will be large enough to walk through and get a feel for variability of treatment effects. Co-location with small-plot trials will make the demonstration easier to visit, with less time spent moving between sites on crop walk days. It will also be easier and faster to walk through medium size plots to look at variability.
- Use a "nearest neighbour" treatment layout - "control" plot on each side of each treatment plot. This is a simple method of identifying spatial trends and of comparing results for each treatment back to the nearest control. If the issue is a focus for more than one site, then a consistent control and selected other treatments combined with one site-specific treatment (selected by participants and differing from site to site) may allow some statistical analysis if a statistician is involved. The focus would need to be agreed prior to the start of the project based on known needs. This may also allow a e.g. "Regional" Focus booklet to be produced with reports for each site as well as an overview of what happened across the sites.

Summary

Rhizoctonia root rot (*Rhizoctonia solani* Ag8) is difficult to control on Upper Eyre Peninsula. Management options for this fungal disease were applied in a large plot, unreplicated demonstration as part of the Agricultural Innovation and Research Eyre Peninsula (AIR EP) component of the GRDC Soilborne Pathogens project. Aims were to provide a venue for discussion about the identification and management of rhizoctonia root rot while observing disease expression and considering inoculum carry-over at the site.

In 2021, one plot was sown to vetch and the other plots to wheat and barley with and without EverGol® Prime fungicide applied to seed. EverGol® Prime suppresses rhizoctonia root rot and this is characterised by a reduction in root damage, an increase in root growth and an increase in above ground crop biomass. Yield was measured for each plot in 2021 and 2022.

Composite soil samples from the red loam area and the sandy area of the site were taken for PREDICTA® B analysis at the start of 2021 and 2023. A composite soil sample was taken from each soil type in each treatment plot prior to sowing the site to barley in 2022.

In-crop observations of uneven growth in cereal plots (treated and untreated) during early spring in 2021 were consistent with rhizoctonia causing substantial loss of crown roots, but this cannot be confirmed as no root health assessments were made.

No cereal yield responses to the EverGol® Prime seed treatment were seen in 2021. All cereal plots yielded similarly – 2.0 t/ha for bread wheat and 2.7 t/ha for barley. The moisture stress conditions (direct due to low rainfall or induced due to high temperatures) during flowering and grain filling required to induce yield loss did not occur during 2021. As there was little or no moisture stress on the crops, yield improvements due to seed treatment might not have occurred or might have been too small to measure without replication of treatments at the site.

There appeared to be a general decrease in inoculum in cereal plots from the start of 2021 to the start of 2022 for rhizoctonia root rot, take-all and common root rot. Over the whole demonstration period (2021-2023), there appeared to be a general decrease in inoculum or inoculum levels remained low/below detection. Thes findings are likely to be due to either high rainfall over summer (particularly for take-all) and/or to different operators taking samples at the start of 2021 and the start of 2022.

Trends in the results appear to show that EverGol® Prime seed treatment increased rhizoctonia root rot inoculum and decreased inoculum of take-all, crown rot and white grain disorder. These results are unexpected and difficult to explain as the direct effect of EverGol® Prime on rhizoctonia root rot inoculum should be to reduce inoculum and there should not be any direct effect on inoculum of take-all, crown rot or white grain disorder.

Fungicide treatment for rhizoctonia root rot will not last all season, so improved root growth early in the season may have supported greater multiplication of Rhizoctonia during spring resulting in an increase in inoculum at the start of 2022. Improved root growth may have improved plant access to moisture in treated plots so reducing moisture stress during grain filling which could have had an indirect effect on crown rot inoculum by reducing crown rot expression. The apparent treatment effects on inoculum of take-all and white grain disorder are less easy to explain.

EverGol® Prime is not registered for control or suppression of take-all, crown rot or white grain disorder and there are no reports of efficacy of the active ingredient on these diseases. Further investigation might be warranted to determine whether the findings from this demonstration can be

repeated or whether they were due e.g. to chance alone (treatments were not replicated); different people taking samples; underlying trends in inoculum concentrations at the site.

Why do the work?

Where low rainfall, intensive cereal cropping, stubble retention and reduced tillage are combined, stubble and plant root systems can take a long time to break down. This means that soil/stubble-borne diseases such as rhizoctonia root rot, crown rot and take-all can become increasingly difficult to manage. This has been the experience on Upper Eyre Peninsula (UEP) in South Australia, with rhizoctonia root rot being particularly problematic. Where rhizoctonia root rot is present at high risk levels it can cause 20%-50% yield loss.

Despite changes in farming practices that have seen some reduction in this problem, rhizoctonia root rot continues to be difficult to manage on UEP. Sowing early into warm soil has become standard practice, allowing plants to establish quickly with less seedling stunting and death caused by this root disease. Obvious bare patches where plants do not establish or are very stunted are not usually seen any more.

The common symptom now is a general un-evenness in growth and plant height in small to large areas of the paddock – usually most obvious from early tillering on. Uneven crop growth due to rhizoctonia root rot can easily be overlooked or mistaken for unevenness caused by soil variability or other factors.

This means it is important to improve industry capability to identify and to better understand management strategies for this disease at a local level by implementing and monitoring management options in large scale plots.

Agricultural Innovation and Research Eyre Peninsula (AIR EP) decided to investigate management of rhizoctonia root rot (caused by the fungal pathogen *Rhizoctonia solani* Ag8) and, from all the sites recommended by local agronomists, selected the site at Buckleboo for this demonstration.

Aims of the Buckleboo demonstration were to:
- Assess effects of treatments for rhizoctonia root rot management on:
  - Yield in barley and bread wheat
  - Inoculum levels after treatment (using qPCR DNA analysis of soil samples provided by the PREDICTA® B service at the South Australian Research and Development Institute).
- In conjunction with Buckleboo Farm Improvement Group, provide a venue for discussion about:
  - Identification of paddocks at risk from rhizoctonia root rot
  - Management options for UEP – their implementation and effectiveness.

How it was done

Farmer cooperator: Tim Larwood
Location: Buckleboo, Pine paddock
Target: Rhizoctonia root rot (*Rhizoctonia solani* Ag8)
Treatments 2021: 1 x Vetch – non-host break from cereal
2 x Barley (susceptible) - seed treated or not treated for rhizoctonia.
2 x Wheat (less susceptible) - seed treated or not treated for rhizoctonia.
Seed treatment: EverGol® Prime @ 1.3 L/tonne (130 mL/100kg) of seed.
Soil samples 2021: 4 May – taken by Amanda Cook to characterise the demonstration site.
Sown 2021: 3 May – Vetch. 14 May – Barley. 21 May – Wheat.
Soil samples 2022: 21 March taken from each treatment area by Ian Richter.
Sown 2022: 3 May – Barley @ 30 kg/ha with CROPLIFT® 19 @ 90 kg/ha
CROPLIFT® 19 has N 18.8%; P 13%; S 9.4%.
Varieties used: 2021 Vetch = Timok; Bread wheat = Scepter; Barley = Commodus.
2022 Commodus barley over the whole site.
Soil samples 2023: 6 February taken from each treatment area by Amy Wright.

The label states that "EverGol® Prime will suppress rhizoctonia root rot and its symptoms. Suppression of rhizoctonia root rot by EverGol® Prime is characterised by a reduction in root damage, an increase in root growth and an increase in above ground biomass. Early biomass enhancements from disease control are generally higher with seed treatment application compared to in-furrow application, however as the growing season progresses the growth of crops treated with either application method generally becomes comparable."
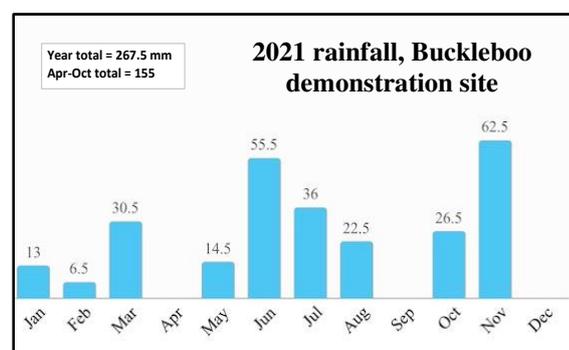
Results and discussion

Treatment effects on crop growth and cereal yields in 2021

In-crop observations of uneven growth in cereal plots (treated and untreated) during early spring in 2021 were consistent with rhizoctonia causing substantial loss of crown roots, but this cannot be confirmed as no root health assessments were made.

No visual improvements in evenness of crop growth or of cereal yield responses were apparent where seed was treated with EverGol® Prime fungicide pre-sowing in 2021. Cereal plots yielded similarly – 2.0 t/ha for bread wheat and 2.7 t/ha for barley.

Moisture stress (direct due to low rainfall or induced due to high temperatures) during flowering and grain filling is required to induce yield loss from crown rot. These types of stresses did not occur during 2021. As there was little or no moisture stress on the crops, yield improvements due to seed treatment might not have occurred or might have been too small to measure without replication of treatments at the site.

Factors affecting interpretation of treatment effects on inoculum

2021 rainfall, Buckleboo demonstration site

Year total = 267.5 mm
Apr-Oct total = 155

2022 rainfall, Buckleboo

Year total = 492.6 mm
Apr-Oct total = 193.6 mm

Sowing date. Good spring rainfall allowed early May sowing of treatments into warm soils in 2021. This means that rhizoctonia root rot expression on roots would have been limited early in the season.

Moisture stress. No September rain would have imposed moisture stress during grain filling (perhaps favouring crown rot), but October rain allowed cereal treatments to yield well.
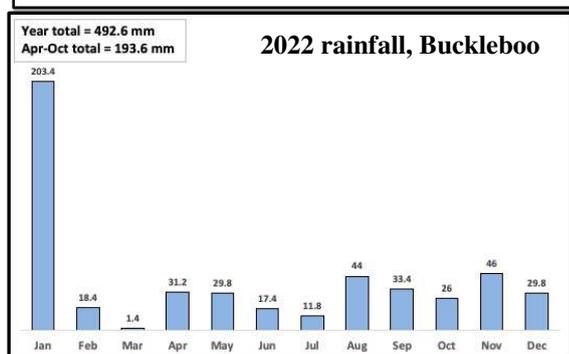
Summer rainfall. Significant summer 2021-2022 rainfall (Nov-Feb = 310 mm) would have reduced inoculum of some diseases (e.g. take-all, crown rot) but made management of summer and autumn weeds difficult. The presence of these weeds may have increased rhizoctonia root rot inoculum prior to soil sampling in 2022, although high summer rainfall usually decreases rhizoctonia root rot inoculum.

Site variability. Pathogen concentrations for each plot at the start of 2021 are not known. This means trends and levels of variability across the site cannot be identified, so interpretation of treatment effects is difficult. Knowing pathogen concentrations pre-treatment for each plot (even if it's after treatments come up) would provide a check for trends and general variability across the plots.

Soil sampling effects. The person taking soil samples can influence results. As different operators took the soil samples each year at the Buckleboo demonstration site, this might have had a direct effect on changes in pathogen concentrations detected across the three years.

Demonstration layout ⇨ North

Wheat Untreated 2022
Wheat Treated 2022
Barley Untreated 2022
Barley Treated 2022
Vetch 2022

Replication. Demonstrations provide a great local opportunity to see and discuss disease identification and management. For simplicity of treatment application with commercial equipment and to keep the size down, demonstration treatments were not replicated. This makes it difficult to tell whether results are due to treatment effects or to chance alone, soil type changes, sampling strategies, background variability of diseases at the site etc.

Weed management. Barley grass was an issue at the Buckleboo site and took over the vetch treatment plot in 2022. To prevent disease build-up on the barley grass roots and an unacceptable increase in the barley grass seed bank, the vetch plot was brown manured (chemically) in mid-September.

Explanation of information in tables

Risk categories			Preliminary risk categories	
Below detection			Below detection	
Low risk			Low level	
Medium risk			Medium level	
High risk			High level	

Numbers in coloured areas in the tables to the left are fungal pathogen DNA concentrations or numbers of nematodes per g of soil sample.

Concentrations are in pg DNA for pathogens with risk categories (and for common root rot and pythium) and in kcopies DNA for pathogens with preliminary risk categories.

Risk categories relate to potential yield loss (as given in the Broadacre Soilborne Disease Manual version 10.4). Actual yield loss will depend on a range of factors, including crop type/variety susceptibility to the disease(s), soil nutrition, soil moisture and seasonal weather conditions.

Treatment effects on inoculum concentrations at the start of 2022

Interpret results carefully, remembering that:
- Normal spatial variability in inoculum concentrations is high.
- There is no replication.
- Underlying trends in inoculum concentrations across the site are not known.
- Different people taking the samples in 2021 and 2022 is likely to have influenced results.
- There were good summer falls of rain after treatment.

Rhizoctonia root rot   **Hosts – winter cereals; grasses**

	Rhizoctonia	
	Loam	Sand
Pretreatment 2021	146	96
Post treatment		
Wheat Untreated	50	9
Wheat Treated	71	47
Barley Untreated	31	29
Barley Treated	75	73
Vetch	23	14

Rhizoctonia root rot was present at medium to high risk levels at the start of 2021 and medium to low levels at the start of 2022. It is probable the decrease over time is a reflection of different people taking samples in 2021 and 2022.

The rhizoctonia root rot pathogen can multiply on secondary roots when the soil dries out and the crop matures toward harvest. This means that treatments (particularly fungicide treatments) may reduce rhizoctonia root rot expression earlier in the season but not decrease inoculum carry-over to the next season. To detect direct treatment effects it would be necessary to assess roots for damage or to soil sample early in the season when the treatment is applied.

Rather than a decrease, there appears to have been some increase in inoculum concentrations and risk levels in the treated compared with the untreated cereal plots at the start of 2022. It is unclear

whether these results are due to chance or to the soil samples being taken the year after treatments were applied. If the findings are real, then it is possible that the seed treatment provided some protection for the secondary roots resulting in a larger root system on which the rhizoctonia root rot pathogen could multiply at the end of the season.

Vetch brown manured generally had lower inoculum concentrations than did the other treatments. This could be a treatment effect as there would have been no secondary roots in the soil late in the season on which the rhizoctonia root rot pathogen could multiply.

Take-all (wheat strain)   Hosts – winter cereals; many grasses

	Take-all	
	Loam	Sand
Pretreatment 2021	48	29
Post treatment		
Wheat Untreated	16	47
Wheat Treated	5	5
Barley Untreated	14	10
Barley Treated	7	7
Vetch	4	5

Take-all was present at medium risk levels at the start of 2021, suggesting it is a significant issue in this paddock.

It is interesting to note that inoculum concentrations and risk levels appear to be less in the treated when compared with untreated cereal plots. This is unexpected and might be due to chance or to the normal spatial variability associated with soilborne diseases. An alternative explanation might be that the seed treatment resulted in healthier root systems making it more difficult for the take-all pathogen to colonise those roots and build up. It is a result that might be useful to follow up with further research.

The vetch treatment has, as might be expected in a one year break from cereal, reduced take-all to below-detection levels. In this demonstration the reduction is unexpected as the vetch treatment was badly infested with barley grass, which is a host for take-all. Brown-manuring the vetch in September combined with good summer rain is likely to have allowed infested barley grass and cereal residues to break down prior to sowing in 2022.

Inoculum concentrations and risk levels decreased between the start of 2021 and the start of 2022 in both cereal (host) and vetch (non-host). This suggests that either there was some inoculum breakdown over summer as a result of good falls of rain or that different people taking samples in 2021 and 2022 influenced results.

Soil type had an inconsistent effect on inoculum concentrations and did not influence risk levels, suggesting the differences in concentrations are due to chance or to normal spatial variability in inoculum concentrations.

Crown rot (*Fusarium pseudograminearum)*   Hosts – winter cereals; many grasses

	Crown rot	
	Loam	Sand
Pretreatment 2021	4,788	1
Post treatment		
Wheat Untreated	17,287	4,600
Wheat Treated	908	0
Barley Untreated	2,242	1,273
Barley Treated	2	248
Vetch	75	3

Crown rot inoculum concentrations varied from below detection to high risk levels at the start of 2021 and 2022.

This variability is typical for crown rot and makes it very difficult to interpret treatment effects in the Buckleboo demonstration.

Further research would be required, but results suggest there were lower inoculum concentrations in treated cereal plots than in untreated plots. Perhaps because primary root systems (the main water gatherers) were less damaged by rhizoctonia root rot in treated cereals so reducing the stress that favours crown rot expression and inoculum build-up. It is

also possible that the last two plots at the site (this includes the treated barley plot) had pre-existing lower inoculum concentrations and that there was no treatment effect.

As might be expected, the brown manured vetch decreased inoculum concentrations and risk levels. The decrease was quite large for a single year of break, but warm soil and high rainfall during November and December 2021 and January 2022 would have promoted breakdown of infested residues.

A soil type effect seems to be present, with the loam generally having higher crown rot inoculum concentrations than those seen on the sand. Possibly due to slightly poorer plant growth occurring on sand, meaning less bulk of infested cereal residues on the sand. As there was no rain during April, perhaps lower soil moisture/humidity on the sand meant later and lower infection rates than on the loam, where moisture retention is better.

Despite the difference in inoculum concentrations between the soil types, both had the same (high) risk level in the untreated cereal plots. When interpreting treatment effects it is important to consider both the changes in inoculum concentrations and the changes in risk levels.

Common root rot

Hosts – broad range, including winter cereals

	Common root rot	
	Loam	Sand
Pretreatment 2021	1,389	6,121
Post treatment		
Wheat Untreated	849	602
Wheat Treated	128	1,753
Barley Untreated	366	1,536
Barley Treated	609	639
Vetch	16	71

Common root rot was present at high levels at the start of 2021 and medium to high levels at the start of 2022. It is probable this decrease is a reflection of different people taking samples in 2021 and 2022.

Vetch (non-host) brown manured to kill barley grass reduced inoculum from high to medium levels in one year – common root rot can survive for at least two years on infested residues. None of the cereal (all hosts) treatments reduced the high level of this pathogen.

Root lesion nematodes (RLN)

Hosts – broad range (includes grain crops, pastures)

	P. neglectus	
	Loam	Sand
Pretreatment 2021	5	4
Post treatment		
Wheat Untreated	9	2
Wheat Treated	4	2
Barley Untreated	4	1
Barley Treated	1	2
Vetch	1	1

Pratylenchus neglectus (the only RLN species present) was at low risk levels in both 2021 and 2022 over the whole site.

Numbers were too low to detect treatment or soil type effects.

Pythium root rot

Hosts – grain crops (cereal, pulse), pastures

	Pythium root rot	
	Loam	Sand
Pretreatment 2021	1	15
Post treatment		
Wheat Untreated	21	11
Wheat Treated	9	14
Barley Untreated	15	13
Barley Treated	18	14
Vetch	11	36

Pythium root rot was generally at low levels in both 2021 and 2022 over the whole site.

Inoculum concentrations were too low to detect treatment or soil type effects.

White grain disorder (WGD)

	White grain	
	Loam	Sand
Pretreatment 2021	3	0
Post treatment		
Wheat Untreated	114	3
Wheat Treated	11	23
Barley Untreated	68	5
Barley Treated	0	0
Vetch	1,098	2

Hosts – winter cereals

E. tritici-australis was the only WGD pathogen at the site.

Inoculum concentrations and levels were low at the start of 2021 and highly variable (below detection to high level) at the start of 2022.

WGD is favoured by good moisture during flowering and grain filling (particularly as the crop moves toward maturity) so good October and November rain in 2021 may have favoured inoculum increases.

WGD inoculum levels were generally higher on the red loam soil than on the lighter (sand) end of plots. Moisture retention on the red loam would have been better than on the sand and this may have contributed to higher WGD inoculum concentrations on the loam.

WGD caused significant issues in 2011/2012 on Upper Eyre Peninsula (UEP). The presence of the causal pathogen at this demonstration site suggests there is potential for WGD to be an issue on UEP in the future if seasonal conditions are conducive.

Yellow spot

	Yellow spot	
	Loam	Sand
Pretreatment 2021	1	2
Post treatment		
Wheat Untreated	0	8
Wheat Treated	8	42
Barley Untreated	0	2
Barley Treated	1	3
Vetch	5	6

Hosts – bread wheat, durum wheat, triticale

Yellow spot was below detection or at low levels in both 2021 and 2022 over the whole site.

Inoculum concentrations were too low to detect treatment or soil type effects.

Charcoal rot

	Charcoal rot	
	Loam	Sand
Pretreatment 2021	6	59
Post treatment		
Wheat Untreated	1	4
Wheat Treated	2	12
Barley Untreated	29	10
Barley Treated	6	15
Vetch	110	1,287

Hosts – broad range

Charcoal rot was at low to medium levels at the start of 2021 and 2022, except after the vetch treatment at the start of 2022, where inoculum was at high levels.

Results were highly variable, indicating there were no treatment or soil type effects on inoculum concentrations, except after vetch. Why inoculum levels were so high after the vetch treatment is unclear.

Blackspot of peas

	Blackspot	
	Loam	Sand
Pretreatment 2021	4	2
Post treatment		
Wheat Untreated	0	0
Wheat Treated	0	0
Barley Untreated	0	0
Barley Treated	0	0
Vetch	0	46

Hosts – pulses, pasture legumes

Blackspot of peas (*Didymella pinodes, Phoma pinodella*) was below detection at the start of 2021 and 2022. The one exception was on the sand end of the vetch treatment and this result is most likely due to chance.

Inoculum concentrations were too low to detect treatment or soil type effects.

Treatment effects on inoculum concentrations at the start of 2023

By the start of 2023, inoculum concentrations for all pathogens had generally decreased in all treatments or stayed at similar levels to those seen in previous years. This finding would have been influenced by higher than normal rainfall over the 2021/2022 summer and by different people taking soil samples over the years. The normal spatial variability of pathogen inoculum and the difficulties of sampling (finding old cereal rows and stubble; deciding which year of row/stubble to sample) have also added to the variability amongst the data. All of these factors (without replication) makes it difficult to interpret the data from this demonstration.

It should be noted that at the start of 2023 there were still significant risk levels for crown rot in plots where barley was sown in 2022. Also that there were medium to high risk levels for take-all and common root rot in a number of the treatment plots.

| | Pathogens of most concern for cereals | | | | Pathogens of lesser or no concern for cereals | | | | | |
	Take-all	Rhizoc-tonia	Crown rot	Common root rot	Yellow spot	Pythium root rot	WGD	P. neglectus	Blackspot	Charcoal rot
Whole area of each treatment plot - 2023										
Wheat Untreated	3	1	0	54	1	9	0	1	0	2
Wheat Treated	142	0	0	195	1	2	0	0	0	3
Barley Untreated	9	1	876	46	2	15	0	1	0	2
Barley Treated	16	0	77	8	0	15	0	1	0	2
Vetch	5	31	1	21	0	1	0	7	0	5
Red loam area of each treatment plot										
2021	48	146	4,788	1,389	1	1	3	5	4	6
2022										
Wheat Untreated	16	50	17,287	849	0	21	114	9	0	1
Wheat Treated	5	71	908	128	8	9	11	4	0	2
Barley Untreated	14	31	2,242	366	0	15	68	4	0	29
Barley Treated	7	75	2	609	1	18	0	1	0	6
Vetch	4	23	75	16	5	11	1,098	1	0	110
Sandy area of each treatment plot										
2021	29	96	1	6,121	2	15	0	4	2	59
2022										
Wheat Untreated	47	9	4,600	602	8	11	3	2	0	4
Wheat Treated	5	47	0	1,753	42	14	23	2	0	12
Barley Untreated	10	29	1,273	1,536	2	13	5	1	0	10
Barley Treated	7	73	248	639	3	14	0	2	0	15
Vetch	5	14	3	71	6	36	2	1	46	1,287

Risk categories		Preliminary risk categories	
Below detection		Below detection	
Low risk		Low level	
Medium risk		Medium level	
High risk		High level	

References

Broadacre Soilborne Disease Manual version 10.4. Technical editors – Alan McKay (SARDI), Allan Mayfield (Allan Mayfield Consulting Pty Ltd), Laura Davies (SARDI), Shawn Rowe (SARDI).

Acknowledgements

APPENDIX I – Pathogens at the Buckleboo site 2021, 2022, 2023

Presence and absence of pathogens at the demonstration site
PREDICTA® B analysis employs 24 tests that detect pathogens causing diseases in broadacre crops. Ten of these tests returned positive and fourteen returned negative results at the Buckleboo demonstration site on Upper Eyre Peninsula, SA, in 2021 and/or 2022 and/or 2023.

Pathogens detected at the Buckleboo site: 7 pathogens that cause disease in cereals (1-7) and 3 pathogens that cause disease in legumes/pulses/oilseeds (8-10) were present:
1. *Fusarium pseudograminearum*   crown rot
2. *Rhizoctonia solani* AG8   rhizoctonia root rot
3. *Gaeumannomyces graminis var. tritici*   take-all wheat strain (Ggt)
4. *Pratylenchus neglectus*   root lesion nematodes (RLN)
5. *Bipolaris sorokiniana*   common root rot (CRR)
6. *Pyrenophora tritici-repentis*   yellow spot
7. *Eutiarosporella tritici-australis*   white grain disorder (WGD)
8. *Pythium* clade f   pythium root rot
9. *Didymella pinodes, Phoma pinodella*   blackspot field peas
10. *Macrophomina phaseolina*   charcoal rot

Pathogens not detected at the Buckleboo site: 10 pathogens causing disease in cereals (1-10) and 4 pathogens causing disease in legumes/pulses/oilseeds (11-14) were below detection:
1. *Heterodera avenae*   cereal cyst nematode (CCN)
2. *Ditylenchus dipsaci*   stem nematode
3. *Gaeumannomyces graminis* var. *avenae*   take-all oat strain (Gga)
4. *Fusarium pseudograminearum* Type 2   crown rot
5. *Fusarium culmorum/graminearum*   crown rot/head blight
6. *Eutiarosporella darliae/pseudodarliae*   white grain disorder (WGD)
7. *Oculimacula yallundae*   true eyespot
8. *Pratylenchus penetrans*   root lesion nematode (RLN)
9. *P. quasitereoides*   root lesion nematode (RLN)
10. *Pratylenchus thornei*   root lesion nematodes (RLN)
11. *Phytophthora medicaginis*   phytophthora root rot
12. *Ascochyta rabiei* (synonym *Phoma rabiei*)   ascochyta blight of chickpeas.
13. *Sclerotinia sclerotiorum*   sclerotinia stem rot (white mould)
14. *Phoma koolunga*   blackspot (ascochyta blight)

APPENDIX II – Summary of PREDICTA® B data and risk categories, 2022

Treatments (including EverGol® Prime to cereal seed for rhizoctonia suppression) were applied in 2021.

Soil samples were taken on 4 May 2021 and on 21 March 2022, with samples being taken by different people at the start of 2021 and 2022.

	Take-all		Rhizoctonia		Crown rot		Common root	
	Loam	Sand	Loam	Sand	Loam	Sand	Loam	Sand
Pretreatment 2021	48	29	146	96	4,788	1	1,389	6,121
Post treatment								
Wheat Untreated	16	47	50	9	17,287	4,600	849	602
Wheat Treated	5	5	71	47	908	0	128	1,753
Barley Untreated	14	10	31	29	2,242	1,273	366	1,536
Barley Treated	7	7	75	73	2	248	609	639
Vetch	4	5	23	14	75	3	16	71

Risk categories		Preliminary risk categories	
Below detection		Below detection	
Low risk		Low level	
Medium risk		Medium level	
High risk		High level	

	Yellow spot		Pythium root rot		White grain		P. neglectus		Blackspot		Charcoal rot	
	Loam	Sand	Loam	Sand	Loam	Sand	Loam	Sand	Loam	Sand	Loam	Sand
Pretreatment 2021	1	2	1	15	3	0	5	4	4	2	6	59
Post treatment												
Wheat Untreated 2022	0	8	21	11	114	3	9	2	0	0	1	4
Wheat Treated 2022	8	42	9	14	11	23	4	2	0	0	2	12
Barley Untreated 2022	0	2	15	13	68	5	4	1	0	0	29	10
Barley Treated 2022	1	3	18	14	0	0	1	2	0	0	6	15
Vetch 2022	5	6	11	36	1,098	2	1	1	0	46	110	1,287

APPENDIX III – Raw PREDICTA® B data, 2022

SampleNo	Notes	Farmer	Paddock	Received Wt	Processed Wt	CCN eggs /g soil	Stem nematode nematodes/100 g soil	Take-all (wheat + oat strains) pgDNA/g Sample*	Gga pgDNA/g Sample*	R. solani AG8 pgDNA/g Sample*	F. pseudograminearum test 1 pgDNA/g Sample*	F. pseudograminearum test 2 pgDNA/g Sample*	F culmorum / graminearum pgDNA/g Sample*
BC70808	Red loam	Larwood	Wheat Un-treated	550	546	0	0	16	0	50	17287	0	0
BC70809	Red loam	Larwood	Wheat Treated	549	542	0	0	5	0	71	908	0	0
BC70810	Red loam	Larwood	Barley Un-treated	549	544	0	0	14	0	31	2242	0	0
BC70811	Red loam	Larwood	Barley Treated	549	540	0	0	7	0	75	2	0	0
BC70812	Red loam	Larwood	Vetch	546	537	0	0	4	0	23	75	0	0
BC70813	Sand	Larwood	Wheat Un-treated	550	549	0	0	47	0	9	4600	0	0
BC70814	Sand	Larwood	Wheat Treated	549	547	0	0	5	0	47	0	0	0
BC70815	Sand	Larwood	Barley Un-treated	549	547	0	0	10	0	29	1273	0	0
BC70816	Sand	Larwood	Barley Treated	550	548	0	0	7	0	73	248	0	0
BC70817	Sand	Larwood	Vetch	548	546	0	0	5	0	14	3	0	0

SampleNo	Notes	Farmer	Paddock	Received Wt	Processed Wt	Pyrenophora tritici-repentis (YLS) kDNA copies/g Sample*	Bipolaris pgDNA/g Sample*	Pythium clade f pgDNA/g Sample*	Eutiarosporella tritici-australis kDNA copies/g Sample*	Eutiarosporella darliae/pseudodarliae kDNA copies/g Sample*	Eyespot kDNA copies/g Sample*	Pratylenchus neglectus nematodes /g soil	Pratylenchus thornei nematodes/g soil
BC70808	Red loam	Larwood	Wheat Un-treated	550	546	0	849	21	114	0	0	9	0
BC70809	Red loam	Larwood	Wheat Treated	549	542	8	128	9	11	0	0	4	0
BC70810	Red loam	Larwood	Barley Un-treated	549	544	0	366	15	68	0	0	4	0
BC70811	Red loam	Larwood	Barley Treated	549	540	1	609	18	0	0	0	1	0
BC70812	Red loam	Larwood	Vetch	546	537	5	16	11	1098	0	0	1	0
BC70813	Sand	Larwood	Wheat Un-treated	550	549	8	602	11	3	0	0	2	0
BC70814	Sand	Larwood	Wheat Treated	549	547	42	1753	14	23	0	0	2	0
BC70815	Sand	Larwood	Barley Un-treated	549	547	2	1536	13	5	0	0	1	0
BC70816	Sand	Larwood	Barley Treated	550	548	3	639	14	0	0	0	2	0
BC70817	Sand	Larwood	Vetch	548	546	6	71	36	2	0	0	1	0

SampleNo	Notes	Farmer	Paddock	Received Wt	Processed Wt	Pratylenchus penetrans nematodes /g soil	Pratylenchus quasitereoides nematodes/g soil	Phytophthora medicaginis kDNA copies/g Sample*	Didymella pinodes/Phoma pinodella pgDNA/g Sample*	Phoma koolunga pgDNA/g Sample*	Macrophomina phaseolina kDNA copies/g Sample*	Phoma rabiei kDNA copies/g Sample*	Sclerotinia sclerotiorum/S. minor kDNA copies/g Sample*
BC70808	Red loam	Larwood	Wheat Un-treated	550	546	0	0	0	0	0	1	0	0
BC70809	Red loam	Larwood	Wheat Treated	549	542	0	0	0	0	0	2	0	0
BC70810	Red loam	Larwood	Barley Un-treated	549	544	0	0	0	0	0	29	0	0
BC70811	Red loam	Larwood	Barley Treated	549	540	0	0	0	0	0	6	0	0
BC70812	Red loam	Larwood	Vetch	546	537	0	0	0	0	0	110	0	0
BC70813	Sand	Larwood	Wheat Un-treated	550	549	0	0	0	0	0	4	0	0
BC70814	Sand	Larwood	Wheat Treated	549	547	0	0	0	0	0	12	0	0
BC70815	Sand	Larwood	Barley Un-treated	549	547	0	0	0	0	0	10	0	0
BC70816	Sand	Larwood	Barley Treated	550	548	0	0	0	0	0	15	0	0
BC70817	Sand	Larwood	Vetch	548	546	0	0	0	46	0	1287	0	0

APPENDIX IV – Raw PREDICTA® B data, 2023

SampleNo	Notes	Farmer	Paddock	Received Wt	Processed Wt	Cereal Cyst Nematode eggs /g soil	Stem nematode nematodes/100 g soil	Take-all (wheat + oat strains) pgDNA/g Sample*	Take-All (Oat race) pgDNA/g Sample*	R. solani AG8 pgDNA/g Sample*	F. pseudograminearum test 1 pgDNA/g Sample*	F. pseudograminearum test 2 pgDNA/g Sample*	F culmorum / graminearum pgDNA/g Sample*
BD68568	Whole treatment area	Larwood	Wheat untreated	1052	510	0	0	3	0	1	0	0	0
BD68569	Whole treatment area	Larwood	Wheat treated	1071	510	0	0	142	0	0	0	0	0
BD68570	Whole treatment area	Larwood	Vetch	977	510	0	0	5	0	31	1	0	0
BD68571	Whole treatment area	Larwood	Barley untreated	853	512	0	0	9	0	1	876	0	0
BD68572	Whole treatment area	Larwood	Barley treated	871	505	0	0	16	0	0	77	0	0

SampleNo	Notes	Farmer	Paddock	Received Wt	Processed Wt	Pyrenophora tritici-repentis (YLS) kDNA copies/g Sample*	Bipolaris pgDNA/g Sample*	Pythium clade F pgDNA/g Sample*	Eutiarosporella tritici-australis kDNA copies/g Sample*	Eutiarosporella darliae/pseudodarliae kDNA copies/g Sample*	Eyespot kDNA copies/g Sample*	Pratylenchus neglectus nematodes /g soil	Pratylenchus thornei nematodes/g soil
BD68568	Whole treatment area	Larwood	Wheat untreated	1052	510	1	54	9	0	0	0	1	0
BD68569	Whole treatment area	Larwood	Wheat treated	1071	510	1	195	2	0	0	0	0	0
BD68570	Whole treatment area	Larwood	Vetch	977	510	0	21	1	0	0	0	7	0
BD68571	Whole treatment area	Larwood	Barley untreated	853	512	2	46	15	0	0	0	1	0
BD68572	Whole treatment area	Larwood	Barley treated	871	505	0	8	15	0	0	0	1	0

SampleNo	Notes	Farmer	Paddock	Received Wt	Processed Wt	Pratylenchus penetrans nematodes /g soil	Pratylenchus quasitereoides nematodes/g soil	Phytophthora medicaginis kDNA copies/g Sample*	Didymella pinodes/Phoma pinodella pgDNA/g Sample*	Phoma koolunga pgDNA/g Sample*	Macrophomina phaseolina kDNA copies/g Sample*	Phoma rabiei kDNA copies/g Sample*	Sclerotinia sclerotiorum/S. minor kDNA copies/g Sample*
BD68568	Whole treatment area	Larwood	Wheat untreated	1052	510	0	0	0	0	0	2	0	0
BD68569	Whole treatment area	Larwood	Wheat treated	1071	510	0	0	0	0	0	3	0	0
BD68570	Whole treatment area	Larwood	Vetch	977	510	0	0	0	0	0	5	0	0
BD68571	Whole treatment area	Larwood	Barley untreated	853	512	0	0	0	0	0	2	0	0
BD68572	Whole treatment area	Larwood	Barley treated	871	505	0	0	0	0	0	2	0	0